Handbooks of Sociology and Social Research

Havidán Rodríguez
William Donner
Joseph E. Trainor *Editors*

Handbook of Disaster Research

Second Edition

Springer

Handbooks of Sociology and Social Research

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We dedicate this book to two of the founding scholars of disaster research and the founding fathers of the Disaster Research Center (DRC) without whom an entire field of inquiry, as well as this book, would have likely never existed—or, at the very least, would likely exist in a form largely absent of the depth, scope, and breadth with which we encounter it today. Their dedication, commitment, contributions, and impact on the field of disaster research has been nothing short of remarkable; they helped set strong and firm foundations for the field. Their contributions will forever shape the landscape of disaster research:

Russell (Russ) R. Dynes
Enrico (Henry) L. Quarantelli

We already miss you Henry.

We also dedicate this book to two outstanding colleagues and friends who are no longer with us, but will forever be remembered:

William (Bill) A. Anderson
Joseph (Joe) Scanlon

Foreword by Senator Thomas Richard Carper

In the decade-and-a-half since the devastating attacks of September 11, 2001, communities across the U.S. have worked to improve their efforts to prepare for, and respond to, crises of all kinds—from cyber and terrorist attacks waged by our enemies, to natural disasters, such as Hurricane Katrina and Hurricane Sandy, to public health epidemics like Zika and Ebola, and the threats we face from climate change.

As former Chairman and, later, Ranking Member of the United States Homeland Security and Governmental Affairs Committee, I worked hand-in-hand with Democratic and Republican colleagues to strengthen federal emergency response through our oversight of the Department of Homeland Security and the Federal Emergency Management Agency. Through our efforts and those of many others, these agencies have improved their approaches to preparedness and response, in part by drawing on the lessons learned from previous disasters.

Ensuring real preparedness, however, requires not only sound management at the federal level, but coordination and cooperation among federal, state, and local governments, as well as among community leaders, emergency responders, health workers, and members of communities themselves. Ensuring real preparedness also requires the participation of experts, such as sociologists, epidemiologists, and public policy practitioners, who can help us understand the impacts of disasters and how best to use our resources to mitigate and prevent damage, as well as loss of life.

Like the first edition, this second edition of the ***Handbook of Disaster Research*** provides an in-depth review of many aspects of disasters, including some that have been less explored in the past. These include research that shines a light on the technological solutions needed to help first responders provide lifesaving assistance, the varying impacts disasters have on different segments of the population, and the important role that innovation in individual communities play in the development of disaster response.

It is often said that an ounce of prevention is worth a pound of cure. Nowhere is that maxim more true than when a community faces unexpected crisis that tests the strength of ties, practices, and principles built up *before* disaster strikes. The research collected in this book underscores the importance of bringing diverse perspectives together to explore the social,

economic, physical and psychological aspects—along with other aspects of disasters—in order to continually inform and improve our preparedness and our response.

Thomas Richard Carper
U.S. Senator
Capt., USN (RET)

Foreword by Russell (Russ) R. Dynes

Disasters have impacted and reshaped the everyday lives of tens of millions of people throughout the world. Some of the most recent devastating disasters (e.g., 9–11, the Indian Ocean Tsunami, Hurricane Katrina, and the meltdown of the Fukushima Dai-Ichi nuclear plant, among others) remind us of the increasing negative consequences of these events for the most vulnerable populations throughout the world. We are also reminded that disasters are socially constructed events that result from the intersection of hazard events combined with societal responses or lack thereof. For over 50 years, disaster researchers throughout the globe, have studied the social, economic, organizational, and political factors that give rise to devastating disasters, as well as the impacts, outcomes, and consequences of such events. During this same time period, the Disaster Research Center (DRC), as well as other disaster research and educational centers in the U.S. and abroad, have established strong foundations that have resulted in a field of study with solid research contributions, which have increased our knowledge and understanding regarding the detrimental impacts and outcomes of disasters.

The first edition of the ***Handbook of Disaster Research*** (co-edited by Havidán Rodríguez, Enrico L. Quarantelli, and Russell R. Dynes, 2006) resulted in a compilation of chapters reflecting some of the most relevant and timely topics in disaster research. The ***Handbook*** highlighted some of the most important issues and themes in the field of disaster studies while also focusing on the increasingly interdisciplinary nature of the field with contributions from research scholars throughout the world. The ***Handbook*** has become an important "must read" in the field of disaster studies, which significantly impacted the dissemination of disaster research both inside and outside the classroom and has become a handy reference book among teachers, scholars, and practitioners, both nationally and globally.

The second edition of the ***Handbook of Disaster Research*** (co-edited by Havidán Rodríguez, Joseph (Joe) Trainor, and William (Bill) Donner) builds and expands on the rich contributions of the first edition, while undergoing significant, important, and very positive changes. While still highlighting some of the key and iconic themes of the 1st Edition, including what is a disaster; morbidity and mortality associated with disasters; gender and disasters; and race, class, ethnicity, and disasters, among others, the second edition also brings to the forefront new and emerging research themes in the field of disaster studies, including climate change; children and disasters;

technological and natech disasters; as well as the news media and disasters, among others. Also, while some of the most important researchers in the disaster field remain as contributors to the second edition, the editors have also included new and emerging scholars who are making significant contributions to this important field of study.

As one of the founding directors of the Disaster Research Center (DRC) and one of the co-editors of the 1st Edition of the ***Handbook of Disaster Research***, I am very pleased and optimistic to see that our field of study has continued to grow and develop. What has emerged over the last decade is a strong and vibrant community that will continue to make significant contributions in substantive, theoretical, and methodological areas that are fundamental to our research and scholarship. Consequently, disaster researchers from a diversity of disciplinary backgrounds will continue to have a significant and positive impact on the growth and development of this field, which continues to contribute to alleviating or mitigating the devastating impacts of disasters on societies throughout the world.

Russell (Russ) R. Dynes
Founding Director, Disaster Research Center,
University of Delaware

Foreword by Dennis E. Wenger

In 2006, Bill Anderson wrote a Foreword to the first edition of the ***Handbook of Disaster Research***, a landmark document that was edited by Havidán Rodríguez, Henry Quarantelli, and Russ Dynes. In addition to their involvement in the original work, Bill and Henry shared a number of research interests, passions, and concerns. One of their most significant concerns was the future of the hazard and disaster research community. They were concerned about producing the next generation of researchers and expanding the existing knowledge base in the field. They were worried that the field might "gray out."

If Bill and Henry were with us today, this second edition of the ***Handbook of Disaster Research*** would quell many of their fears. Building upon the acclaimed 2006 first edition, this revision demonstrates how the field is expanding, increasingly bringing together social scientists, engineers, and physical scientists to examine complex issues inherent in this multidisciplinary topic. Through this updated edition, one can see that the next generation of hazard and disaster researchers is now here—a multidisciplinary community of experts that are building upon the significant contributions of the research community's senior scholars.

Thirteen of the 28 chapters in this volume include revised and updated discussions of previous chapters that incorporate research findings from the past ten years. These thirteen chapters discuss the core building blocks for the hazard and disaster literature over the past three decades. Among these topics are definitions of disaster; race, class, ethnicity and vulnerability; gender and disasters; GIS and technology in disaster management; disaster recovery and resilience; popular culture of disasters; community innovation and disasters; community processes and coordination; sheltering and housing; crisis modeling; and terrorism as hazard and disaster. The authors of these chapters include some of the most lauded researchers in the field.

The remaining 15 chapters include discussions that indicate what have been major trends in research over the past decade. These topics include resiliency and disasters; climate change and disasters; social capital and resilience; computer simulation and optimization; disabilities and vulnerability; population and community displacement; crisis informatics; technological and NATECH research; and children in disasters, among others.

This volume includes exceptional analyses by gifted researchers on the most current issues in the field of hazards and disasters. The collection is

brilliantly edited, and both the research community and practitioners will benefit from it greatly. Although Henry, Russ, and Bill were not a part of the production of this edition, I am certain that they would applaud it and be encouraged about the future of disaster research for the next ten years and beyond.

Dennis E. Wenger
Program Director (Retired), Infrastructure
Managementand Extreme Events,
National Science Foundation

Foreword by Norma Doneghy Anderson

It is my great pleasure to contribute a Foreword to the ***Handbook of Disaster Research***, 2nd Edition. As many of you may know, my husband, Bill Anderson, wrote a Foreword for the 1st Edition, published in 2006. I have been so pleased to realize how many of the hazard and disaster academics and professionals who were a part of Bill's professional network find the Handbook to be a tremendous asset in the classroom and for their own reference.

In reviewing the contributors who are included in this edition, I recognize names that Bill frequently mentioned as making stellar contributions in terms of publications and their ability to reach out to students to bring them along, in effect assuring that the field of hazards and disaster management would continue. The new contributors for this edition also bear witness to the domestic and global growth of this research area.

The inclusion of emerging areas, such as the impacts of disasters on children, the enhancement of disaster recovery using changing and enhanced technologies, and the need for a willingness to collaborate across cultures reinforces how much we all need to participate in addressing the severe societal impacts caused by disasters.

I also have tremendous excitement and anticipation regarding the contributions to the disaster field to be made by the new scholars that are being developed and nurtured through the Bill Anderson Fund. I am confident that they will be major contributors to the field by the time this volume is ready for a third edition. It's my projection that they will bring broadened cultural comprehension and academic scholarship that will enhance the diversity and richness of the field of hazards and disaster research.

Norma Doneghy Anderson
Founder, The William Averette Anderson Fund
for Hazard and Disaster Mitigation
Research & Education,
The Bill Anderson Fund

Acknowledgements

Putting together a book of this nature is a complex, complicated, and time consuming process. However, it is also a very rewarding and gratifying project, especially when it is published! Dozens of individuals have contributed to this volume and their critical work, feedback, and contributions have been indispensable in bringing this book to fruition. First and foremost, we want to recognize, express our most sincere gratitude, and honor the long-term impact and contributions of two of the founding fathers of the disaster field who have been our friends, mentors, and colleagues, Enrico (Henry) L. Quarantelli and Russell (Russ) R. Dynes. Without them, we would not be here; without their contributions, research, and active engagement, the field would definitely not be where it is today; and without their friendship and support, this work would have been much more difficult. Sadly, our dear friend Henry is no longer with us, but his work will live forever in the work of each of us for generations to come. We also want to recognize and acknowledge the contributions of two other dear friends and colleagues who are no longer with us, but who made significant impacts to the disaster research field and the lives of many scholars throughout the world, William (Bill) A. Anderson and Joseph (Joe) Scanlon. We also dedicate this book to them; to honor their legacy; and celebrate their impact on this important field of inquiry.

Many of the authors who are part of this book have also been very fortunate to have received funding for their disaster research work from the National Science Foundation (NSF). Dennis Wenger (NSF Retired Program Director, Infrastructure Management and Extreme Events) was instrumental in ensuring that disaster researchers had competitive access to NSF funds to support their work, which has had a significant impact on the scientific and scholarly contributions of the disaster field and to the creation of new knowledge in this important area of inquiry. We are eternally grateful to Dennis for his ongoing work, commitment, and support, which has impacted several generations of disaster researchers.

As the authors of this Handbook, and certainly the co-editors, will readily acknowledge, this edition of the Handbook would, without a doubt, not be possible without the leadership, active engagement, commitment, and hard work of Antonio Paniagua Guzmán. Antonio has become a “household name” among the contributors of this book. He literally sent hundreds of reminders about drafts, abstracts, bios, due dates, etc. Most, if not all, authors

were relieved when Antonio's email finally indicated "*After reviewing your draft, we are happy to inform you that it is ready to be published in the* ***Handbook of Disaster Research***." As the co-editors of this Handbook, we cannot say enough about Antonio, his diligent work, constant follow-ups, instrumental feedback, and ongoing communication with the authors of this book; his work has been outstanding. Without Antonio's active engagement and constant work in this project, we would not be here today. Antonio: from the co-editors and the authors in this **Handbook**, we say "*muchas gracias*," thank you very much, and congratulations on being admitted to the PhD program in Sociology at the University of Wisconsin-Milwaukee!

We also want to thank the authors of the chapters included in the **Handbook**; we appreciate your patience and understanding and that you took the reviewers' feedback and recommendations (on 2, 3, and even 4 drafts) very seriously. Many of you worked through multiple drafts to reach a final product that will have a significant impact in this field. The Handbook is a much stronger edition, thanks to all your work and ongoing contributions.

We also want to thank our colleagues at Springer for their support and feedback throughout the development of this book, especially Hendrikje Tuerlings and Esther Otten. Also, thanks to John D. DeLamater at the University of Wisconsin-Madison for inviting us to be part (once again) of this very important project. His careful review and constructive feedback and ideas on our original book proposal and the final draft chapters was extremely important. Also, we extend our most sincere gratitude to Pat Young, the Coordinator at DRC's E.L. Quarantelli Resource Collection. Her contributions, in more ways than one, were very important in the development of the Handbook. We also extend our appreciation to Marcela (Marcy) de León and Claudia Dole at the University of Texas Rio Grande Valley (UTRGV) for their administrative help throughout this process, and to Marie Mora, Professor of Economics at UTRGV, for her excellent feedback and insights.

Finally, we want to thank our families that stood by our side as we worked, day-in and day-out, on this important project, not to mention the other teaching, research, and administrative roles in which we are all actively engaged in as part of our professional responsibilities.

Once again, thank you for all your contributions, patience, and hard work. Job well done!

Havidán Rodríguez
William Donner
Joseph E. Trainor

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Editors and Contributors

About the Editors

Havidán Rodríguez is the President of the University at Albany of the State University of New York (SUNY). However, most of his work for this Handbook took place in his previous role as Founding Provost & Executive Vice President for Academic Affairs, and a tenured professor in the Department of Sociology & Anthropology, at the University of Texas Rio Grande Valley. He also served as director of the Disaster Research Center (DRC) at the University of Delaware. He was the principal investigator for the Research Experience for Undergraduates (REU) Program: Training the Next Generation of Disaster Researchers, funded by NSF. Dr. Rodríguez is the co-editor (with Quarantelli and Dynes) of the ***Handbook of Disaster Research*** (2006).

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E.L. (Henry) Quarantelli was one of the founding fathers (along with Russell—Russ—R. Dynes) of the Disaster Research Center. His most recent faculty appointment was in the Department of Sociology and Criminal Justice at the University of Delaware. His contributions and impact in the field of disaster studies have been significant and extensive.

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Laura M. Stough's current research investigates the psychological and social effects of disaster on individuals with disabilities. Dr. Stough serves as the Assistant Director of the Center on Disability and Development at Texas A&M University and is Director of Project REDD or Research and Evaluation on Disability and Disaster, which investigates the effects of disasters on individuals with disabilities and conducts evaluation studies on disaster recovery organizations.

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Dennis E. Wenger Retired from the National Science Foundation (NSF) where he was director of the Infrastructure Management and Extreme Events program. Previously, he served as the director of the Hazard Reduction & Recovery Center at Texas A&M University and co-director of the Disaster Research Center at the University of Delaware. He has undertaken multidisciplinary research on disasters for 50 years.

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Editors' Introduction

Since the "inception" of the disaster research field, disaster scholars have focused their attention on the social and economic impact of hazard events and disasters at the local, regional, national, and international level. Whether studying, among other hazard events, the devastating earthquakes in Haiti, Iran, Italy, Japan or Turkey; the Exxon Valdez oil spill (1989); the Indian Ocean Tsunami (2004); Hurricanes Katrina (2005) and Sandy (2012); 9/11; the Fukushima Prefecture nuclear plant accident (2011); or recent terrorist attacks, disaster researchers have made significant contributions to our understanding of disaster prevention, mitigation, preparedness, response, recovery, and vulnerability. These scholars have provided a comprehensive and holistic approach to disasters that has deeply influenced how policy-makers, emergency managers, and organizations craft risk reduction and management policies. Furthermore, their contributions to substantive, theoretical, and methodological aspects in disaster research and across other disciplines (e.g., sociology, political science, geography, public administration, engineering, etc.) have been significant.

Increasingly in the modern era, dynamic pressures such as population growth, composition, and distribution, as well as income inequality, stratification, and poverty, have exacerbated disaster vulnerability among communities in unprecedented and profound ways. Previous disasters, such as the Indian Ocean Tsunami and Hurricane Katrina, brought to light the differential impacts of disasters on certain communities, particularly those that did not have the necessary resources to cope with and recover from such devastating events. Disasters are socially constructed events that need to be studied from a social science perspective. Nevertheless, an interdisciplinary perspective, which includes other sciences and engineering, is also necessary to capture the deep state of complexity that defines interactions between an increasingly hazardous environment and a rapidly changing society.

The past decade has seen a new awareness of catastrophes that have profoundly reshaped and challenged the field's historical perspectives on the genesis, impact, and consequences of how we organize societies and the risks associated with those decisions. Resulting from a massive earthquake and tsunami, the Fukushima Dai-Ichi nuclear plant accident, stands out as an example of this. This was an event that will have impacts that will reverberate for decades to come. Six years later, its devastating impacts on people's livelihoods, their health and well-being, as well as on the economy, continue to persist. Tens of thousands of individuals and their families lost loved ones, witnessed their communities decimated, saw livelihoods vanish, and watched

as the environment suffered adverse consequences. The same can be said, increasingly and sadly, for other major disaster events throughout the world. Moreover, new technological and "natech" disasters, as well a terrorist events, continue to emerge with significant impacts in terms of the loss of life and its deleterious effects on global communities, taking a disproportionate toll on vulnerable populations, including children. Recent terroristic events, such as the Orlando nightclub shootings (June 2016); the Istanbul "airport attack" (July 2016); the terror attacks in Nice, France (July 2016); the use of nerve gas in Syria (April 2017); the "truck attack" in Amsterdam (April 2017); and the Manchester Arena bombing attack (at the Ariana Grande concert; May, 2017) are constant reminders regarding how these types of events continue to impact societies across the globe and the fear and concerns they generate among different population groups.

It is of critical importance to highlight another series of devastating hazard and human-induced events that transpired as we were finalizing this edition of the Handbook, from hurricanes to earthquakes, to wildfires, to yet another shooting massacre, all of which became the most devastating events of their kind in recent recorded history. For example, within two weeks of each other, during the month of September 2017, Mexico experienced two monumentally powerful earthquakes (7.1 and 8.1 on the Richter Scale), which resulted in the deaths of hundreds of individuals as well as significant destruction of buildings and other critical infrastructure. Combined, these two earthquakes were described as perhaps the costliest "natural" hazard events in recent Mexican history. We should note that the second earthquake struck Mexico (September 19, 2017) on the anniversary of Mexico City's deadliest disaster, the 1985 earthquake (September 19, 1985) that killed more than 10,000 people and destroyed integral parts of the city.

Also around the same time, in late August 2017, Hurricane Harvey emerged as a ferocious Category 4 event on the Saffir-Simpson scale before making landfall near Rockport, Texas. Counteracting pressure systems essentially "trapped" Harvey, resulting in devastating consequences for many cities throughout the Gulf Coast primarily due to unprecedented rainfall (in some cases, 40 to 60 inches of rain) within a few days. The impacts of these events were especially catastrophic for Houston, which was essentially paralyzed for weeks. In the aftermath, Hurricane Harvey resulted in over 80 deaths with an estimated economic impact of over $190 billion in Texas alone, figures that would surpass the economic impact of Hurricane Katrina (The final figures might be higher, as the events were still unfolding as this Handbook went to press).

About two weeks later, Hurricane Irma formed over the Caribbean, reaching the catastrophic Category 5 (with sustained wind speeds of 185 miles per hour, equivalent to an Enhanced Fujita (EF) 4 tornado), and becoming the second most intense hurricane/tropical cyclone in recorded history in the region. However, its ferocious power would be surpassed by Hurricane Maria just a few days later. Hurricane Irma effectively decimated many islands in the Caribbean (many of which have yet to recover as this book went to press); it also impacted Puerto Rico, Haiti, and Cuba, among others, outside of the direct path of the eye of the storm. Moreover, Hurricane Irma made landfall in Florida as a Category 3 hurricane. Hurricane Irma to

date has resulted in over 130 deaths across the Caribbean and Florida, and an estimated economic impact of over $100 billion in Florida alone, not to mention the economic impacts throughout the Caribbean.

Hurricane Maria, which also became a Category 5 Hurricane, followed almost immediately after Hurricane Irma, and completely demolished a number of Caribbean islands, including Dominica, Puerto Rico, and the Virgin Islands, among others. Hurricane Maria became one of the most powerful and most destructive hurricanes on record. In Puerto Rico alone, the number of casualties, as we finalize this section, is thought to be around 50, although some reports expect the death toll to be in the hundreds in light of the humanitarian crisis that escalated from slow recovery and relief efforts. The estimated economic impact ranges from $30 to over $90 billion in an island, which was already confronting the crippling effects of a $74 billion budget deficit, $49 billion in unfunded pensions, and massive net migration to the U.S. mainland.

Described by island residents as a "monster hurricane," Hurricane Maria ranks highest among the most devastating hurricanes in the last 80 years in Puerto Rico. The island's infrastructure was fundamentally destroyed, with 100% of its residents losing electrical power and the overwhelming majority left with no running water, no landline or cellular phone service, and practically no access to gasoline to power the generators (among those "fortunate" few that owned them). As we write this section, over 80% of Puerto Rico residents still do not have electricity in their homes—over one month after Hurricane Maria struck the island—and largely remain without any modern form of communication throughout many sectors of the island. Nearly a third remain without reliable drinking water, and 90% of the public schools remain closed. This catastrophic event will have social, economic, and environmental impacts on Puerto Rico and its inhabitants for decades to come, and it will become known as one of the most destructive and costliest disasters in U.S. history.

Widespread criticism and disappointment continues to follow the U.S. response to Hurricane Maria in Puerto Rico, which, by any standard, has resulted in a prolonged humanitarian crisis on an island that is part of the United States with 3.4 million American citizens (more than in 21 states or DC). Making matters worse, the response, already of questionable adequacy, faces challenges from the sheer scope and devastation of Maria, Puerto Rico's distance to the U.S. mainland, as well as its massive economic debt. Initially, the U.S./federal response was extremely slow. Moreover, much of the disaster relief that arrived to the island sat in ports or in trucks without drivers, and was not being delivered to those most in need. The overwhelming majority of Puerto Ricans on the island, and especially those outside the San Juan area, for days if not weeks after this catastrophic event, not only lacked access to electricity and telecommunications, but also lacked basic survival goods, such as food and water, and adequate healthcare. Puerto Rico is certainly showing all the signs of a full-blown humanitarian crisis. That said, the strong response and support (through disaster relief aid) that is coming to Puerto Rico from many states on the U.S. mainland raises some degree of hope. For example, the States of New York and Florida, among others, have embarked on massive humanitarian responses to provide many

of the emergency goods to island residents in desperate need, which is commendable. However, Hurricane Maria brought to the forefront serious concerns regarding what seemed to be an extremely slow response by federal officials; the lack of adequate and coordinated disaster relief efforts; the social, economic, and healthcare impacts of this event on a highly vulnerable population of U.S. citizens; and the specter of differential treatment due to a lack of adequate and expedient response efforts to an island with 3.4 million inhabitants regularly referred to as "second class" U.S. citizens.

Following these hazard events, in October 2017, the U.S. experienced a shooting massacre in Las Vegas, Nevada, which resulted in 58 fatalities and close to 490 wounded. The Las Vegas shootings have already been called the "deadliest mass shooting" in modern U.S. history, and the third worldwide in recent history. Further, California recently (October 2017) experienced what has been called its "most destructive wildfire." It is estimated that the total costs to the economy as a result of this event will be in the range of about $85 to $100 billion. Moreover, about 40 deaths have been associated with this wildfire with dozens of individuals still missing.

These hazard and human-induced events and catastrophes stand out because they occurred within a relatively short period of time (August–October, 2017) and they were devastating to the communities impacted. Further, these events highlight critical issues regarding disaster mitigation, preparedness, response, recovery, and reconstruction. They also serve to remind us how historical, social, and economic factors impact disaster vulnerability. These events brought to the forefront (as Hurricane Katrina did) how impoverished groups, including traditionally marginalized ethnic/racial minority groups, disproportionately suffer the impacts of these devastating events. Finally, these catastrophic events highlight the critical role that local, state, and federal agencies, as well as elected officials, play in disaster preparedness, response, and recovery. The lack of effective and expedient responses can be construed as a major contributor to the creation, longevity, and severity of humanitarian crises, as clearly demonstrated by the case of Hurricane Maria and Puerto Rico.

As stated by Quarantelli, Boin, and Lagadec in this Handbook, "Disasters and crises are as old as when human beings started to live in groups. Through the centuries, new types have emerged while older ones did not disappear… The newer disasters and crises are additions to older forms; they recombine elements of old threats and new vulnerabilities." One of our goals in this Handbook is to focus on the old, new, and emerging disasters from a social science perspective with a focus on the genesis, impact, and outcomes of such events. The second edition of the ***Handbook of Disaster Research*** focuses on these and a number of other important issues in the field of disaster studies. This edited volume pays specific attention to:

- The growth and development of the field of disaster studies, from a social science/sociological perspective, especially since the 1st Edition was published over 10 years ago (2006);
- The theoretical, methodological, and public policy contributions of the field of disaster studies at the national and international level;

- Lessons learned and best practices that have emerged in the field;
- And, new trajectories and opportunities for social science research in disasters.

A key development of disaster research, as of the last two decades or so, has been its interdisciplinary focus, which has routinely contributed to the development of research teams composed of engineers, geologists, geographers, sociologists, political scientists, urban planners, psychologists, oceanographers, and the list goes on. Similar to the 1st Edition, this 2nd Edition continues to explore interdisciplinary as well as international aspects of disasters.

Given the increasing focus on emerging and cutting-edge disaster research; the growth of interdisciplinary research initiatives; and the expansion of academic programs focusing on disaster research, risk and crisis, climate change, new technologies, homeland security, and emergency management, we anticipate there will be significant demand for a revised ***Handbook of Disaster Research***, and there are increasing expectations and excitement among the disaster research community regarding this 2nd Edition and the topics and research areas it will explore. The 1st Edition of this Handbook was very well received and is being widely used and cited not only in the United States, but throughout the world. The previous edition of the Handbook received extremely favorable reviews, having been described as "*the most important publication of its type during this decade*;" a volume that focuses on "*articulating and unpacking the many social complexities of modern disasters and catastrophes*;" "*a 'must have' for anyone who wants to know the cutting edges of disaster research*;" and "*a valuable reference for social scientists*." Thus, the co-editors (and the authors) are presented with a significant task and a great challenge, but also with excellent opportunities to enhance and strengthen this Handbook; to reflect the significant changes that have occurred in the field during the past decade with a focus on new and emerging disasters; and to introduce innovative and exciting perspectives from new scholars in the field.

We anticipate that the 2nd Edition, with the significant revisions from the 1st Edition, will be extensively used not only by social scientists, but by engineers, geologists and other researchers/scholars, as well as practitioners, students, and policy makers. Given the increased focus on disasters, homeland security, and emergency management, we anticipate that emergency managers, and agencies such as FEMA, NOAA, and Homeland Security will also be important users of this 2nd Edition. As with the 1st Edition of this Handbook, the expectation is that it will be extensively used not only nationally, but at the international level as well, especially by institutions of higher education.

Organization of the Handbook

The co-editors had extensive planning conversations about the 2nd Edition of the ***Handbook of Disaster Research***. Indeed, it may be a misnomer to call this publication a 2nd Edition. Typically, 2nd editions have minor to

moderate changes or "tweaks," but they generally have the same (updated) content relative to previous editions. However, this is certainly not the case for this new version of the **Handbook**, quite the contrary. As shown below, there were significant modifications to this edition relative to the 1st Edition of the Handbook, as follows:

- First of all, we have two new co-editors Joseph (Joe) Trainor from the University of Delaware and the DRC and William (Bill) Donner at the University of Texas Rio Grande Valley. Henry Quarantelli and Russ Dynes (co-editors with Havidán Rodríguez) of the 1st Edition established a strong and excellent foundation for this new edition of the **Handbook**. However, the new co-editors bring new ideas, insights, and research interests that helped shape, expand, and strengthen this new edition.
- We also engaged a large group of authors of the first edition in significant revisions and updates to their chapters, which were also included in this version of the Handbook. Several of the authors significantly edited and restructured their chapters and emerged with almost new chapters. Through a thorough peer-review process, we asked for major revisions of a number of existing chapters that have had significant appeal, as measured by the extensive number of citations since the publication of the 1st Edition. There are also chapters, such as "What is a Disaster;" "Race, Class, and Disaster Vulnerability;" and "Gender and Disasters," among others, that are at the core of our field. These, and other chapters, are foundational readings in the disaster field, which are also included in the revised Handbook, but with significant revisions.
- We added a number of new chapters with emerging themes and important substantive, theoretical or methodological contributions that are generating significant interest in the disaster studies field. For example, the focus on disasters and children, climate change, social media, public health, and computer simulation raise important issues in the disaster studies field that are increasingly relevant to contemporary society and this field. These chapters provide new and innovative approaches to disaster research/scholarship. Some of these chapters also resulted in the inclusion, in this Handbook, of new and emerging scholars in the field of disaster studies.
- We also asked the authors to emphasize the importance of critical research questions and new areas of inquiry for emerging generations of disaster scholars to pursue. Many authors attempted to develop a concrete vision for future research in their corresponding areas addressing some of the following questions, among others. What are some of the critical issues in the disaster field that scholars/researchers should pay particular attention to? What are some of the major research questions that need to be addressed? What research areas do we need to continue to focus on to have a better understanding regarding disasters, their impacts, outcomes, and consequences? How do societies and communities prepare for, respond to, and recover from disaster events?
- Finally, the Handbook was organized around several thematic areas, including Perspectives on Disasters; Contemporary Issues and Disasters;

Inequality, Social Stratification, and Disasters; Methods and Methodological Issues in Disaster Research; Communities in Disaster; Communication and the Mass Media; and From Coordination to Recovery: Managing Disasters. After a careful review of each chapter, the co-editors determined how they would be distributed among these thematic areas. While a number of chapters could have fallen in multiple areas, we made an "executive" decision regarding where they should be located.

The decision on which chapters to include in the final volume of the Handbook was not an easy one. This volume reflects a rigorous process that included many meetings and extensive discussions that appraised the field and its current directions. Further, the proposal we submitted to Springer indicated "*It is important to highlight that the inclusion of the proposed chapters and authors in the final version of this Handbook is subject to substantive revisions of existing chapters by current or new authors; the availability of authors to commit to this work…*" We really did not know nor could we anticipate how this statement would turn into reality until we started the development of this important project. We soon found out (not surprisingly) that the disaster research community is a microcosm of society at large and that emergencies happen, life gets really busy, people get sick, some of our dear and esteemed colleagues are no longer with us, and others experience "disasters" of their own. Consequently, the final version of the 2nd Edition of the Handbook is also a result of the issues and circumstances we all confront as we go about our daily lives.

That said, our goal was to maintain a very high level of scholarship by including prominent researchers in the field while also adding new and rising scholars to provide a good balance of previous, ongoing, and emerging work in the field of disaster research. The authors of the chapters included in this Handbook represent some of the most distinguished scholars in the field of disaster studies. The authors come from very diverse research backgrounds, representing a variety of disciplinary fields, from a broad array of social sciences to engineering, among others. The authors include scholars, researchers, and practitioners from throughout the United States and a number of countries around the world.

Each of the chapters contained herein were extensively reviewed at least twice (some three or four times) by the reviewers. The final list of chapters for the 2nd Edition of the ***Handbook of Disaster Research*** was a result of extensive conversations (e.g., emails and phone calls) and deliberations between the co-editors and ongoing exchanges with the authors. The final outcome reflects some of the past and foundational topics for disaster research; current substantive, methodological or theoretical topics of interest; as well as new and emerging topics in the field. Again, many of the chapters included in this edition have both an interdisciplinary approach and an international focus, with a strong sociological/social science foundation.

We certainly hope and expect that the 2nd Edition of the Handbook will continue to inform the field of disaster studies for years to come; that it will expand our knowledge in this important field of inquiry, but that it will also generate new questions and research ideas; that it will continue to positively impact the growth, development, and expansion of this field and our growing

community; and that it will continue to raise awareness regarding the onset and impact of these events in societies throughout the world, and that, in turn, this can have a significant and positive impact on disaster mitigation, preparedness, response, and recovery.

Havidán Rodríguez
William Donner
Joseph E. Trainor

Part I
Perspectives on Disasters

Defining Disaster: An Evolving Concept

1

Ronald W. Perry

Contents

Definitions of disaster serve many important functions, particularly as an attempt to capture the content and essence of the concept. This is a critical issue for social scientists who must understand and specify the phenomena of disasters as a preface to systematic research that delineates their causes, conditions and consequences. Tracing the evolution of disaster definitions forms a basis for clarifying different sources and categories of definitions—popular, journalistic, applied, mandated, and social scientific. Further, comparing multiple definitions can inform the conceptualization process by illuminating different perspectives on and dimensions of disasters. A definition also allows the delineation of phenomena similar to disasters but that rest in different conceptual arenas. Such clear definition is required if social scientists are to meaningfully aggregate findings to create models and theories of basic disaster-related phenomena. This is a critical issue when social science knowledge forms the basis for recommending public policy and programs.

This chapter traces disaster definitions devised by social scientists, thereby elucidating the evolution of scholarly thinking and the elements of the conceptualization. There is no intent to create an exhaustive inventory, but only to capture the principal approaches to defining disasters. Similarly, the goal in examining definitional content is to grasp intent and meaning; every detail of a given definition may not receive attention. In addition, the emphasis here is upon the definition of the phenomenon itself. Stallings (2005) and Quarantelli (2005, 1989) have each cautioned that definitions should be separated from statements of causes, conditions and consequences of disasters; these are important in a broad theoretical sense but they are not critical definitional constituents. The discussion of definitions requires the identification of apparent consensus across researchers at different times, in spite of the challenges associated with such designations. Consensus is here pronounced subjectively, knowing that ultimately there is no expectation a single definition is possible (Alexander, 2005, p. 38; Quarantelli, 1987a) and that probably it is

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not critical for the persistence and success of disaster research (Oliver-Smith, 1998, p. 177).

Because there are many definitions, from many sources, used for many purposes, it is important to specify what definitions form the content for this chapter. Thus, for this review disaster is a social scientific concept that refers to a particular class of phenomena whose specification rests in theory-based thinking (cf. Perry, 1998). So emergencies and catastrophes are distinct from disasters and not included here (Alexander, 2014, p. 127; Perry & Lindell, 2007; Quarantelli, 2000, p. 68, 2005; Rodriguez, Trainor, & Quarantelli, 2006). Also, research indicates that severe disruptions arising from conflict situations are fundamentally different than those that arise from consensus situations (Peek & Sutton, 2003, Quarantelli, 1993, 2005; Singh-Peterson, Salmon, Baldwin, & Goode, 2015; Waugh, 2006, p. 392). Consistent with these findings, disaster definitions considered here are those that are separate from conflict-based occasions.

Finally, the definitions included herein are those devised by social scientists for theory-based uses. Sometimes, social scientists help to create disaster definitions that are used to identify the phenomenon for particular societal, organizational, institutional or governmental uses. Thus, governments develop "mandated" definitions of disaster for purposes of determining the boundaries of emergency management (such as mitigation, preparedness, response and recovery) and particularly in connection with the distribution of funds and other resources (Buckle, 2005; Britton, 2005). Shaluf, Ahmadun, and Mustapha (2003) described the role of regulatory agencies in defining disasters associated with technology. Also, organizations which provide aid, nongovernmental organizations (NGOs) and private sector organizations establish disaster definitions. Mayner and Arbon (2015) catalogued over 100 mandated definitions in use worldwide and Marre (2013) created a glossary of definitions to guide NGOs navigating multiple agencies simultaneously. These definitions are important, but not included here because they focus largely on setting technical thresholds and this chapter is concerned with definitions created by social scientists in pursuit of disaster research and theory construction.

1.1 Definitions of Disaster

Prince (1920) is generally credited with conducting the first systematic disaster study, although issues of definition and context awaited introduction by Carr (1932). There was real growth during the decade of the 1950s, accelerated by the founding of the Disaster Research Center (DRC) in 1963, with significant increases each decade thereafter, tied roughly to the availability of funding for research and application and to the occurrence of highly visible and destructive disasters (Tierney, Lindell, & Perry, 2001). Amid the increasing inventory of research findings, Drabek (1986) summarized 1,000 empirical studies and Quarantelli (1982, 1987b) began to call for attention to issues of defining disasters. His sustained work has kept the issue visible, produced both special issues of journals and volumes dedicated to the topic (Perry & Quarantelli, 2005; Quarantelli, 1998a) and significantly increased the number of formal definitions from many perspectives to appear in the literature.

Selectivity is an issue in an environment with many definitions, complicated by the fact that publication dates may have limitations as a way of capturing patterns of changing meaning. Indeed, some researchers have used a definition for years before publishing it or simply never published it. Researchers may have adopted a definition from the literature, sometimes making their choice explicit, sometimes not. When the occasion studied falls within broadly accepted social scientific ideas of what constitutes a "disaster", there is a temptation to simply not address the issue of definition. Finally, it is clear that the specific content of disaster definitions vary over time, between researchers and even for the same researcher in different times and contexts. This is appropriate and expected if disaster research is a conducted as a social scientific endeavor; as data accumulate and theories form, both

conceptualization processes and new knowledge produce changes in fundamental definitions.

One remedy to these challenges to cataloguing disaster definitions is to group them by broad era, with simultaneous concern for what might be called paradigm or orientation. While definitions themselves are purposed to identify the phenomenon being characterized (Perry, 2005; Reynolds, 2007), they are typically proposed in a context that elaborates attendant causes and consequences. These elaborations place the definition within a "world view" commonly captured by the concept of paradigm (Johnson, 2008, p. 100). This chapter identifies three traditions or paradigms that grew over time and became foci for disaster definitions: a classic approach with variants, the hazards-disaster tradition and an explicitly socially-focused approach. These paradigms are used only as an organizing feature; analytic creations designed to facilitate discussion. There is no suggestion that researchers self-identify within one of these categories when they engage study design or think of an answer to the question of what constitutes a disaster. It is clear that the "traditions" overlap in time and content and that a different observer may devise different paradigms and place definitions within different categories. They are at best a temporary ordering device and for that purpose they appear practicable.

1.2 Classic Period and Its Evolution

The classic period may be seen as beginning at the end of World War II and closing with the publication of Fritz' definition in 1961. The influence of the thinking and writing in this period on disaster definitions extends into the twenty first century. Three important intellectual and research activities operated early in this period. The WWII bombing studies from Europe (Ikle, 1951) were systematically examined to document both the reaction of the population and patterns of physical damage foreshadowing later databases. In 1951, the National Opinion Research Center (NORC) at the University of Chicago initiated a series of eight disaster studies (mostly airplane crashes, but also fires and an earthquake). Charles Fritz oversaw the NORC studies and the field teams included E.L. Quarantelli. These data formed the first explicitly social science database. The third development was the 1952 formation of the Disaster Research Group at the National Research Council under the auspices of the National Academy of Sciences (NAS-NRC). This group conducted a review of the state of disaster research as well as what has become a classic series of studies (Williams, 1954) thereby codifying and expanding the disaster knowledge base.

Many of these studies left the meaning of disaster implicit. The definitions that did arise mentioned an event as catalyst but focused explicitly on the concomitant failure of the social system to deliver reasonable conditions of life. Minimally, the data from these studies formed the earliest social scientific (as opposed to journalistic or historical) information about human behavior in disasters. It is important to make two observations about this era. First, while the definitions explicitly mentioned an agent as catalyst (hence the use of the term "event"), most really dealt with social disruption. Careful reading of this literature reveals little emphasis upon specific agents underlying disaster except insofar as different agents were linked to differing elements of experience (dimensions) such as speed, duration, magnitude or scope of onset (Perry, 1985, p. 18). The emphasis on the social can be seen in Fritz' (1961b) research on the therapeutic community which he argued arose out of the social disruption itself. Thus it would not be accurate to characterize this era as event centered; events were seen as precipitants with some implications for social disruption. Second, the seeds of emergent norm thinking were planted during this period. This framework was ultimately developed by social psychologists and influenced students of collective behavior (particularly those interested in crowd behavior) and some disaster researchers. It produced the vision of social interactions supported by norms that might be rendered ineffective by disasters, thereby requiring different norms until the environment began to stabilize again. The notion of "return to a

stable state" implied here has long elicited skeptics and been qualified multiple times (cf. Gillespie & Perry, 1974; Luchmann, 2013, pp. 3–6). Stallings' (1998) presentation of "exceptions" and "exception routines" to understand disasters within the social order is a modern adaptation of emergent norm thinking. It is important that emergent norm thinking grew later than the classical era and that the majority of researchers operating at the time discussed disasters within the context of social change perspectives. Research following the social change premise included Anderson's (1969) study of Anchorage following the 1964 Alaska earthquake. The classical era saw a great deal of inductive research (field studies), some deductive research (hypothesis based) and much thinking that spawned subsequent theory and definitional attempts.

In this active research context, three enduring formal definitions of disaster were published. Wallace (1956, p. 1) characterized disasters as "extreme situations" that involve not just impact, but also the threat of "an interruption of normally effective procedures for reducing certain tensions, together with a dramatic increase in tensions." The social readjustment following these interruptions was also cited as part of the definition of the disaster. This early definition highlights threats, not just impacts of agents, while emphasizing the role of the social both during and after the threat or impact. The use of the term "extreme situations" prefaced the later concern that disasters may actually be a sub-category of a larger class of events. At about the same time, Killian (1954, p. 67) proposed that disasters are disruptions of the social order producing physical destruction and death requiring that people cope by departing "from the pattern of norm expectations." Killian here prefaced his later work on emergent norm thinking but also placed social disruption at the forefront. Moore (1958, p. 310), as part of his studies of tornadoes in Texas, felt that disasters make people adopt new behavior patterns as a defining feature, however, he believed "the loss of life is an essential element." These three definitions are remarkably consistent with one another. Each characterizes disaster in terms of the impact or threat of an agent and each has a focus on social disruption. One interpretation is that the disruption or interrupted stability was the "disaster" which had an agent as cause and that later required social readjustments.

Charles Fritz, working for the most part in the same tradition and on many of the same projects as the first three authors, proposed a definition in 1961 (and reiterated it in 1968) designed to capture the sociological notion of disaster. Fritz saw disaster as affecting an entire society or some subdivision and included both threat and actual impact, but emphasized that "essential functions of the society [are] prevented" (1961a, p. 655). This definition doesn't depart radically from the previous ones, but it attempts to be more precise regarding the place of the social. It did specify disaster as an "event" which later critics would argue moved the focus from strictly social, but Fritz explicitly added "time and space" qualifications. Some scholars subsequently contended (Quarantelli, 1984) that these qualifications limited disasters to being rapid onset events, although that implication was already implicit in the other definitions. There was also the requirement that a "society or relatively self-sufficient subdivision" be affected. At the time the definition proposed (and since), little research was directed at disasters affecting an entire society. It appears that the liberal interpretation of "relatively self-sufficient subdivision" allowed disaster researchers to embrace the definition for decades while studying communities and groups smaller than communities.

Fritz' definition was generated from the intellectual context of the major disaster research efforts of the 1950s and the social context of the cold war. The apparent societal and governmental concerns of that time raised awareness about threats of an external attack; to some extent these appear to be reflected in the notion that disasters were both driven by agents and external to a focal society or social group. In retrospect, one advantage of the definition was that it seemed to provide an umbrella for much of the increasing number of studies done by a growing multidisciplinary and international body of disaster researchers (Quarantelli, 1987a). Many

researchers have adopted Fritz' definition verbatim or cited it in their own studies. Examples can be found across decades in Wettenhall's (1975) studies of bush fire disasters, work by Peacock and Bates (1987, p. 292) on social change and disaster, Perry's study of a nuclear power plant accident (1985), the review of flood studies by Perry and Lindell (1997) and Lowendahl's (2013, p. 11) cross national studies of natural disasters.

The Fritz definition has been used by many researchers who embrace the basic tenets of the definition while introducing slight variations to better fit contemporary research understandings. Sjoberg (1962, p. 357) characterized disaster as a "severe, relatively sudden, and frequently unexpected disruption" of a social system resulting from some precipitating event that is not subject to societal control. Thus, Sjoberg introduces the notions that the precipitating event is sudden onset, external to the system and not subject to control. This approach links disasters to the state of technology that might define human control, but over time, all types of disaster have come to be seen as arising from human causes (cf. Mileti, 1999; Tierney, 2014). Cisin and Clark (1962, p. 30) dropped some of Fritz' qualifiers, saying a disaster is any event that "seriously disrupts normal activities." In elaboration, these authors added the explicit qualifier that the disaster also may result from a threat that does not materialize. Turner (1978, p. 83) embraced part of the Fritz definition, but emphasized that there must be a collapse of social structural arrangements previously "culturally accepted as adequate;" this moves away from judging whether pre-disaster conditions were either "normal" or "fair" (cf. Donner & Rodriguez, 2008, p. 1092). Drabek (1986, p. 7) adopted Fritz' definition but included the provision that "disasters are accidental or uncontrollable events, actual or threatened." Moving into the 21st century, Buckle (2005:179) extended the definition by emphasizing the magnitude of social disruption, saying there is a sense of significant, irreversible loss and damage, requiring "the need of long term recovery." Similarly, Smith (2005:301) proposed that disasters are events that produce death and damage and cause "considerable social, political and economic disruptions." Fischer re-emphasized part of the classical era that appeared to be declining in visibility by adding that what sociologists really study is social change in connection with disasters (2003:95). Drabek and McEntire (2003, pp. 98–99) clarified the idea that the social order returns to "normalcy" after disasters, arguing that during and after the disaster operating norms shift to modified or novel forms in the short-term (therapeutic community, emergent organizations) and later "regularize" or stabilize, not necessarily reproducing pre-disaster states. Other researchers have also made additions to accommodate variance from the original definition. Thus, changes crept into the Fritz definition, introduced by researchers who largely embraced what they believed was Fritz' original meaning, but who sought to add theoretical clarity or update for changes in the extant body of knowledge.

As one traces the definition proposed by Fritz into contemporary disaster research, it appears that many researchers have come to share a focus on the social order as a key defining feature. While the authors cited below may or may not see themselves as operating in a "classical era" context, their definitions do reflect a concern with many of the key defining features mentioned by Fritz. Like Fritz, however, each places explicit emphasis upon disasters and social process or change. Perhaps Kreps (1998, p. 34) remains closest to Fritz when he defines disasters as "non-routine events" that create social disruption and physical damage. In elaborating his definition, he focuses upon four key defining properties – forewarning, magnitude of impact, scope of impact, and duration of impact. Robert Stallings created a picture of disasters that firmly placed them within a context of classical social theory, while at the same time emphasizing the notions of disruption and change. Stallings (1998, p. 136) examines routines, exceptions and exception routines: the social order is seen as routinized and "disasters are fundamentally disruptions of routines." Stallings also acknowledges that disasters are only one kind of occasion that interrupts routines in social life. Later,

Stallings (2005, p. 263) defined disaster as "a social situation" precipitated by non-routine destruction by forces of nature. Stallings was writing in the context of natural disasters and undoubtedly did not intend to limit disasters to agents of the natural environment. Stallings work is important both for its extension of Fritz' definition (placing disaster within the social order) but for allowing that disruption may be associated with situations that are not disasters. Porfiriev (1998, p. 1) also sees disaster as the destabilization of the social system, indicated by a failure of normal functioning that requires an intervention to reinstate stability. Again, one sees an emphasis upon disaster as transition or change that involves vulnerability and requires different patterns of social intercourse.

The spirit embodied in Fritz' definition is certainly reflected in these definitions and others, especially those that retain an agent or "event" perspective. However, few would completely embrace the classical definition any longer. While the influence of the classical era is present in many features of contemporary disaster research, we have moved from the original conception to a perspective that expands the phenomena that are studied as disasters. Also, a critical point of difference is that the early classical era saw disaster causes as outside human control and often external to the focal social system (Dynes & Drabek, 1994, p. 12). Most researchers currently acknowledge that all disasters ultimately arise from human agency and are thereby vested in the social system. Also, among the definitions sampled here, there is a progressively stronger emphasis (in the definition or in each author's elaborations) upon the social; on process, adaptation and change. These notions were more implicit in the approach taken by Fritz (Quaranatelli, 1998b). Indeed, the extent of emphasis is sufficient to later discuss a separate category of definitions and group them as characterizing disasters as "social phenomena."

1.3 The Hazards-Disaster Tradition

The study of natural hazards involves many disciplines but principally geography and other geophysical disciplines. One focus is upon understanding the hazard processes that produce earthquakes, tornadoes, floods, volcanic eruptions and similar events. Another focus is natural disaster but within the context of the processes associated with the hazard. This is a holistic approach sometimes seen in the context of another endeavor such as resource management (Burton & Kates, 1964). Natural hazards perspectives have early and enduring links to human ecology (Barrows, 1923; Burton, Kates, & White, 1968; Kates, 1971). The classic statement of the hazards approach is found in the work of Burton, Kates, and White (1978). Within this context generally, a disaster is viewed as an extreme event that arises when a hazard agent intersects with a human use system. Consequently, disasters take place as part of normal environmental processes and those processes are important for study. For example, when an earthquake occurs, it is a disaster if it affects humans, but it arises from patterns of seismic activity whether people are affected or not. At least in early formulations, the cause of a disaster is the extreme event and understanding disaster rests upon understanding the larger process (engaging both social science and natural science perspectives). The macroscopic view of hazards researchers contrasts with the more narrow focus on disaster events found in many of the classical era definitions. Quarantelli (2005, p. 342) argued that when hazard cycles and agents are the focus, disasters become an epiphenomenon rather than a central target for definition and explanation. It is equally true, however, that "a disaster is but a moment or materialization of [important] underlying conditions" (Birkmann et al., 2014, p. 4). Gaillard (2016) has pointed out that each of the disciplines where disasters are studied—

sociology, geography, psychology, anthropology and others—can be expected to reflect disciplinary interests in developing definitions. It is clear, too, that research from each perspective has contributed significantly to the body of knowledge associated with disasters.

Oliver (1980, p. 3) defined disaster as a part of the environmental process, but as a phenomenon that occurs when human systems intersect with the hazard creating major "human hardship with significant damage." The critical issue of a cyclic environmental process is present here, with the notion of serious social disruption and physical damage. Susman, Okeefe, and Wisner (1983, p. 264) are closer to the traditional geographers view when they define disaster as "the interface between an extreme physical event and a vulnerable human population." Hewitt (1998, p. 77) elaborates disaster as events where "physical agents define the problem." In 1983 he argued that disasters may be seen as unexpected and unprecedented impacts that "derive from natural processes of events" (Hewitt, 1983, p. 10). Peek and Mileti (2002, p. 512) see disasters produced when extreme events in the natural environment "interact [with] the natural, social and constructed environments." Paton and McClure (2013, p. 4) also view disasters arising from interactions between human use systems and natural processes that produce significant negative impacts for people and the built environment. However, these scholars include among consequences those that damage systems that support human life (agriculture, infrastructure, etc.). The logic for this is that such damage may affect human systems even if they are distant or otherwise protected. Each of these definitions highlights the traditional concern of hazards researchers with the cycle of hazard agents and the consequences when human systems intersect them. While the principal thrust of hazards perspectives dealt with hazards from natural processes, it is possible to use a hazards view when the nature of the underlying threat is human-generated by specifying the underlying force or process.

Consistent with a macroscopic emphasis, some hazards researchers have adopted an explicit focus on the nature of consequences and upon social vulnerability. Alexander (1993, p. 4) pointed out that natural disasters can be thought of as quick onset events with significant impacts on the "natural environment upon the socio-economic system." In later writing, he elaborated this by saying that disasters are not defined by fixed events "but by social constructs and these are liable to change" (Alexander, 2005, p. 29). Alexander is stressing that the disaster is not just the event arising from intersection of human and natural systems, but the social consequences (which are ever changing and variable across groups) of the event. Mileti (1999, p. 3) also warrants that disasters flow from overlaps of the physical, built and social environments, but that they are "social in nature." Mileti emphasizes that humans can be seen as creating disasters through their encroachment on the physical environment. Although he still places the origins of disasters in a hazard context, Mileti is explicit about the social emphasis when studying the events. Wisner, Gaillard, and Kelman (2012, p. 30) define a disaster as "a situation involving a natural hazard which has consequences in terms of damage, livelihoods, economic disruption and/or casualties" that outstrip local capacity to cope. The authors cautioned that they did not mean to eliminate events in small isolated towns, which may not have the option to seek resources from outside. Firmly in a vulnerability context, Cutter (2005, p. 39) argued that the issue is not disasters as events but instead human "vulnerability (and resiliency) to environmental threats and extreme events."

Each of these definitions moves toward an emphasis upon social contexts to varying degrees. Certainly hazards approaches have a longstanding interest in consequences and vulnerability (Quarantelli, 1998b), but definitions from this perspective have increasingly included social disruption as at least one defining feature of the disaster. To the extent that hazards researchers are moving in this direction, they are converging with sociological researchers to place people and social relationships at the core of disaster study.

1.4 Disasters as a Social Phenomenon

Relatively recently, many scholars have incorporated more aspects of social relations as defining characteristics of disasters and moved away from conceptions that are largely agent-based or that depend heavily upon notions of physical destruction. Physical damage is still cited as a correlate of the magnitude of the disruption that defines the disaster, but not as a primary defining feature. This trend includes those who may generally use classical era thinking in their formulations as well as those who approach from a hazards perspective. While Drabek (2013) has often included the essentials of Fritz' definition into his own writing, he has consistently specified that disasters are found in the social disruption rather than the agent. As Quarantelli (2005, p. 345) indicates, this emphasis reinforces the traditional notion that in defining and studying disasters, one should look first at social systems, since they (not the agent) are the real locus of disruption and vulnerability. The definition of disaster as social phenomena is evidenced when scholars place disaster in social systems and relationships and (not necessarily as definitional elements) seek its sources in human agency and vulnerability. The vision of disasters as social phenomena has roots in classical era definitions, those of hazards researchers and those from scholars working with macroscopic perspectives such as human ecology, social change and anthropologists who place disasters within social and cultural parameters. Although assigned here to the later evolution of the classic era, the definitions offered by Kreps (1998), Stallings (1998), and Porfiriev (1998) are transitional into the social phenomena classification. Each definition is distinct in emphasis upon social phenomena, attention to vulnerability as socially constructed, and the idea of social change; all to the near exclusion of physical agents. Barton (1989, p. 348) expressed concern that sociologists need to define disaster more firmly in social terms and place less emphasis on agents. Erikson (1976, p. 254) gave voice to this view early, when he contended that "are socially defined as having reached one or more acute stages."

E.L. Quarantelli's career spans the classical era through the present and has always included social in the definition of disaster, but has moved to a largely social position. Quarantelli (2000, p. 682) identifies defining features as: (1) sudden onset occasions, (2) serious disruptions of the routines of collective units, (3) evidenced in the adoption of unplanned courses of action to adjust to the disruption, (4) with unexpected life histories designated in social space and time, and (5) posing danger to valued social objects. Subsequently, he emphasized that disasters interact with vulnerability, reflecting "weaknesses in social structures or social systems" (Quarantelli, 2005, p. 345). In this evolving characterization, Quarantelli emphasizes neither an event nor a physical place or time as necessarily relevant to disasters.

While social phenomena definitions may explicitly or implicitly mention an agent, they share the distinction of making the key defining features of disaster rest in the social, often asserting that vulnerability (or danger) might be modified through social change processes. Clausen (1992, p. 182) emphasized the latter, arguing that disasters flow from normal social change even though their consequences are negative and their frequency rare. The reference to normality underscores the point that vulnerability lies within the social structure itself and is a regular part of human intercourse. Similarly, Gilbert (1998, p. 13) argues that "disasters are not a function of agents, but are social in origin;" like Mileti and Tierney later, he saw disaster as stemming from human agency. Wisner, Kelman, and Gailliard (2014, p. 16) point out that disasters are inherently social and that their occurrence both creates an opportunity for change simultaneously introducing stimulation for change. Rosenthal (1998, p. 226) discusses disaster as a socially defined occasion, related to social change that is "recognized across social time as a radical change" in the normative environment. The reference to social time particularly sets this definition apart.

Social change has long been associated with disaster definitions posed by sociologists but it is

not necessarily a sole defining characteristic of the social phenomena category. Dynes (1998, p. 13) defines disaster as occasions when norms fail, causing a community to engage in extraordinary efforts "to protect and benefit some social resource." Rodriguez and Barnshaw (2006, p. 222) see disaster as "human induced, socially constructed events that are part of the social processes that characterize societies." Carter (2008, p. 9) emphasized that disasters strike "with such severity that the affected community has to respond by taking exceptional measures." McEntire (2015, p. 3) defines disaster in relationship to underlying hazards but underscores that they are significant disruptive social events that require changes in routine behaviors. Mayner and Arbon (2015, p. 24) find disaster in altered social patterns arising from severe disruption and damage to the community. Pescaroli and Alexander (2015, p. 5) view disaster as situations that "generate a sequence of events in human subsystems that result in physical, social and economic disruption" and contend that levels of vulnerability determine the magnitude of the disruption.

Researchers interested in cross-national or cross-cultural aspects of disasters have long focused upon social systems to understand disasters. For example, Bates and Peacock (1993, p. 13) characterize disasters as a social event arising from "a process that involves a sociocultural system's failure" to protect its population from external or internal vulnerability. The event notion is present in the definition, but for these authors, disasters are social phenomena that have roots in the social structure itself. In his study of West African disasters, Ait-Chellouche (2015, p. 423) characterizes disaster as "serious disruption of the functioning of the community following widespread human, material, economic or environmental losses."

Jigyasu (2005) bases disasters exclusively in social systems, and he draws upon human interactions and the cognition that drives them for part of his definition. Conversely, for Horlick-Jones (1995, p. 311), "disasters are disruptions in cultural expectations" that result in the perception that institutions can't keep threats in check. He points out that disruptions stem from the ways in which society deals with vulnerability. Similarly, Dombrowsky (1998, 2005) proposes that disaster is the collapse of cultural protections—captured in habits, folkways, laws or policies—that either deflect or fail to deflect the threatening forces to which societies are exposed. For Dombrowsky, the disaster is social; it is engendered in social structure and can only be examined via that route. Anthropologist Anthony Oliver-Smith (1998; Oliver-Smith & Hoffman, 2002, p. 4) sees disaster as occurring when a destructive agent overlaps with a vulnerable population disrupting "social needs for physical survival, social order and meaning." Hewitt (2016, p. 8) similarly believes that the key features of disaster arise from the "disruption of a significant part of society's productive activity and administrative functions." For Hewitt, these are key drivers of social systems. Finally, Boin (2005, p. 159) believes that disasters flow from the normal functioning of social systems that take place when the "life sustaining functions of the system break down." Boin (like Barton, Quarantelli, Kreps and Stallings) argues that disasters are a subclass of a larger class. Barton called the larger class collective stress situations, while Boin (like Quarantelli and Rosenthal) uses the label crisis. For Boin, disasters are rooted in social structure and changes that cause disruption (a chapter by Boin, further elaborating crises, appears in this *Handbook*).

Although interdisciplinary in their training and international in origin, these authors share a conception of disaster that places it firmly in society and social relations. Disaster is social disruption that originates in the interruption of the social system and social relations. The preponderance of scholars who proposed social definitions elaborated disaster in the context of social change. Lovekamp and Arlikatti (2013, p. 468) have presented an articulate discussion of mechanisms that arise from disasters to create opportunities for change in many aspects of social systems, including opportunities for traditionally marginalized groups. Of course, changes implemented are not necessarily in the direction of reduced risk. Wisner, Blaikie,

Cannon, and Davis (2004, p. 32) found that both pre and post-disaster changes may enhance or retard vulnerability. Chakraborty, Collins, Montgomery, and Grineski (2014) argue that in the absence of apparent changes, those vulnerable and affected by a disaster at one time will become more vulnerable to future disasters.

1.5 Human Ecology, Vulnerability and Resilience

The perspective afforded by human ecology and the concepts of vulnerability and resilience have become ubiquitous in the contemporary disaster literature. It is important to point out that the content of theory-based definitions of disaster may be connected to ecological thinking only in a general fashion. There are no unique "ecological definitions" although a reader can surely identify definitions that may be argued to be more or less macro in scope. Similarly, vulnerability and resilience are concepts related to causes, conditions or consequences of disasters (Quarantelli, Lagadec, & Boin, 2006); they do not directly define disasters. The role that ecological thinking, vulnerability and resilience might play in disaster definitions is not as defining features, but as influences on the design of research addressing disasters. As noted below, there have been studies and theorizing that attempt to establish vulnerability and resilience as causes or effects of disasters. As such, each notion merits brief mention here.

The human ecology literature is classic, with roots in plant ecology and a significant presence in many social sciences (Park, 1915; Hawley, 1944, 1950), as well as being a framework used by scholars from the very beginning of disaster studies. Human ecology is an area of study and a framework for thinking about human societies and communities (Bates & Pelanda, 1994; Gaillard, 2016; Peacock & Ragsdale, 1997). Faupel (1987, p. 182) is one of only a few who used human ecology as an integrative perspective specifically for understanding human disaster behavior in the context of the community (broadly defined). He argued that the environment plays a role in shaping social processes which subsequently can produce disasters. The principal impact of a human ecological perspective on formulating disaster definitions is that such scholars tend to use more macroscopic thinking and place the disruption that defines disaster in a broader community context, rarely relying on a single physical agent as a primary defining feature (Oliver-Smith, 1996). Consequently, one finds the influence of ecological perspectives across classic, hazards type and social phenomena based definitions. Certainly in the contemporary disaster literature one sees social phenomena definitions in a position of prominent use and (whether so labeled or not) underpinned by macroscopic thinking.

Boin, Comfort, and Demchak (2010) contend that vulnerability and resilience have achieved the status of fashionable buzzwords, appearing not just in technical literatures but also in popular discourse about politics, sports and everyday pastimes. Gaillard (2010, p. 219) points out that each term began prominently appearing in the disaster literature in the 1970s—vulnerability first (O'Keefe, Westgate, & Wisner, 1976), and resilience later (Torry, 1979). After it was introduced, each concept frequently appeared in research and theory, particularly among scholars using hazards type perspectives (cf. Singh-Peterson et al., 2015, p. 756) and in anthropology. Both concepts have been widely employed by sociologists, especially those embracing ecological perspectives or interested in social change (cf. Donner & Rodriguez, 2008, p. 1091). In fact, both vulnerability and resilience have a generic quality (similar to "systems theory") and have been used across many different disciplines, sciences, and applications for decades, if not centuries.

The idea if not the term, vulnerability, is present in most historical and contemporary discussions of disaster. A few have explicitly used the term in their disaster definition. Wamsler (2014, p. 4) says that disasters arise when there is an interaction between "hazards and vulnerable conditions." Bradshaw (2014, p. 34) believes disaster exists when "an individual or group is vulnerable to the impact of a natural or

human-made hazard." Each of these definitions actually keeps the disruption that is the disaster implicit while highlighting the conditions that create it. Most scholars, however, see vulnerability as a cause, condition or consequence of disasters, or correlated with magnitude of disruption, but not as a feature of the definition itself (Konukcu, Mentese, & Kilic, 2015, p. 14). Blaikie, Cannon, Davis, & Wisner (1994) produced what is widely seen as the classic statement of the relationship between human vulnerability and disasters. Alexander (2016, pp. 2–3) argues that vulnerability is a critical concept for future research and practice, emphasizing that attention must be given both to clarifying the conceptual relationship of vulnerability to disaster, and to understanding the critical dimensions of vulnerability itself (as a distinct concept). Lindell (2013, pp. 11–12) also presents this critique, noting that the conventional definition of vulnerability is conceptually and operationally ambiguous and that there is a need to identify which variables are indicators of vulnerability, which are proximal and distal causes, and which are simply correlates of vulnerability. Indeed, many of the challenges posed by vulnerability—as well as resilience—arise from the need to specifically adapt it disaster research and theory. Aguirre (2007, p. 41) began the process of clarifying the relationships among the concepts of disaster, vulnerability and resilience and suggests that much scrutiny by the body of scholars is required to meaningfully integrate either concept into the dialog about disasters.

Zakour and Gillespie (2013, p. 73) argue that disaster resilience is a logical extension of and complement to the concept of vulnerability; resilience captures the capacity to reduce the effects of disasters through many possible mechanisms or conditions. Disaster researchers have found resilience a useful concept but continue to seek clarity and consensus on issues of meaning and conditions (Aguirre, 2006). Both Hayward (2013) and Aldunce, Beilin, John Handmer, and Howden (2014, p. 252) seek basic meaning consensus in the face of many apparently different definitions and especially explication of the notion of "bouncing back from disasters." Paton (2006, p. 305) sought to integrate a wide variety of perspectives on resilience (individual, community, institutional and environmental) and Berkes and Ross (2013) recently tried to find "common ground" between approaches based in social-ecological systems and those centered in the psychology of individuals. But there remain issues to be resolved for applications at the community level of analysis (Barrios, 2014), for ways to measure resilience (Cutter, Ash, & Emrich, 2014) and for the relationship of resilience to public policy, especially disaster risk reduction (Amundsen, 2012). At the most basic level, Cutter (2016) points out that while resilience and vulnerability are related, there is a need to specify not just the conceptual particulars of each concept but also the nuanced relationship between them.

Resilience may arise in disaster definition elaborations to the extent that it is conceptually seen as a modifier of vulnerability or in the applied arena to the extent that resilience can be defined, learned, and implemented across disasters and communities (Leykin, Lahad, Cohen, Goldberg, & Aharonson-Daniel, 2016). Resilience has not been used as an element of disaster definitions themselves to date, probably because the thrust of the concept appears to be more as either a reaction to disasters (after the disruption) or as features of the unit of analysis (ecologically the community) that modify the magnitude of subsequent disasters (thereby before the focal disruption). Intuitively, the disruption that most agree forms a defining characteristic of disasters could certainly be affected by the presence of resilience. The observation remains, however, that systematic use of the concept must await further conceptualization that elucidates the definition and elements of resilience and its relationship to other concepts such as vulnerability, as well as empirical verification of the proposed relationships (Klein, Nichols, & Thomalla, 2003, p. 41).

1.6 Consensus Regarding Disaster Definition

A reasonable reviewer would not expect to find significant homogeneous content among a great number of definitions, devised at many different times by researchers from many different disciplines. Indeed, the degree of consensus seen depends both upon the observer and upon the level of specificity demanded to define consensus. However, with the qualification that definitions focus on the phenomenon itself and not accounting for views about causes or consequences, the past decade has seen increasing agreement among researchers about important features of disasters. Even historically, particularly within the three artificially constructed "families" of definitions used here as an organizing devise, there exists more than a small degree of congruence regarding the meaning of disaster. There are clear differences between disciplines especially regarding focus, but one expects some difference flowing from the different domains of disciplines. This a positive condition since much of the richness and fecundity of research, models and theory-work about disasters arises from cross- and inter-disciplinary involvement. Of course, discussion and debate stimulate the interplay between (abstract) concepts and (concrete) research findings thereby forming a fundamental part of metatheory and hence the process of science (Perry, 2005, p. 323). There is great variation with respect to the theory context in which definers place disaster and considerable variation among scholars with respect to how many defining features are assigned to the term.

There is significant contemporary consensus that all disasters have origins in human volition; sometimes in complex ways, many factors under human control are characterized as the ultimate cause of disasters. There is also growing consensus about what might be called the minimum defining features of disasters. Nearly two decades past, Quarantelli (2000, p. 682) reported that a consensus definition could be stated as: disasters are "relatively sudden occasions when… the routines of collective social units are seriously disrupted and when unplanned courses of action" must be undertaken to cope. Most contemporary researchers would only find small issue with this composite definition. Quarantelli (2005, p. 339) later stressed that disaster must be understood as an inherently social phenomenon. Again, many contemporary researchers agree that the disaster is the fundamental disruption in the social system (of whatever size) that renders ineffective whatever patterns of social intercourse prevail. This characterization does not judge the equity or normalcy of the patterns of social intercourse prior to or after the disaster, although it is acknowledged that some researchers believe that social inequity is the root cause of all disasters (cf. Donner & Rodriguez, 2008). Those who study emergent phenomena also point out that sometimes new, but definitely different, patterns of social intercourse (perhaps reflected even in formation of informal groups) will arise (for the short or long term) as a function of the disaster. Some researchers refer to the changed patterns as a "coping" response to the disaster disruption. This view can be interpreted as a phase-type vision that has original patterns followed by alternate patterns which are presumably followed by more regularized patterns. While some remain comfortable with this interpretation, other researchers are not; expressing concern that phases are not necessarily distinct in time and that their specification invites difficult to defend labels such as "normal." An alternate approach common in the literature identifies the disruption of social intercourse and acknowledges that alternate patterns arise within this context and over time some may disappear, while some may persist. The latter approach keeps the focus on social disruption without partition and embraces the notion that the patterned interactions observed during and after a disaster are likely to be different than the patterns observed before the disaster (whether the patterns carry functionalist labels or not).

The review of definitions also revealed several issues lacking wide consensus and that are under scrutiny or at least left unresolved. One is the role of a hazard agent and how physical damage should be considered in disaster definitions. For

many years it has been contended that agents don't define disasters, social disruption defines disasters. In part, the agent focus lead to the development of pseudo-typologies that attempt to describe or group disasters into various categories such as natural, man-made, public health, creeping, hybrid or by any other surface characteristic (Shaluf, 2007, p. 687). These are principally agent descriptions that fail to meet the basic definition of a typology, namely that it is theory-based (underlain by taxonomic thinking) and composed of a collection of classifications (categories) that are mutually exclusive and collectively exhaustive (McKinney, 1970, p. 168). The variation along dimensions of disaster—such as speed and scope of onset, duration, etc.—is easily documented to be as great within the category of "natural" events as between that category and "technological" events or any other agent-based or descriptive category. Quarantelli called such practice phenotypic classification and argued that there is sufficient disaster research and theory that social scientific attention should focus classification along more fundamental theory-based lines (genotypic). Although these classifications are not theory-based and are rarely used analytically any longer, they still appear in various literatures (cf. Perrow, 2006, p. 523).

Some researchers continue to stress the importance of a proximal agent as a manifestation of hazard processes when defining disasters. A few of these superficially resemble the non-theoretical typologies mentioned above. Some are based in physical science perspectives, where geologists—as part of their scientific ethos—center their work on hazard process and define disasters in those terms (Abbott, 2014; Keller & DeVecchio, 2014). Among social scientists, some definitions acknowledge that the nature of physical agents affect features of disaster occasions (such as level of fear, magnitude of impact, and others) that may themselves affect the behaviors (content of social intercourse) that arise during and following the disruption. There has been, however, movement away from the contention that any agent "is" the disaster, but disagreement persists regarding the extent to which agents are central or peripheral features of disaster definitions. A related issue is the contention that disasters originate "outside" the focal social system, which arises in some classical era definitions. This claim appears rarely in contemporary literature, probably owing to the growing acknowledgement that all disasters are human-caused. Thus, ecological perspectives emphasize that disasters originate within the social system itself where causes rest in the social structure, social interactions and the environment as a whole.

The role of physical damage in defining disasters also remains open to different interpretations. Researchers since the classical era acknowledge that damage is not necessarily a defining feature of disaster; for example, threats can produce the social disruption as well. But there is also agreement that physical damage is correlated with and can magnify social disruption, and that physical damage is often correlated with agent type. Some classic era definitions and some used by anthropologists include physical damage as part of the definition of disaster. In these cases, disagreement remains about the theory consequences of including damage as part of a definition. There is some consensus, however, that the magnitude of a disaster should be measured not in lives or property lost, but by the extent of the disruption and failure of the normative or cultural system. There is reasonable agreement that fundamental differences in individual and social system behavior should be expected among emergencies, disasters and catastrophes and that physical damage may indirectly arise in connection with catastrophes. These are not phenotypic categories based in magnitude or damages or similar characteristics. Instead, the categories represent differences in dimensions including social preparedness, destabilization of the social system through blocks to the ability to sustain interaction, and still others including the inability of people to occupy the physical area of the social system. In this view, the importance of physical destruction rests in its relationship to the need to completely empty an impact area prior to, during or after the disaster and the limitations that dispersal places upon social intercourse.

There also are apparent "agent-related" differences among disasters, documented in the literature, that make it appear some research findings do not apply to all events labelled disasters. That is, if "disasters" actually constitute a single class of phenomena, then one would expect consistency of research findings across them, but empirically differences arise that are in some cases apparently correlated with the agent. For example, behaviors seen in disasters associated with conflict environments (e.g. terrorism) are different from those arising from consensus environments (e.g. some natural hazards). Similarly, "disasters" characterized by very wide scopes of impact and very gradual onset (climate change) also appear to be empirically distinct from other "disasters". During the classic era, some researchers addressed this issue by either qualifying their findings in terms of the specific agent studied (volcano, flood, etc.) or by narrowing the findings to a given category of disaster events (natural or technological). Although such solutions can qualify differential research findings, over time this approach builds bodies of knowledge specific to agents or to categories of agents wherein differences may still persist within the class of agents or the narrower categories of disasters (Perry, 2006, pp. 13–15). For example, citizen warning compliance levels were lower for volcanic eruptions at Mt. St. Helens, Washington, than for those at Mt. Usu, Japan (Perry & Hirose, 1991, p. 180). Quarantelli (1982) has long argued that agent-based classifications of disasters are problematic; he believes that if social scientific principles of disaster behavior are to be devised, they must be based on theoretical distinctions instead of differences among agents. Quarantelli (1998b, p. 245) emphasizes that in examining disasters, one must separate "…phenotypical (surface or manifest characteristics) and genotypical (common non-visible factors [theory-based])" approaches. Quarantelli (1998b, p. 248) further notes that "I stopped using the natural/technological disaster distinction [phenotypic typology] long ago;" he favored instead a conceptual approach where disasters were classified based on analytic dimensions such as scope, duration, speed of onset, the nature of secondary impacts, predictability and social preparedness. Using such a conceptual approach, when empirical studies report that mental health consequences are rare in "natural disasters" but more common in certain kinds of "technological disasters," the real operative differences in mental health response may be more related to differential fear and knowledge of the threat (and other analytic characteristics as above) rather than to anything inherent in the difference between nature and technology. These anomalies may be seen as typological classification error; comparing two things that are similar in phenotype (appearance), but actually represent different genotypes (thus having distinct conceptually-based differences). One means of approaching such anomalies, when the goal is to construct theory, is to engage in taxonomic thinking to create typologies of disasters wherein comparison of research findings is done within categories of the classifications.

Thus, typologies offer a way of sorting occasions and findings to make more conceptually appropriate comparisons (Perry, 1989, p. 354). Lukic et al. (2013) has argued that disasters only can be meaningfully defined within the categories of a classification scheme or typology. Two comprehensive typologies have been devised. Barton (1969, 2005) created many categories in a typology of "collective stress" situations (of which disasters are one) and subsequently further classified disaster types based upon a matrix of four dimensions (scope of impact, speed of onset, duration of impact, and social preparedness) and characterized each cell in social and interpersonal terms (Barton, 1989). Kreps (1989) devised an intricate system by looking at domains, tasks, resources and activities (DTRA). Most recently, Boin and his colleagues have begun to elaborate "crises" as a more general dimension which includes disasters and to conceptualize other kinds of crises as well (cf. Quarantelli et al., 2006, p. 16). To date, researchers have engaged in only scant use of typological classification to place their studies in conceptual space, but especially with Boin's work, the practice may be increasing. The scant use of typologies also extends to issues other

than types of disasters. Fischer (2003, p. 100) proposed a ten-point scale to measure the *severity* of disasters which was theory-based, but has also been rarely used by social scientists or emergency managers. While Fischer's scale is superior on social scientific grounds, severity measures are routinely given in terms of damages (calculated in a variety of ways) or with agent-specific measures such as the Saffir-Simpson hurricane scale (with five categories based on based on wind speed).

Geographers and anthropologists have long focused thinking and research on the context in which hazards and disasters are present. In spite of this, research that examines multiple hazards and disasters simultaneously constitutes only a small portion of all disaster studies. The growing contemporary emphasis on ecological perspectives may introduce new tactics for research design and encourage adjustments of disaster definition. Ecological perspectives embrace a macroscopic view that minimally should direct attention to the threat or risk environment. There has been some movement toward studying disasters in the context of the range of threats that affect the focal system or environment. Perry and Lindell (2008) studied hazard perception in the context of three natural hazards (volcanoes, fires and earthquakes) and research by Lindell and Hwang (2008) included natural hazards (flood and hurricane) with a toxic chemical release threat. Diefenbach, Wood, and Ewert (2015) have examined the risk environment of communities threatened by multiple volcanoes. There is also a growing literature on hazardous materials releases in connection with natural disasters (Sengul, Santella, Steinberg, & Cruz, 2012; Young, Balluz, & Mililay, 2004). The term cascading disasters has been used in the literature to characterize the broader vulnerability of a place. Sometimes the usage is narrow scope, referring to disasters that happen in time sequence and appear to be connected (Kumasaki, King, Arai, & Yang, 2016). Others argue that cascading disasters can be conceptualized in broader terms (not "falling dominoes") that more effectively captures the hazard and disaster context (Pescaroli & Alexander, 2015). Ultimately, however, cascading disasters are not a variant on the disruption (disaster), but a focus on the broader hazard and disaster environment and how that environment may be manifest in multiple disaster episodes that are in some way sequential or linked.

In closing, this review has followed definitions and visions of disaster since the earliest social scientific studies. Consistent with the classic description of the process by Hempel (1952), disaster as a concept has been much refined and defined over years and generations of researchers. For at least the first three decades of research and theorizing, much concern was devoted to isolating what constituted the "disaster" from associated causes, conditions and consequences. Over time, researchers have moved away from an agent-centered, damage-driven, uncontrollable event vision. In the context of disaster events, it is now generally acknowledged that, although agents may be proximal causes, humans "cause" virtually all forms of occasions we label "disasters." Relative to the disaster concept itself, most researchers currently view social disruption as the key defining feature or essential dimension. Conceptual refinements have attempted to understand individual, organizational and social system levels of disruption and how these may differ or interact within the context of "disaster" episodes (Quarantelli, 2000, 2005; Perry & Lindell, 2007; Gaillard, 2016). There has also been attention to how (and whether) the disruption feature of disasters should be analytically separated from short-term, temporary interactions (such as emergent groups) that appear to arise as part of the disruption (Stallings, 1998; Drabek & McEntire, 2003). As research findings continue to accumulate and the potential for anomalous findings increase, like the differential mental health consequences cited above, researchers may turn to theory-based approaches such as typologies to find interpretable meaning in the body of research. Whether the typologies that come into use are those of Barton or Kreps or something entirely different, the categories of the classification schemes will serve as contexts to further specify the nature and character of the disruption now broadly viewed as the defining feature of disaster. Ultimately, researchers and

theorists need to embrace Quarantelli's admonition that a social scientific vision of disasters requires focus on the key dimensions of the concept, independent of externalities that may constitute causes, conditions for or consequences of disasters. To build a theory-basis for disaster research does require much knowledge of causes, conditions and consequences, but it is critical to build such a body of knowledge on a shared understanding of the concept of disaster.

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The Crisis Approach

2

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Contents

2.1 Introduction: Crisis and Disaster

The terms 'crisis' and disaster' are often used synonymously. They are clearly related. Both deal with events that belong in the 'un-ness' category: unexpected, undesirable, unimaginable and often unmanageable situations (Hewitt, 1983). But in academic discourse, "crisis" and "disaster" typically refer to different types of situations, which prompt different questions that require different theories. There is a disaster research community and a more diffused group of crisis researchers. The concepts 'crisis' and 'disaster' signal different research interests and approaches.

As researchers in both communities can and do draw from each other's work, we think it is important to debate what these key concepts refer to and how they inform research. In this chapter, we focus on what we call the "crisis approach" in academia and position it as a complementary approach to the disaster paradigm presented in this handbook (see in particular Chap. 1 of this Handbook). But first we should discuss how the concepts differ.

We define a disaster as an episodic event that is collectively construed as very harmful (cf. Boin, 2005; Perry & Quarantelli, 2005). A disaster refers to an event that causes human suffering and infrastructural damage. Disaster researchers used to predominantly study agents of destruction that fall into the category of natural forces such as floods, hurricanes, tsunamis and earthquakes (Stallings, 2005). More recently, they have begun to pay more attention to "man-made" events such as terrorism, ethnic conflicts, economic breakdowns and technological failure (see Erikson, 1994; Kendra & Wachtendorf, 2016; Perry, this volume). Disaster researchers are interested in prevention and mitigation of these events; they also study the consequences of disasters.

Crisis researchers typically focus on a temporal slice of the process through which a disaster emerges and eventually fades. They are mostly interested in the phase where intervention

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can still limit the effects of an emerging or escalating incident. We define a crisis as a *threat* that is perceived to be existential in one way or another (cf. Rosenthal, Boin, & Comfort, 2001). No disaster has materialized just yet, but the prospect is imminent. Speaking of a crisis is in an odd way deeply optimistic: it suggests that the threat in question may still be averted if people, communities, institutions, leaders or systems rise to the challenge. That's why the term "crisis" is usually closely linked to the term "crisis management". This definition gives rise to a particular yet broad-ranging way of academic work that we try to summarize here in terms of 'the crisis approach.'

The crisis approach brings together ideas of vulnerability, risk, threat, trigger, process, response and outcome. It is agnostic to the source of threat: it is applied to such disparate events as 9/11, the Asian tsunami, the swine flu pandemic, Hurricane Katrina, the Deep Water Horizon oil spill, the Fukushima Daiichi nuclear meltdown, the financial breakdown, and Brexit. While it recognizes the importance of prevention and risk management, it accepts the notion that crises can always happen. It advocates the idea that preparation can make the difference between a small incident and a full-blown disaster. It trains our attention on the opportunity dimension of adversity: what is a crisis to some may be an opportunity to others. It accepts that crisis outcomes are socially construed and will likely be contested.

In this chapter, we lay out the various components of the crisis approach. We build the chapter around two sets of questions that seem equally relevant to crisis and disaster researchers. The first set addresses the nature of crisis, inquiring into the causes, characteristics, and consequences of crises. The second set addresses the effectiveness of crisis management. We offer the outlines of a framework that may help assess the performance of crisis managers in a more subtle way than public inquiries and many academic studies often do. We start the chapter off with a discussion of the crisis concept.

2.2 The Nature of Crisis

In ancient Greek, the term crisis refers to a critical point, a fork in the road of development, a moment of decision. In medical parlor, a crisis refers to the critical phase of a patient's fight against a deadly threat: will she live or die? In contemporary usage, crisis still combines the grave threat and the escape door: the situation may look bad, but it is not hopeless. In fact, a crisis may open up unforeseen "windows of opportunity" (Kingdon, 1984). This fundamental ambiguity stands in marked contrast to the doom implied by the Greek word for disaster (literally: bad alignment of stars).

We speak of a crisis when a group, organization or community experiences a "serious threat to the basic structures or the fundamental values and norms of a system, which under time pressure and highly uncertain circumstances necessitates making vital decisions (Rosenthal, Charles, & 't Hart, 1989, p. 10). This definition of crisis allows us to compare a wide variety of adversity: natural disasters and environmental threats, financial meltdowns and terrorist attacks, epidemics and exploding factories, infrastructural breakdown and organizational decline. What all these events have in common is that they create impossible conditions for those who seek to manage a response operation; they force first responders, public managers and political leaders to make urgent decisions while essential information about causes and consequences remains unavailable, unreliable or incomplete. Here we will consider in somewhat more detail the three key components—threat, uncertainty, and urgency—that make up this classic definition.

Crises occur when core values or life-sustaining systems of a community come under *threat*. Think of widely shared values such as safety and security, welfare and health, integrity and rule of law, which become shaky or even meaningless as a result of (looming) violence, destruction, damage or other forms of adversity. When critical infrastructures fail, the normal functioning of modern society is

threatened. That is why a natural disaster evokes a deep sense of crisis: deeply embedded values of safety and security for oneself and one's loved ones come under threat (Raphael, 1986, p. 26).

In the crisis approach, the threat agents are less interesting than the resulting experience of threat. This approach is not overly focused on categorizing events in "natural", "man-made" or "terrorist" boxes. It is the *perception* of threat that matters. A threat may cause widespread fear (even when objectively there may be little to worry about), which will force authorities to act.

Crises induce a sense of *urgency*. Threats that do not pose immediate problems—think of climate change or future pension deficits—do not induce a widespread sense of crisis. Experts may raise red flags but most politicians (and most people) do not lose sleep over problems with a horizon that exceeds their political life expectancy. Time compression is a critical element of crisis: the threat is here, it is real and must be dealt with now.

In a crisis, the perception of an urgent threat is accompanied by a high degree of *uncertainty*. This uncertainty pertains both to the nature and the potential consequences of the threat: What is happening and how did it happen? What's next, how bad will it be? More importantly, uncertainty clouds the search for solutions: What can we do? What happens if we select this option? What will others do? How will people react?

This approach recognizes that a crisis is the product of shared perception. People do not always agree whether a threat exists, whether it is urgent and what should be done to mend the threat. This creates room for manipulation. Politicians, stakeholders, media and citizens actively try to create a sense of crisis to further action that would be otherwise impossible; others work just as hard to defuse any talk about crisis to preserve the status quo. A crisis is political in nature.

Two core questions have dominated the study of crisis. The first question pertains to the causes of crisis. Why do systems become unstable? Why do people perceive some situations as a crisis whereas they ignore seemingly similar situations? The second question pertains to crisis management. How should we assess crisis management? What determines the effectiveness of crisis management efforts? The crisis approach comprises a variety of theoretical perspectives to answer these questions. We will now briefly consider the interdisciplinary building blocks of this approach.

2.2.1 Theoretical Perspectives

The crisis approach borrows from all social sciences. This rich and fruitful mix of perspectives provides exactly what is needed to understand the complexities and dynamics of crises and crisis management. Let us review how crisis researchers have cherry picked from the various theoretical fields in the search for answers to the research questions formulated above.

The crisis approach shares with the disaster perspective a deep relation with sociology. In sociological terms, a crisis marks the phase during which order-inducing institutions stop to function—the threat of anomy lurks in the background (cf. 't Hart, 1993). It is the moment —to cite Everett Hughes (1946)—when "the cake of custom is broken." Sociologists saw an optimistic lining in the crisis cloud, noting that during a crisis "the attention is aroused and explores the situation with a view to reconstructing modes of activity" (W.I. Thomas cited in Hughes [1946]). This idea of possible renewal has sensitized crisis researchers to the ways in which policymakers and politicians exploit crises to bring about changes that would be impossible in more stable times (Boin, 't Hart, Stern, & Sundelius, 2016).

A sociological subfield of organization theory produced one of the most powerful theories informing our crisis perspective. In *Normal Accidents*, Perrow (1999) applied two wholesale sociological concepts (complexity and coupling) to explain organizational breakdown (we will elaborate on Perrow's theory in the next section). This and other similar work in organization theory helped raise a fundamental debate about the

feasibility and desirability of entrusting dangerous technology to large-scale bureaucracies (Chiles, 2001; La Porte, Perrow, Rochlin, & Sagan, 1994; Sagan, 1993).

Psychology has always been a source of inspiration to crisis researchers. Through their work, we have learned much about individual decision-making under stress and uncertainty (Coates, 2012; Holsti, 1979; Janis & Mann, 1977; Kahneman, 2011). Social-psychologists have shown that group decisions do not necessarily compensate for the shortcomings of the stressed individual's decision-making process (Janis, 1982; 't Hart, 1994; 't Hart, Stern, & Sundelius, 1997).

In addition, psychologists have done important work that helps us understand the relation between human error, technology, organizational culture and the development of crisis (Flin, 1996; Klein, 2001; Reason, 1990). They explain why and how people act on negligible risks (avoiding flying) while they ignore others (smoking; driving without seatbelts) (Gardner, 2008; Pidgeon, Kasperson, & Slovic, 2003). This explains why well-trained operators make crisis decisions in a very particular way: they compare their situational assessment with mental slides of similar situations (they select the decision that comes with the slide that matches their assessment). Their research helps us understand that crisis decision-making differs quite dramatically from the incremental, semi-rationalistic way often prescribed in textbooks on management and decision-making.

The political science field of International Relations (IR) has traditionally paid much attention to international crises. Crisis scholars in IR—a small minority in this huge field of political scientists—tend to analyze international conflicts in terms of high-level decision-making (Herek, Janis, & Huth, 1987; Hermann, 1972) as well as dynamic interaction between parties (Brecher, 1993). In explaining the escalation and outcomes of international conflicts, they study how pervasive perceptions, bureau-politics, and small-group dynamics affect the critical decisions made during a crisis (Allison, 1971; George, 1991; Jervis, 1976; Lebow, 1981). This firm body of richly documented studies has taught us much about political leadership behavior in times of crisis.

In the more traditional study of political development, a crisis refers to a necessary phase of disorder in a nation's march toward democracy (see f.i. Almond, Flanagan, & Mundt, 1973; Linz & Stepan, 1978; Zimmerman, 1983). The sociological meaning of the term was thus preserved, as political scientists applied it to describe a phase in which established institutions had lost their influence. But the term was infused with a normative meaning, which has made the study of crisis slightly suspect in this field ever since. When political scientists refer to crisis, the automatic question is: whose crisis are we talking about? In more recent years, this question has led to intriguing contributions that stress the subjective nature of crisis and its outcomes.

Business scholars have produced a substantial body of usually rather prescriptive work to prepare managers and MBA-students to deal with reputation damage, shifting markets, fraud, product recalls and other adverse events that threaten the profitability of the firm (Mitroff & Pauchant, 1990; Pauchant & Mitroff, 1992). The rising number of books and articles on the topic of business continuity suggests the emergence of a crisis field in its own right. A similar niche has grown on the topic of corporate reputation in crisis (Coombs, 2007; Sellnow, Veil, & Anthony, 2015).[1] The "Great Recession", which has held the U.S. and Europe its grip between 2006 and the time of writing, spurned an interdisciplinary effort to understand why this crisis was so badly managed. In addition, the business field has produced many studies that help understand the importance of regulatory environments (or the lack thereof).

In yet another niche—tucked away in the field of communications studies—interesting work is being done on the relation between crisis actors, (political) stakeholders, media and civilians (Fearn-Banks, 1996; Seeger, Selmer, & Ulmer,

[1]The topic of organizational reputation has made headway into the field of political science and public administration as well (Carpenter, 2010).

2003). This body of research helps us understand why sound decisions may or may not help to manage a crisis, depending on the way they are communicated. It helps us understand how media frames shape reporting about crisis (Miller, Roberts, & LaPoe, 2014), which, in turn, affect general perceptions of the crisis and the authorities managing it (Cross & Ma, 2015).

Our *tour d'horizon* would not be complete without mentioning the field of disaster research. The thorough understanding of collective behavior, disaster myths and the pathologies of top-down coordination in times of adversity have proved particularly fruitful to understanding crisis dynamics (see the other chapters of this book for the lessons of disaster research). The recent rediscovery of resilience provides a bridge between issues of vulnerability, challenges of response and controversial outcomes (Aldrich, 2016; Cutter, Ash, & Emrich, 2014).

These perspectives have helped us to better understand the nature of crisis and the dynamics of crisis management. In the next two sections, we present the key insights generated in the crisis field with regard to key questions formulated above.

2.3 The Ubiquity of Crisis

Crises were once explained in terms of bad luck or God's punishment, but this view has become obsolete (Bovens & 't Hart, 1996, 2016; Quarantelli, 1998; Steinberg, 2000). It is now accepted, at least by scholars, that crises are the result of multiple causes, which interact over time to produce a threat with devastating potential.

This may be somewhat counterintuitive, as it defies the traditional logic of "triggers" and underlying causes. Linear thinking ("big events must have big causes") thus gives way to a more subtle perspective that emphasizes the unintended consequences of increased complexity (Buchanan, 2000). The approach does not seek to identify specific factors that "cause" a crisis. It proposes that *escalatory processes undermine a social system's capacity to cope with disturbances*. The agents of disturbance may come from anywhere—ranging from earthquakes to human errors—but the ultimate cause of the crisis lies in the inability of a system to deal with the disturbance.

The causes of vulnerability often reside deep within the system. They typically remain unnoticed, or key policy makers fail to attend to them (Turner, 1978). In the process leading up to a crisis, these seemingly innocent factors combine and transform into disruptive forces that come to represent an undeniable threat to the system. These factors are sometimes referred to as pathogens, as they are present long before the crisis becomes manifest (Reason, 1990, 2008).

The notion that crises are an unwanted by-product of complex systems has been popularized by Perrow's (1999) analysis of the nuclear power incident at Three Miles Island. Perrow describes how a relatively minor glitch in the plant was misunderstood in the control room. The plant operators initially thought they understood the problem and applied the required technical response. But as they had actually misinterpreted the warning signal, the response worsened the problem. The increased threat mystified the operators (they could not understand why the problem persisted) and invited an urgent response. By again applying the "right" response to the wrong problem, the operators continued to exacerbate the problem. Finally, someone figured out the correct source of the problem, just in time to stave off a disaster.

The very qualities of complex systems that drive progress lie at the heart of most if not all technological crises. As socio-technical systems become more complex and increasingly connected (tightly coupled) to other (sub)systems, their vulnerability for disturbances increases (Perrow, 1999; Turner, 1978). The more complex a system becomes, the harder it is for anyone to understand it in its entirety. Tight coupling between a system's component parts and with those of other systems allows for the rapid proliferation of interactions (and errors) throughout the system.

Complexity and lengthy chains of accident causation do not remain confined to the world of high-risk technology. Consider the global financial crises that have rattled the world in recent years (Posner, 2011). Globalization and ICT tightly connect world markets and financial systems. As a result, a minor problem in a seemingly isolated market can trigger a financial meltdown in markets on the other side of the globe. Structural vulnerabilities in relatively weak economies such as Russia, Argentina or Turkey may suddenly "explode" on Wall Street and cause worldwide economic decline. Economic problems in Greece, Spain and Portugal brought the European Union's common market on the verge of breakdown.

The same characteristics can be found in crises that beset low-tech environments such as prisons or sports stadiums. Urban riots, prison disturbances and sports crowd disasters always seem to start off with relatively minor incidents (Waddington (2007) refers to flashpoints). Upon closer inspection, however, it becomes clear that it is a similar mix of interrelated causes that produces major outbursts of this kind.

In the case of prison disturbances, the interaction between guards and inmates is of particular relevance (Boin & Rattray, 2004). Consider the 1990 riot that all but destroyed the Strangeways prison in Manchester (UK). In the incubation period leading up to the riot, prison guards had to adapt their way of working in the face of budgetary pressure. Inmates did not understand or appreciate this change in staff behavior and subsequently began to challenge staff authority, which, in turn, generated anxiety and stress among staff. As staff began to act in an increasingly defensive and inconsistent manner, prisoners became even more frustrated with staff behavior. A reiterative, self-reinforcing pattern of changing behavior and staff-prisoner conflict set the stage for a riot. A small incident started the riot, which, in turn, touched off a string of disturbances in other prisons. Many civil disturbances between protestors and police seem to unfold according to the same pattern (Goldstone & Useem, 1999; Smelser, 1962; Waddington, 2007).

All this makes a crisis hard to detect. It is hard to understand the manifold activities and processes that take place in these systems.[2] Growing vulnerabilities go unrecognized and ineffective attempts to deal with seemingly minor disturbances continue. The system thus "fuels" the lurking crisis. Only a minor "trigger" is needed to initiate a destructive cycle of escalation, which may then rapidly spread throughout the system. Crises may have their roots far away (in a geographical sense) but rapidly snowball through the global networks, jumping from one system to another, gathering destructive potential along the way.

Modern vectors such as globalization, just-in-time delivery chains, increasing volumes of travel and transportation have enhanced the speed and potential scope of crisis escalation. The tight connections between policy systems, business multinationals and internationally oriented communities give rise to crises that are increasingly transboundary (Ansell, Boin, & Keller, 2010). Think of the 2010 volcanic ash crisis that virtually paralyzed European air transport networks for almost two weeks (Kuipers & Boin, 2015). The eruption and ash cloud production of the Icelandic Eyjafjallajökull volcano triggered a crisis that rippled across the European continent, causing a mobility crisis for the European economy.

Have modern systems become more vulnerable to breakdown? One might argue that modern society is better than ever equipped to deal with routine failures: great hospitals, computers and telephones, fire trucks and universities, regulation and funds – these factors have helped to minimize the scope and number of crises that were once routine (Wildavsky, 1988). Others argue that the resilience of modern society has deteriorated: when a threat does materialize (say an electrical power outage), modern systems

[2]The laws of complex systems are still largely unknown. And the more we learn about the behavior of complex systems, the less we seem to understand. Complexity theorists are busy uncovering the hidden patterns that they say underlie this process, but practical insights (for our purposes at least) have yet to emerge. For an introduction see Buchanan (2000).

suffer most. Students of natural disasters make a similar point: modern society increases its vulnerability to disaster by building in places where history warns not to build (Tierney, 2014). The costs of natural and man-made disasters continue to grow, while scenarios of future crises promise more mayhem.[3]

This approach to crisis holds an important lesson for practitioners: before anything can be done to prevent a crisis from materializing, an emerging threat must be explicitly recognized. There are at least three reasons why many potential crises fail to gain such recognition.

First, threats to shared values or life-sustaining functions cannot always be recognized before their disastrous consequences materialize. As the crisis process begins to unfold, policy makers often do not see anything out of the ordinary. Everything is still in place, even though hidden interactions eat away at the pillars of the system. It is only when the crisis is in full swing and becomes manifest that policy makers can recognize it for what it is.

The second reason is found in the contested nature of crisis. A crisis rarely, if ever, "speaks for itself." The definition of a situation is, as argued above, the outcome of a subjective process. More often than not people will differ in their perception and appreciation of a threat. In fact, we might say that crisis definitions are continuously subjected to the forces of politicization (Edelman, 1977). One man's crisis is another man's opportunity.

The third reason has to do with the closed nature of policy agendas. Even if consensus would exist that a serious threat is emerging, the status of this new problem is far from assured. Governments deal with urgent problems everyday; attention for one problem takes away attention from another. For a threat to be recognized as a crisis, it must gain sufficient societal and political attention to earn a place on overcrowded policy agendas (Birkland, 1997; Bovens & 't Hart, 1996).[4]

2.4 Crisis Management: Crucial Challenges for Leadership

We define crisis management as the set of efforts aimed at minimizing the impact of an urgent threat. This response typically involves multiple actors. Some of these actors may operate at the strategic (policy-making) level, others more at the operational level (think of police officers, firemen, ambulance drivers, technicians etc.). These worlds are quite distinct in the types of responsibilities actors have and the activities they engage in (Boin & Renaud, 2013).

Crisis management will differ based on the "knowability" of the situation. Some crises are unique events, leaving both strategic crisis managers and operational first responders with few preconceived ideas as to how to handle the situation. Other crises may offer a variation on a theme: think of hurricanes and floods, or certain infrastructural failures, which may follow familiar patterns even if they differ in important details. For these latter events, specific plans and scenarios may be developed. For events that occur regularly and often, a quantitative basis may exist to allow for risk assessments (calculating what the chances are that a certain event will occur). As uncertainty rises, crisis managers will find risk assessments and disaster plans less useful.

Crisis management is not an easy job. Psychological constraints operate at the individual, group and organizational level. The stress of crisis can impair information management and decision-making in severe ways. A combination of political and media pressure typically makes the jobs of crisis managers harder. Citizens whose lives are affected by critical contingencies expect governments and public agencies to do their utmost to keep them out of harm's way. They expect the officials in charge to make critical decisions and provide direction even in the most difficult circumstances. So do the journalists that produce the stories that help to shape the

[3]Recent scenarios feature radical weather changes, biological terrorism, and asteroid collisions (Bryson, 2003; OECD, 2003, 2011; Schwartz & Randall, 2003).

[4]How and when policymakers recognize (or not) threats is object of research in the policy studies community (Birkland, 1997; Kingdon, 1984).

crisis in the minds of the public. And so do members of parliament, public interest groups, institutional watchdogs and other voices on the political stage that monitor and influence the behavior of leaders. However misplaced, unfair or illusory these expectations may be, it hardly matters. These expectations are real in their political consequences (Thomas & Thomas, 1928).

Crisis management has become more challenging because the democratic context has changed over the past decades. Analysts agree, for instance, that citizens and politicians alike have become at once more fearful and less tolerant of major hazards to public health, safety and prosperity. The modern Western citizen has little patience for imperfections; he has come to fear glitches and has learned to see more of what he fears. In this culture of fear—sometimes referred to as the "risk society"—the role of the modern mass media is crucial (Beck, 1992).

In contemporary Western society, a crisis sets in motion extensive follow-up reporting, investigations by political forums as well as civil and criminal juridical proceedings. It is not uncommon for public officials and agencies to be singled out as the responsible actors for prevention, preparedness and response failures. Public leaders must defend themselves against seemingly incontrovertible evidence of their incompetence, ignorance or insensitivity. Crisis management therefore should be viewed a deeply controversial and intensely political activity (Edelman, 1977; Habermas, 1975; 't Hart, 1993).

Given these constraints and the nature of the crisis management challenge, one might ask what we can reasonably expect from crisis leaders operating at the strategic level? Research suggests that effective and legitimate crisis management is enhanced by the performance of several managerial functions: *early recognition*, *sense making*, *decision making and coordination*, *meaning making*, *accounting* and *learning* (Boin et al., 2016). Let us now briefly review these functions in somewhat more detail.

2.4.1 Early Detection

A crisis seems to pose a straightforward challenge: once a crisis becomes manifest, crisis managers must take measures to deal with its consequences. Reality is much more complex, however. Most crises do not materialize with a big bang; they are the product of escalation. Policymakers must not only recognize from vague, ambivalent, and contradictory signals that some threat is emerging. This means that they have to define the evolving situation and arrive at a collective understanding of its potential scope and effects. Effective crisis management begins with a shared recognition that a threat has emerged which requires immediate attention.

Inquiry reports often give the impression that most crises could have been foreseen. In hindsight, when we all know what happened and why, criticasters wonder how those in charge could have missed so many red flags (Tetlock, 2005; Turner, 1978; Woods, 2005). However, during the emergence of a crisis, the bits of fragmented information that later turn out to be signals cannot be easily distinguished from other 'noise.'

In the literature, we identify two conditions for "foresight" (cf. Turner, 1978). The first condition pertains to extensive experience among first responders and system operators with incidents and their dynamics. Apparently, experienced fire fighters can develop a keen sense of impending danger (Klein, 2001). Likewise, operators develop an ability to recognize deviations in complex but known processes. Roe and Schulman (2008) show how vulnerabilities in organizational design and high risk infrastructures design are compensated by the people who manage for high reliability, even during peak demand times or periods of stress. The second is organizational. Organizations should stimulate rapid detection of impending threats (Weick & Sutcliffe, 2002). They should put a premium on continuous vigilance and on a collective willingness to act on faint signals, tolerate false

alarms and encourage voluntary admissions of failures and near-misses.

2.4.2 Sense Making

However penetrating the events that trigger a crisis - jet planes hitting skyscrapers, thousands of people found dead in mass graves – a uniform picture of the events rarely emerges: do they constitute a tragedy, an outrage, perhaps a punishment, or, inconceivably, a blessing in disguise? Crisis managers will have to determine how threatening the events are, to what or whom, what their operational and strategic parameters are, and how the situation will develop in the period to come. Signals come from all kinds of sources: some loud, some soft, some accurate, some widely off the mark. But how to tell which is which? How to distill cogent signals from the noise of crisis?

Rational information processing is very hard under conditions of deep uncertainty (Coates, 2012; Kahneman, 2011; Reason, 2008). The bewildering pace, ambiguity and complexity of crisis can easily overwhelm normal modes of situation assessment. Stress may further impair sense-making abilities. The organizations in which crisis managers typically function tend to produce additional barriers to collective agreement on a common operational picture of the situation.

Effective sense-making is hard without an established and practiced routine that allows strategic crisis managers to process information, circulate it among the relevant people and consider their feedback, create a common operational picture, analyze mid- and long term consequences, and articulate and adequately address specific information needs. Even organizations (think of NASA or the worldwide network of national and international centers of disease control) with an extensive sense-making machinery in place, struggle to arrive at a shared picture of the situation in time.

An important new trend is the ability of first responders, humanitarian relief organizations and affected citizens – who happen to be present at ground zero — to provide information and engage directly in sense making by means of social media. Innovative tools, such as UNOCHA's humanitarian aid app, and emerging theoretical approaches focus on employing a "knowledge commons" to support crisis leaders in extreme events (Comfort & Okada, 2013). Using social media tools and applications, citizens play an increasingly central role in disaster response (Sabou and Klein, 2016; Vieweg, Palen, Liu, Hughes, & Sutton, 2008; Yates & Paquette, 2011). This emerging involvement of ad hoc citizen networks employing new media brings a new set of actors and perspectives to the sense making table, for better and for worse. They can provide crucial information but also add to the stream of unverified rumors and thereby critically skew the collective assessment of what is going on. The leadership challenge is to benefit from the possibilities these upcoming information sources and networks without falling prey to its potential downsides.

2.4.3 Making Critical Decisions

Responding to crises often confronts governments and public agencies with pressing choice opportunities. These can be of many kinds. The needs and problems triggered by the onset of crisis may be so big that the scarce resources available will have to be prioritized. This is much like politics as usual except that in crisis circumstances the disparities between demand and supply of public resources are much bigger, the situation remains unclear and volatile, and the time to think, consult and gain acceptance for decisions is highly restricted. Crises also confront governments and leaders with issues they do not face on a daily basis, for example concerning the deployment of the military, the use of lethal force, or the radical restriction of civil liberties.

The classic example of crisis decision-making is the Cuban Missile Crisis (1963), during which U.S. President John F. Kennedy was presented with pictures of Soviet missile installations under construction in Cuba. The photos conveyed a geostrategic reality in the making that Kennedy

considered unacceptable, and it was up to him to decide what to do about it. Whatever his choice from the options presented to him by his advisers – an air strike, an invasion of Cuba, a naval blockade – and however hard it was to predict the exact consequences, one thing seemed certain: the final decision would have a momentous impact on Soviet-American relations and possibly on world peace. Crisis decision-making is making hard calls, which involve tough value trade-offs and major political risks (Brecher, 1993; Janis, 1989).

Many pivotal crisis decisions are *not* taken by individual leaders or by small informal groups of senior policy makers. They emerge from various alternative loci of decision making and coordination (McConnell, 2003; 't Hart, Rosenthal, & Kouzmin, 1993). In fact, the crisis response in modern society is best characterized in terms of a network. This is not necessarily counterproductive, many leaders have learned, as delegation of decision-making authority down the line usually enhances resilience rather than detracting from it.

2.4.4 Crisis Coordination

Crises typically require intense cooperation in a network of organizations that may well be new to each other (Boin & 't Hart, 2012; Boin & Bynander, 2015). Vertical and horizontal cooperation must be orchestrated to accomplish a state of coordinated behavior. Because a situation can be urgent and threatening but the network of partners is often not hierarchically related, orchestrating a response requires striking a careful balance between persuasion and "command and control." Persuasion does usually not suffice to reach a state of optimal cooperation. Top down command can easily back-fire.

After all, each decision must be implemented by a set of organizations; only when these organizations work together is there a chance that effective implementation will happen. Getting public bureaucracies to adapt to crisis circumstances is a daunting – some say impossible – task in itself. Most public organizations were originally designed to conduct routine business in accordance with such values as fairness, lawfulness and efficiency. The management of crisis, however, requires flexibility, improvisation, redundancy, and the breaking of rules.

Coordination is not a self-evident feature of crisis management operations. The question of who is in charge typically arouses great passions. In disaster studies, the "battle of the Samaritans" is a well-documented phenomenon: agencies representing different technologies of crisis coping find it difficult to align their actions. Moreover, a crisis does not make the public suddenly "forget" the sensitivities and conflicts that governed the daily relations between authorities and others before the crisis. Trust and social capital therefore receive increasing attention in the disaster literature on effective response and recovery operations (Aldrich, 2012).

Disaster researchers see self-organization as a central feature of coordination. Disaster-stricken communities, local organizations and individual victims can be surprisingly creative and adaptive. Their ad hoc nodes of cooperation may even be best suited to local needs (Aldrich, 2012; Carr, 1932; Comfort & Okada, 2013; Drabek, 1985). The effectiveness of self-organization instructs central authorities to hold back (Boin & Bynander, 2015). Such situations are best served by "enabling leadership" (Nooteboom & Termeer, 2015). Effective leaders are "asking more than telling, requesting rather than ordering, delegating and decentralizing rather than narrowing and centralizing" (Quarantelli, 1988:382). If, however, network parties clash or local capacity is completely overwhelmed, central officials should take charge and intervene.

2.4.5 Meaning Making

In a crisis, leaders are expected to reduce uncertainty and provide an authoritative account

of what is going on, why it is happening and what needs to be done. When they have made sense of the events and have arrived at some sort of situational appraisal and made strategic policy choices, leaders must get others to accept their definition of the situation. They must impute "meaning" to the unfolding crisis in such a way that their efforts to manage it are enhanced. If they don't, or if they do not succeed at it, their decisions will not be understood nor respected. If other actors in the crisis succeed in dominating the meaning-making process, the ability of incumbent leaders to decide and maneuver is severely constrained.

Two problems often recur. First, public leaders are not the only ones trying to frame the crisis. Their messages coincide and compete with those of other parties, who hold other positions and interests, who are likely to espouse various alternative definitions of the situation and advocate different courses of action. Censoring them is hardly a viable option in a democracy.

Second, authorities often cannot provide correct information right away. They struggle with the mountains of raw data (reports, rumors, pictures) that are quickly amassed when something extraordinary happens. Turning them into a coherent picture of the situation is a major challenge by itself. Getting it out to the public in the form of accurate, clear and actionable information requires a major public relations effort. This effort is often hindered by the aroused state of the audience: people whose lives are deeply affected tend to be anxious if not stressed. Moreover, they do not necessarily see the government as their ally. And pre-existing distrust of government does not evaporate in times of crisis.

2.4.6 Accounting for Performance

In a democratic polity, crisis leaders will have to render account for what has happened and what government organizations have done in response. If they gain acceptance for their account, legitimacy of public government is effectively preserved (Boin, McConnell, & 't Hart, 2008).

The burden of proof in accountability discussions lies with leaders: they must establish beyond doubt that they cannot be held responsible for the occurrence or escalation of a crisis. These accountability debates can easily degenerate into "blame games" with a focus on identifying and punishing "culprits" rather than discursive reflection about the full range of causes and consequences.[5] The challenge for leaders is to cope with the politics of crisis accountability without resorting to undignified and potentially self-defeating defensive tactics of blame avoidance that only serve to prolong the crisis by transforming it into a political confrontation at knife's edge.

Crisis leaders can be competent and conscientious, but that alone says little about how their performance will be evaluated when the crisis is over. Policymakers and agencies that failed to perform their duties prior to or during the critical stages need not despair, however: if they "manage" the political game of the crisis aftermath well, they may prevent losses to their reputation, autonomy, and resources. Crises have winners and losers. The political (and legal) dynamics of the accountability process determines which crisis actors end up where (Brändström & Kuipers, 2003; Hood, 2010; Resodihardjo, Carroll, Van Eijk, & Maris, 2016).

2.4.7 Learning Lessons

A crisis offers a reservoir of potential lessons for contingency planning and training for future crises. One would expect all those involved to study these lessons and feed them back into organizational practices, policies and laws.

Lesson-drawing is one of the most underdeveloped aspects of crisis management (Broekema, 2016; Lagadec, 1997; Stern, 1997). In addition to cognitive and institutional barriers to learning, lesson-drawing is constrained by the

[5] Although much more pronounced today, the tendency to search for culprits following the occurrence of disaster and crisis is age old, see Drabek and Quarantelli (1967) as well as Douglas (1992).

role of these lessons in determining the impact that crises have on a society. Crises become part of collective memory, a source of historical analogies for future leaders (Khong, 1992; Sturken, 1997). The political depiction of crisis as a product of prevention and foresight failures would force people to rethink the assumptions on which preexisting policies and rule systems rested. Other stakeholders in the game of crisis-induced lesson-drawing might seize upon the lessons to advocate measures and policy reforms that incumbent leaders reject. Leaders thus have a big stake in steering the lesson-drawing process in the political and bureaucratic arenas. The crucial challenge here is to achieve a dominant influence on the feedback stream that crises generate into preexisting policy networks and public organizations.

The documentation of these inhibiting complexities has done nothing to dispel the near-utopian belief in crisis *opportunities* that is found not only in academic literature, but also in popular wisdom (Boin & 't Hart, 2003). A crisis is seen as a good time to clean up and start anew. Crises then represent discontinuities that must be seized upon – a true test of leadership, the experts claim. So most people are not surprised to see sweeping reforms in the wake of crisis: that will never happen again! They intuitively distrust leaders who claim bad luck and point out that their organizations and policy have a great track record.

Crises tend to cast long shadows upon the political systems in which they occur. It is only when we study these longer term processes that we are able to assess the full impact of crises. Unfortunately, such studies are rare (but see Birkland, 1997; Kurtz & Browne, 2004). Most studies of the "crisis aftermath" of emergencies have been about community reconstruction, individual and collective trauma, and legal battles. We need to complement these studies by taking a broader macro-social perspective that looks at collective "learning" for an entire nation, polity or society in the aftermath of crisis (Broekema, 2016). It remains an open question if crises tend to serve as triggers of systemic change or if they serve to forestall such change, and to what extent these processes can be channeled by good crisis governance.

2.5 Conclusion: The Crisis Approach Reconsidered

The crisis approach outlined in this chapter provides a framework for understanding the dynamic evolution of crisis and the prospects for public management of urgent threats. The approach adopts a long time line, which makes it possible to trace a crisis from its early roots to its burial in public memory. It admonishes the research community to complement operational perspectives with political perspectives. Most importantly, perhaps, is its capacity to tease out the interplay between crisis dynamics and crisis outcomes.

Two lessons seem of particular relevance to practitioners. First, one should accept that even the richest and most competent government imaginable can never guarantee that major disruptions will not occur. Policy makers cannot escape the dilemmas of crisis response by banking on crisis prevention. Crisis prevention is a necessary and indeed vitally important strategy, but it pertains only to known emergencies – those that happened before. This requires a strategy of resilience (Wildavsky, 1988). This lesson resonates with key insights in the disaster field.

The second lesson reminds us that crisis is a label, a semantic construction people use to characterize situations or epochs that they somehow regard as extraordinary, volatile and potentially far-reaching in their negative implications. The intensity or scope of a crisis is thus not solely determined by the nature of the threat, the level of uncertainty, or the time available to decision-makers. A crisis is to a considerable extent what people – influenced by the inevitable mass media onslaught following an unscheduled event – make of it.

Why people collectively label and experience a situation as a crisis remains somewhat of a mystery. Physical facts, numbers and other seemingly objective indicators are important factors, but they are not decisive. A flood that

kills 200 people is a more or less routine emergency in Bangladesh, but it would be experienced as a major crisis in, let's say, Miami or Paris. Crises are in the eye of the beholder. It is people's frames of reference, experience and memory, values and interests that determine their perceptions of crisis. A sense of "collective stress" results not just from some objective threat, but also from the intricate interaction between events, individual perceptions, media representations, political reactions, and government efforts at "meaning making."

This process of collective understanding is one of escalation and de-escalation. It is subject to the influence of actors who have a stake in playing up a crisis mood, or playing it down. And this is exactly what happens when unexpected incidents or major disruptions are predicted or actually occur: different political, bureaucratic, societal and international stakeholders will not only form their own picture of the situation and classify it in terms of threats and opportunities, but many of them will actively seek to influence the public perception of the situation. Once a particular definition of the situation has taken hold in mass media and political discourse, it becomes a political reality that policymakers have to take into account and act upon. Initial definitions tend to be persistent.

An effective crisis response will inevitably require a two-pronged strategy: dealing with the events "on the ground" (whether literally as in civil emergencies or, metaphorically, as in a currency or stock market crisis); and dealing with the political upheaval and instability triggered by these events. Neglecting one or the other is detrimental to any attempt to exercise public leadership in a crisis.

These lessons help us to flag three challenges for further research. First, much work remains to be done on the understanding of crisis dynamics. If crises cannot be prevented, we must learn to recognize them in time. Early warning can only work if it builds on a solid theory of crisis development. Second, researchers need to invest in a better understanding of resilience (Duit, 2016). Crisis researchers tend to agree (with disaster researchers we should note) that resilience may be one of the key strategies to deal with system breakdowns. Much more systematic work needs to be done on the identification of mechanisms that provide for resilient societies (Comfort, Boin, & Demchak, 2010). Third, research could benefit our understanding of the tenuous relation between crisis and change: which type of crises and disasters open a window for structural change (and what must be done to exploit that opportunity)?

These research challenges would benefit from a close working relation between crisis and disaster scholars. Both communities have rich research traditions with regard to these questions. Both communities draw from each other's empirical and theoretical findings, but interdisciplinary research – bringing both communities together in joint research – has been quite rare. Crisis scholars are deeply indebted to the work of disaster colleagues such as Joe Scanlon, Russell Dynes, Henry Quarantelli and Kathleen Tierney. Disaster researchers, in turn, increasingly make use of current work done by crisis researchers. Our chapter aims to further the blurring of boundaries still separating these fields.

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Contributions of Technological and Natech Disaster Research to the Social Science Disaster Paradigm

3

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Contents

3.1 Introduction

This chapter explores the development of a disaster social science paradigm using Kuhn's ([1962] 1970) notion of paradigm and scientific revolution. For Kuhn, a paradigm provides a fundamental image of the subject matter within a science and defines what should be studied, the questions that should be asked, how they should be asked, and how to interpret the data. Kuhn contends that there are four stages of paradigmatic change. The first stage begins with "normal science," representing the accumulation of knowledge based upon the image of subject matter, exemplars, methods, and theories. The second stage occurs when normal science encounters anomalies—situations for which the existing paradigm provides inadequate explanation or fails to explain altogether. At this point, the third stage, "crisis," occurs as alternative explanations emerge and challenge the dominant paradigm. In Kuhn's fourth stage, revolution takes place as the old paradigm is replaced by a new paradigm that eventually dominates the field.

Adapting Kuhn's perspective, we argue that a disaster paradigm emerged in the years following WWII and came to dominate the field. Relying on theories associated with functionalism, collective behavior, and social organization, this paradigm used case studies, interviews, secondary data analysis, and surveys to address research questions that increasingly focused on preparation, response, recovery, and mitigation activities associated with sudden-onset natural hazards and disasters. Beginning in the 1970s, extreme events in the form of technological disasters presented anomalies to this dominant

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paradigm and gave rise to alternative perspectives and approaches to the study of disasters. Although not a 'revolution' from Kuhn's perspective, these alternative perspectives introduced new concepts, theories, and approaches that are becoming incorporated into this disaster social science paradigm. Recognition of natech hazards and disasters further reveals the social embeddedness of all hazards, risks, and disasters and presents additional challenges to this evolving disaster paradigm.

We employ Kuhn's paradigm concept and four stages of change as heuristic devices for examining the emergence and contributions of technological and natech hazards and disaster research. Although we must necessarily simplify descriptions of the dominant and alternative paradigms, our intent is not to reify these stages or what they represent; nor do we mean to reify distinctions between technological, natech, and natural disasters. Rather, this approach serves as a lens to show how research on anomalous events of technological and natech origin has influenced the study of disasters.

In this context, Freudenburg's (1997) perspective regarding how to distinguish between natural and technological disasters is instructive:

> The simplest rule of thumb for categorizing disasters as natural or technological… has to do with the triggering event: *if the triggering event could have taken place even if no humans were present*… then the disaster is most appropriately seen as a 'natural' one. By contrast, if the triggering event was one that inherently required human action… then the disaster is most appropriately seen as technological (pp. 24–5).

A "natech" event refers to cases in which a natural hazard event triggers a technological hazard or disaster such as the 2011 Tohoku earthquake and tsunami that led to the Fukushima Daiichi nuclear disaster in Japan.

Our chapter begins with a brief overview of the dominant disaster research paradigm that existed leading up to the 1970s. Next, we discuss the inception and growth of technological disaster social science. We begin with studies of the 1972 Buffalo Creek flood in West Virginia and trace the influence of research associated with subsequent seminal events including the 1979 nuclear accident at Three Mile Island, Pennsylvania, toxic waste contamination at Love Canal, New York, the 1984 Union Carbide gas leak in Bhopal, India, and the 1989 *Exxon Valdez* oil spill. We describe scholarly efforts to synthesize work in the technological disaster research arena and delve into empirically-based distinctions between natural and technological disasters. Specifically, we compare natural and technological disaster characteristics based on etiology, physical damages, disaster phases, post-disaster processes, vulnerability, community reactions, and individual reactions. The chapter then discusses ways in which research on both natural and technological disasters is leading to a convergence of perspectives of natech events—such as Hurricane Katrina—and their consequences. In closing, we consider implications of this increased knowledge about natech events and suggest directions for future research.

3.2 The Dominant Disaster Paradigm

In Chap. 1 of this handbook, Perry discusses the early history and development of disaster research. Here, we present a brief review of the dominant social science disaster paradigm by focusing on etiology, physical damages, disaster phases, post-disaster processes, vulnerability, community reactions, and individual reactions. This provides a context for our examination of technological and natech hazards and disasters.

Prior to the 1960s, disasters were defined primarily with respect to physical agents (e.g., tornadoes, floods, hurricanes, or earthquakes), physical impacts of these agents, and assessment of these impacts (Quarantelli, 1981). Subsequently, distinctions emerged between physically oriented descriptions of disaster and socially

driven conceptualizations. Charles Fritz's (1961) definition synthesized these developments:

> [An event]… concentrated in time and space, in which a society or a relatively self-sufficient subdivision of society, undergoes severe danger and incurs losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential functions of the society is prevented (p. 655).

Likewise, Barton (1969) argued that disasters were a form of collective stress resulting from an imbalance in the ability of a social system to meet the demands of a crisis situation. Russell Dynes and Enrico Quarantelli argued that disasters cannot be understood apart from their social context—including their social causes and effects (Dynes, 1970; Quarantelli, 1992; Quarantelli & Dynes, 1978).

These conceptualizations of disasters were broad enough to consider a range of events such as political unrest, revolution, and war, but the image of the subject matter increasingly focused on sudden-onset natural hazards and disasters. Seen as "acts of God" by the public, natural hazard events are considered to be relatively predictable in terms of geographic location, seasonality, and likely physical impacts. They are also considered to be unpreventable and beyond human control. As Andrew Baum and colleagues (Baum, Fleming, & Singer, 1982, 1983) observed, perceived lack of control is commonly associated with the experiences of those affected by natural disasters. Because natural disasters are considered to be unpreventable, natural disaster survivors tend to believe that the event was beyond their control, as well as beyond the control of any other human agency.

A driving research issue centered on the physical impacts of disasters and how they could be measured with respect to casualties, damage to the built environment, monetary losses, and other easily quantified indicators. Based on this research, changes in warning and evacuation processes were implemented to reduce casualties. Subsequent mitigation efforts (e.g., land use policies, building codes, and infrastructure standards) were aimed at reducing physical damages and associated financial costs and these efforts involved experts in engineering, economics, public administration, and public policy.

The dominant paradigm established disaster phases to assist in framing research issues and questions. For example, Drabek (1986) offered a linear model that includes the now widely-recognized stages of: preparedness (planning and warning); response (pre-impact mobilization and post-impact emergency actions); recovery (restoration—six months or less/reconstruction six months or more); and mitigation (hazard perceptions and adjustments). In this conceptualization, the impact of a natural disaster is sudden, with a definable beginning, middle, and end. Drabek further identified system levels for each phase: individual, group, organizational, community, society, and international. His model informed emergency planning and management practices and additionally helped to frame lines of inquiry for disaster research.

A community experiencing a disaster is often the recipient of outside assistance, understanding, and other forms of benevolent actions. At the Federal government level, compensation for losses is framed by the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988. Each state has policies and programs that offer assistance. Government efforts are bolstered by non-profit organizations with missions of providing post-disaster relief and recovery.

Social and geographic vulnerabilities to natural disasters were also revealed in early research. For example, this critical work shed light on differential impacts of disasters associated with sociodemographic characteristics including age, gender, race and ethnicity, class, and special needs populations. It also demonstrated the relationship between geographic location and vulnerability to natural hazards—place-based vulnerability. This knowledge helped to inform disaster preparedness, response, recovery, and mitigation activities.

Empirical studies revealed patterns of community responses to natural disasters. Typically, community members and those beyond the community share a similar definition of the event. In this context, a "therapeutic" or "altruistic" community tends to emerge and survivors

find collective support in a "community of sufferers," often experiencing "post-disaster utopia" (Barton, 1969; Dynes, 1970; Fritz, 1961; Wolfenstein, 1957). These characteristics enhance community recovery as people come together in a supportive way. Communities affected by natural disasters may emerge stronger —economically and socially—than they were prior to the event through "consensual adaptation" (Cuthbertson & Nigg, 1987). Moreover, the rebuilding process often leads to an "amplified rebound" with a stronger built infrastructure and economy than existed prior to the disaster (Drabek, 1986; Fritz, 1961; Kreps, 1989).

In terms of individual-level responses, studies of natural disasters found that most survivors engaged in goal-directed behavior aimed at ensuring personal and family safety as well as that of those around them. Survivors may undergo temporary "lifestyle" changes to cope with and adapt to post-disaster disruption. Contrary to popular beliefs, panic behavior, looting, and other forms of dysfunctional reactions were found to be rare. Survivors experienced psychosocial stress after natural disasters, but it tended to be short-lived. Like other traumatic life events, the intensity and duration of individual stress were dependent on factors such as severity of experience, exposure to injured and/or deceased, the degree of loss, vulnerability characteristics, and pre-event mental health conditions.

In summary, disaster social science that developed after WWII became a dominant paradigm that increasingly focused on sudden-onset natural hazard events. In doing so, it defined what should be studied, the questions that should be asked, how the questions should be asked, and the rules for interpreting the data. Embedded in this paradigm were the theoretical underpinnings, methodological approaches, and analytic techniques to be applied to the study of disasters. Notably, research based on this paradigm made significant contributions to improving emergency management practices, including preparedness, response, recovery, and mitigation activities.

3.3 Emergence of Technological Disaster Social Science

According to Kuhn, anomalies give rise to paradigmatic revolutions. Beginning in the early 1970s, a series of events with 'technological triggers' occurred which represented anomalies to the dominant disaster paradigm. In this section, we examine some of these seminal events and how research during this period addressed questions that emerged as a result of these anomalies. Previously unexplored questions brought researchers from new disciplines and diverse perspectives into the arena. This opened lines of inquiry to introduce an alternative paradigm that challenged the dominant disaster paradigm.

3.3.1 Buffalo Creek

In the United States, studies of technological disasters began in the 1970s with the Buffalo Creek flood that tore through 16 West Virginia communities on February 26, 1972. This disaster began when the Pittston Coal Company's coal slurry impoundment dam collapsed, causing a flood that killed 125 people and injured more than 1,000 out of a total population of approximately 5,000. Pittston representatives declared the disaster an "act of God," given the days of rain leading up to the dam break; survivors blamed the coal company for poor construction and maintenance of the dam, as well as the government, whose federal mine inspectors had deemed the impoundment safe just four days earlier. These competing interpretations of this disaster—in particular, its "triggering event" as noted in Freudenburg's definition—highlight a key aspect of the ways in which the Buffalo Creek flood set the stage for the birth of technological disaster research.

As a result of the flood more than 550 homes and 30 businesses were destroyed; an additional 950 homes sustained damaged, leaving more than 4,000 residents displaced (Schwartz-Barcott, 2008). Although the federal Department of Housing and Urban Development set up

temporary mobile home communities, neighbors and family members were separated during resettlement. This approach was contrary to recommendations that people be relocated in ways that would recreate a sense of community.

The Buffalo Creek disaster exposed pre-event characteristics and post-event responses that were atypical when compared with those of natural disasters. Although Pittston blamed heavy rains for the breach, subsequent investigations showed that the dam was improperly constructed. In fact, the origins of this disaster were technological malfunctions and human error. The dam failure was perceived by survivors as having been preventable; therefore they blamed the coal company and the government. Ensuing litigation against Pittston further distinguished this event from natural disasters.

As part of a class-action lawsuit, sociologist Kai Erikson was employed by the plaintiffs' attorneys to identify sociocultural and psychosocial damages resulting from the disaster. Erikson's foundational work revealed ways in which the etiology, as well as community and individual impacts of the Buffalo Creek flood, diverged from established perspectives of the dominant disaster paradigm (Erikson, 1976). For example, he described trauma as an event, as well as disruptions associated with an event. In this context, he identified collective, individual, and secondary trauma at Buffalo Creek. Collective trauma involved a "loss of communality" resulting from destruction of homes and communities and accompanying disruption of normal social networks and pre-existing patterns of interaction. Erikson also found individual trauma in the form of survivor guilt, anomie, feelings of loss of control, and other types of psychological stress—some of which became chronic. Involvement in class-action litigation and prolonged disruption created by the relocation process constituted secondary trauma.

Research by Goldine Gleser, Bonnie Green, and colleagues complemented Erikson's study by examining long-term psychological impacts of the Buffalo Creek disaster (Gleser, Green, & Winget, 1981; Green et al., 1990). This work contributed to understanding distinctions between the impacts of natural and technological disasters with respect to the severity of psychological stress as well as the protracted nature of this distress. For example, 14 years after the event, they found persistent post-traumatic stress disorder (PTSD), major depression, and anxiety disorders among survivors (Green et al., 1990). Few long-term studies had been conducted on the psychological impacts of natural disasters. Thus, at the time, the Buffalo Creek research represented groundbreaking work that the dominant paradigm had not considered.

3.3.2 Three Mile Island

On March 28, 1979, the Three Mile Island Unit 2 reactor near Middletown, Pennsylvania experienced a partial meltdown. At the time, it was the most serious accident in nuclear power plant operating history. Within hours after the incident began the governor of Pennsylvania, based on recommendations from the Nuclear Regulatory Commission, advised pregnant women and pre-school age children within five miles of the site to evacuate. By March 30, the evacuation zone extended to a 20 mile radius, but inconsistent and contradictory information combined with public uncertainties about nuclear risks lead to confusion and more than 140,000 residents evacuated the area. Most evacuees returned to their homes within three weeks after the incident. However, controversy and grassroots protests continued and the Unit 2 reactor was never restarted. Moreover, public concerns and reactions to the incident effectively stopped development of commercial nuclear power in the U.S.

Three Mile Island (TMI) was a clear example of an event in which human error and technological failure were to blame—that is, a technological disaster. Investigations pointed to lack of maintenance and oversight, as well as inadequate operator training and poor communication regarding safety protocols. As a high profile example of a technological disaster, TMI increased awareness of psychological stress associated with perceived "loss of control" and elevated uncertainty (Baum, Fleming, & Singer,

1982). Introducing new perspectives based on studies of environmental and social issues, as well as risk perceptions, Baum and colleagues noted "loss of control" over technology in the TMI context versus "lack of control" typically associated with natural disasters (e.g., "acts of God") as a contributing factor to increased anger, fear, frustration, and other forms of psychosocial stress.

With respect to damage characteristics, TMI revealed inadequacies in the dominant disaster paradigm, which focused on damage to the built environment that was visible, measureable, and calculable. Damage or potential damage caused by radiation was invisible, difficult to measure, and incalculable. Based on their observations of the disaster, Kasperson & Pijawka (1985) articulated that technological disasters differ from natural disasters because of the "unfamiliarity," "newness," and a "lack of accumulated experience" associated with technological disasters.

In many ways TMI diverged from the stage model of the dominant disaster paradigm. The incident revealed a lack of planning and anticipation of public reactions. Mixed messages from public officials resulted in inadequate warnings. The "preventative evacuation" behaviors observed in many natural disasters (Perry, 1979) extended well beyond the area deemed at risk by experts. Responses to TMI were primarily focused on gaining control of the reactor and containing the radiation. Once the situation was stabilized, responses centered on investigations into the causes of the accident. Communities surrounding TMI did not experience visible physical damage. Thus, recovery efforts of restoration and reconstruction associated with natural disasters did not apply. Instead, recovery blended into mitigation as individuals, families, and communities adjusted or "rebuilt" their perceptions and lifescapes of the hazards and risks related to nuclear energy. Uncertainty regarding long-term health effects and potential genetic damage from radiation exposure prolonged both individual and collective stress.

Three Mile Island became an exemplar of what Barry Turner labeled "man-made" disasters and Charles Perrow identified as a "normal accident." Turner analyzed industrial crisis incidents in the United Kingdom from 1965–1975, identifying organizational preconditions and processes that contributed to the incident as well as inadequate crisis management (Turner 1978; see also Turner & Pidgeon, 1997). Perrow (1984) examined TMI's tightly coupled technological and organizational systems and concluded that such systems were bound to fail. These "error inducing systems" can be improved to reduce probabilities of failure, but there is always potential for design flaws, failure of parts and procedures, operator errors, and unanticipated conditions. Furthermore, such systems resist regulation, provide inadequate warnings, and lack public preparedness. From these perspectives, disasters are embedded in social processes rather than merely being a sudden-onset event.

3.3.3 Love Canal

In the late 1970s, the neighborhood of Love Canal in Niagara Falls, New York, gained national prominence as the site of toxic contamination resulting from chemical waste disposal by the Hooker Chemical company decades earlier. At the time, Love Canal was home to approximately 900 families. Beginning in 1976, local newspaper reporters drew attention to Love Canal by suggesting that foul odors and health problems were related to living on the waste disposal site. Two years later, the New York State Department of Health released test results showing the strong presence of carcinogens. In an unprecedented move, the state declared the area an emergency site on August 2, 1978.

Research on Love Canal revealed a number of underexplored issues in the dominant disaster paradigm. Uncertainty about toxic exposure, levels of contamination, and concerns about health effects highlighted differences regarding the interpretations of the event, as well as the role of grassroots movements in defining the reality of post-disaster situations. Adeline Levine's (1982) work noted divisions within the affected community between people who believed they had been negatively affected by the disaster—

physically or otherwise—and those who perceived no damage. She referred to these groups as "maximalists" and "minimalists," respectively. Love Canal identified the emergence of secondary trauma related to dealing with the Environmental Protection Agency and other government entities and the challenges of relocation. As Fowlkes and Miller (1982) described:

> The situation at Love Canal differed from traditional disasters in two critical respects: there was no "sudden impact" resulting from the play of natural forces and there were no immediately discernable boundaries of destruction. Some degree of ambiguity regarding the definition of the situation was therefore intrinsic to it (p. 146).

In 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to deal with Love Canal and numerous other hazardous waste sites throughout the nation. Often referred to as the Superfund legislation, CERCLA authorized federal agencies to rank the nation's most damaging hazardous waste sites and clean or neutralize the sites using funds collected from primary responsible parties.

3.3.4 Technological Disasters in the 1980s

The 1980s were marked by multiple events that provided opportunities to further study technological disasters. Compelled by the identification of numerous toxic contamination sites throughout the U.S; a chronic fire in Centralia, Pennsylvania; a train derailment in Livingston, Louisiana; the Union Carbide gas leak in Bhopal, India; and the Chernobyl, Ukraine nuclear accident, a number of scholars led substantive research efforts that advanced understanding of these types of events. During this decade, scholars developed concepts and theories that would lead to a significant paradigmatic shift. Scholarly work included studies of specific events, as well as more general yet influential contributions to the body of knowledge in this area.

Building upon Love Canal research, the 1980s was a period when the notion of contaminated communities emerged—a significant counter to the dominant disaster paradigm. Beginning in 1983, Michael Edelstein published research on children living in the contaminated neighborhood of Legler, New Jersey. He conducted additional work throughout the decade, culminating in his 1988 book *Contaminated Communities: The Social and Psychological Impacts of Residential Toxic Exposure*. Edelstein's qualitative studies shed light upon grassroots movements associated with toxic contamination, focusing on the experiences of victims and their responses to stress. He described cumulative adverse social and psychological impacts and the stigma of living in these environments; the disempowering institutional context in which community members were operating; as well as ways in which residents of contaminated communities underwent lifestyle and lifescape changes. Furthermore, he pointed out tensions between those living in contaminated communities and "outsiders."

Couch and Kroll-Smith (1985) were among the first to synthesize research on "chronic technical disasters." Stemming from their qualitative work in Centralia, Pennsylvania, as well as observations of other contaminated communities, they articulated that these events were longer in duration compared to sudden-onset natural disasters; exhibited high levels of human and technological involvement; generated conflict and social breakdown in affected communities; resulted in long-term psychological impairment; tended to occur in communities that lacked resources to engage in effective responses; and, lacked sufficient government or policy responses (Couch & Kroll-Smith, 1985, 1992).

In a 1992 article, Couch and Kroll-Smith confronted the differential impacts of technological disasters head on, posing the question: "What is it about technological disasters that creates adaptational demands that frequently exceed the demands made by natural disasters and often exceed the capabilities of individuals and communities to cope effectively with the

stress?" (1992, p. 338) They identified the problem of "controllability" as a possible answer:

> Behind the idea of controllability is the relationship between technological disasters and human agency. Human activity—willful, negligent, or otherwise—is responsible for creating the disaster, and human intervention into the environment is required to abate, extinguish or otherwise control the disaster. The often extreme difficulties in detecting and measuring aversive agents that are invisible to the senses, and in developing and implementing mitigation plans that stop their advance, creates the problem of controllability and this problem, in turn, is a principle source of psychosocial stress in technological disasters (Couch & Kroll-Smith, 1992, p. 338).

Also in the early 1980s, Steve Picou and Duane Gill were conducting research on a train derailment and toxic spill in Livingston, Louisiana. Their efforts were part of a court-ordered study that employed a quasi-experimental design to examine the effects of this technological disaster. Picou and Gill used quantitative surveys of residents in Livingston and residents of a control community to document psychosocial stress and perceived health risks. According to their findings, psychosocial stress was highest among those closest to the impact site, those who were evacuated for extended periods of time, and those whose family members were separated when the derailment occurred. Many Livingston residents expressed a desire to move from the community, citing concerns about contaminated drinking water and increased health risks (Gill, 1986; Gill & Picou, 1991; Picou & Rosebrook, 1993).

In 1984, another extreme event in Bhopal, India focused international attention on industrial disasters. A chemical release at the Union Carbide pesticide plant exposed more than 600,000 people to toxic gases, ultimately killing an estimated 15,000 and injuring more than 200,000. Paul Shrivastava's (1987) research assessed the human, organizational, and technological causes of this event and offered insights on the challenges and potential consequences of rapid industrialization—especially in developing countries. Less than a year later, a similar but smaller chemical release from a Union Carbide plant in Institute, West Virginia occurred. Although this event paled in comparison to the deaths and injuries witnessed in Bhopal, the incident became an important driver behind the 1986 Emergency Planning and Community Right-to-Know Act (EPCRA). This legislation was designed to assist communities plan for and respond to incidents involving the numerous hazardous substances produced and used in society.

In 1986, not long after the Bhopal disaster, the Chernobyl Nuclear Power Plant in what was then the Ukrainian Soviet Socialist Republic, experienced a core reactor explosion during a power-failure stress test. The accident resulted in two immediate deaths, another 29 deaths from radiation exposure in the following months, and long-term health effects for thousands more. More than 500,000 workers were exposed to radiation while serving as 'liquidators' during the response and recovery phases. Radiation spread to all parts of the planet with heavy concentrations in parts of Europe resulting in restrictions on the consumption of vegetables and dairy products.

It was in the context of this decade of disasters that Ulrich Beck (1992, 1996) and Anthony Giddens (1990, 1991) began to theorize about risk in late modernity. Both scholars advocated a contextual constructionist approach to understand how sociocultural processes define and mediate risks. They described efforts used by stakeholders—governments, corporations, and others—to manage risk perceptions and policies by articulating claims and counter-claims. For Beck, Chernobyl was an exemplar of how risks in the modern era transcended space and time, as well as social class. Giddens focused on challenges to ontological security—"the confidence that most human beings have in the continuity of their self-identity and in the constancy of the surrounding social and material environments of action" (Giddens, 1990, p. 92). Technological hazards and risks of late modernity lead to doubts about the safety of the air we breathe, water we drink, food we consume, dwellings in which we live and work, and existing social structures and arrangements.

3.4 Synthesizing Work in Technological Disaster Social Science Research

Beginning in the 1990s and continuing through 2004, a number of scholars began to synthesize research findings—advancing concepts and theories in ways that would further contribute to a paradigm shift in disaster studies. Erikson's writings on Buffalo Creek, TMI, and other human-caused tragedies led him to identify a "new species of trouble" that "scare human beings in new and special ways, … [and]… elicit an uncanny fear in us" (1994, p. 144). He eloquently summarized prior research, acknowledging that although distinctions between natural and technological disasters are "hard to draw exactly," it is important to consider them. Understanding the etiology of a disaster is essential to understanding the psychological and sociocultural responses to such events. Although both types of disasters can be considered foreseeable and inevitable, Erikson characterized technological disasters as follows: "the thing ought not to have happened, that someone is at fault, that victims deserve not only compassion and compensation, but something akin to what lawyers call punitive damages" (1994, p. 143). Green (1996) suggests conceptualizing trauma along a "continuum of deliberateness" where technological disasters lie somewhere between natural disasters and purposeful acts of violence and terrorism.

As noted earlier in this chapter, Freudenburg (1997) focused on whether the "triggering event" could have occurred without human presence as the best way to determine the etiology of a natural versus technological disaster. Freudenburg advanced understanding of sociocultural and psychosocial responses to disasters in a number of ways. His work with Timothy Jones identified the "corrosive community" concept associated with technological disasters wherein social relationships are altered and social support is diminished (Freudenburg & Jones, 1991). In this social environment, uncertainty abounds and civil order is disrupted and diminished. Conflict emerges with respect to competing beliefs and narratives regarding blame and responsibility, the nature and extent of damages, and compensation. These competing definitions of the situation tear at the community's social fabric.

Freudenburg also introduced the concept of "recreancy"—referring to "the failure of experts or specialized organizations to execute properly responsibilities to the broader collectivity with which they have been implicitly or explicitly entrusted" (2000, p. 116)—to illuminate the importance of institutional trust and the consequences of breaching that trust. Drawing upon classical theories of Weber and Durkheim, recreancy stems from increased division of labor in modern industrial societies, which has resulted in greater societal interdependence (Freudenburg, 1993, 2000). Beliefs about recreancy contribute to a corrosive community atmosphere through loss of trust in institutions and organizations, as well as increased levels of uncertainty and fear. Perceptions and beliefs about recreancy become significant factors in risk assessment processes as they call into question the reliability and trustworthiness of institutions.

As previously mentioned, Edelstein ([1988] 2004, 2000) described "lifestyle change" and "lifescape change" that communities experience in the aftermath of a technological disaster—both of which represent coping and adaptive strategies. Lifestyle change refers to the interruption of "normal" patterns of everyday life, which occurs following both natural and technological disasters. Lifescape change suggests a more fundamental disruption of taken-for-granted assumptions under which communities operate that occurs in the aftermath of technological disasters. Lifescape change generally results in feelings of isolation, abandonment, distrust of others, concerns about health and the safety of the environment, and loss of control (Edelstein, [1988] 2004, 2000). Changes in lifescape tend to diminish ontological security or sense of order in the world (Giddens, 1991).

Early in the decade, Kroll-Smith and Couch (1991, 1993a) put forth an "ecological-symbolic" perspective to further refine understanding of disaster impacts. They proposed that pre-existing relationships with built, modified, and

biophysical environments strongly influence how individuals, groups, and communities interpret and respond to environmental trauma. They identified two sources of threat to communities faced with technological disasters: cultural change resulting from a lack of shared group assumptions and structural change related to disruptions to social networks and community routines. Similar to Edelstein's "lifescape change" and "lifestyle change," respectively, these collective adaptive responses to environmental trauma generate collective stress. This post-event stress is exacerbated by feelings of loss of control, uncertainty, alienation, and issues surrounding threat-belief systems. The ecological-symbolic perspective suggests that trauma and stress associated with technological disasters require special support to create shared meanings and promote cooperation and recovery (Kroll-Smith & Couch, 1993b).

As the 1980s drew to a close, the U.S. experienced one of the largest environmental disasters in history when the supertanker *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound, Alaska. Despite written contingency plans, efforts to contain and respond to the spill were insufficient and controversial. The spill released between 11 and 33 million gallons of crude oil that sullied 11,000 square miles including 1,300 miles of pristine Alaskan coastline. Immediate damage to the ecosystem was extensive and environmental impacts became chronic throughout the next two decades. More than 25 years later herring, a cultural and biological keystone species, has failed to recover. Chronic resource losses, like herring, combined with 19 years of adversarial litigation prolonged the disaster for many local communities (Gill, Ritchie, & Picou, 2016). Similar to previous technological disaster events, the oil spill gave rise to federal legislation —the Oil Pollution Act of 1990 (OPA).

In the months following the grounding, what became one of the longest-running studies of a technological disaster began with the work of Steve Picou and Duane Gill. Building upon their Livingston train derailment research, they developed a longitudinal field experiment design with Cordova, Alaska identified as the affected community and Petersburg, Alaska as a control community. Between 1989 and 2013, they utilized a mixed-methods approach including document review, ethnographic observations, interviews, and surveys. Each survey conducted over the 24 year period contained standardized measures of psychosocial stress providing an empirical portrait of stress and disruption over time.

Their approach built upon and expanded existing concepts and theories related to technological disasters. In the early years following the *Exxon Valdez* oil spill, they introduced the renewable resource community (RRC) concept to situate culturally based community activities within seasonal ecosystem cycles (Gill, 1994; Gill & Picou, 1997; Picou & Gill, 1997, 2000). They defined an RRC as, "a population of individuals who live within a bounded area and whose primary cultural, social, and economic existences are based on the harvest and use of renewable natural resources" (Picou & Gill, 1997, p. 881). Grounded in ecological-symbolic theory, the RRC concept focused attention on how communities, groups, and individuals responded to resource losses associated with the spill. In this context, Gill and Picou adapted Hobfoll's (1989) Conservation of Resources theory to examine psychosocial stress related to damaged ecosystem resources and economic losses, as well as other forms of resource loss and gain.

The RRC concept offered a framework to explain chronic psychosocial stress associated with technological disasters. It also provided a way to integrate the importance of exchange relationships represented in subsistence activities, the symbolic significance of sharing harvested resources, spiritual connections to the environment, and occupational reliance on harvesting renewable resources (Gill, 1994; Gill & Picou, 1997; Picou & Gill, 1997). Over the years, Picou and Gill incorporated concepts of corrosive community, recreancy, and lifestyle and

lifescape change in their research, with theories on risk perceptions, collective trauma, and collective stress underpinning their efforts.

Additional social science research on the EVOS in Alaska communities identified psychosocial impacts such as elevated levels of depression, anxiety, and PTSD (Impact Assessment, Inc., 1990; Palinkas, Russell, Downs, & Petterson, 1992; Palinkas, Downs, Petterson, & Russell, 1993a; Palinkas, Petterson, Russell, & Downs, 1993b); increased drug and alcohol use and domestic abuse (Impact Assessment, Inc., 1990); and the use of avoidance coping strategies (Endter-Wada et al., 1993). Generally, research findings showed losses in spiritual ties to the environment, a sense of place and feeling safe, exchange relationships, sharing harvested resources, and traditional reliance on harvesting renewable resources (Endter-Wada et al., 1993; Impact Assessment, Inc., 1990; Ritchie, 2004). Studies also revealed adverse effects of the disaster on children, who expressed fears of being left alone, declines in academic performance, and difficulties relating to others (Impact Assessment, Inc., 1990, 1998; Rodin, Downs, Petterson, & Russell, 1992).

In 2001, Liesel Ritchie used social capital theory to examine long-term, chronic impacts of the *Exxon Valdez* oil spill in Cordova. Her research integrated concepts such as corrosive community, recreancy, lifestyle and lifescape change, individual and secondary trauma, and loss of ontological security as dimensions of social capital (Ritchie & Gill, 2007). As Ritchie (2004, 2012) documented, the cumulative effects of the aforementioned concepts perpetuated chronic social capital loss spirals in Cordova, as well as "reluctant resignation" on the part of community members who continued to experience persistent adverse social impacts of the disaster more than fifteen years later. Ritchie's research also served as a basis to extend work on beliefs about recreancy to include organizational processes intended to address economic, social, and environmental consequences of technological disasters (Ritchie, Gill, & Farnham, 2013).

3.5 A Comparison of Natural and Technological Disasters

By the end of the 1990s, some clear distinctions could be drawn between natural and technological disasters based upon etiology, physical damages, disaster phases, post-disaster processes, vulnerability, community reactions, and individual reactions (See Table 3.1). In terms of etiology, natural disasters are rooted in nature (meteorological, geological, and hydrological processes) and are perceived to be predictable but not preventable. Conversely, technological disasters are rooted in hazards created by humans whether they are caused by design flaws, malfunctions, human error, or policy/regulatory failures. Responsible parties can be identified and held accountable for events that are perceived to be preventable. Instead of a perceived lack of control of natural hazard events, technological disasters involve a perceived loss of control over human-designed systems.

With respect to damage characteristics, the impacts of natural disasters are quantifiable and assessable in monetary terms. Technological disasters may or may not result in casualties and they are more likely to cause damage to the natural environment. Damages resulting from technological disasters tend to be difficult to calculate. Exposure to radiation, toxic contamination, and other damages from technological disasters may not be visible or readily detectable with human senses, which contributes to an ambiguity of harm and contested interpretations of the event. Sociocultural and psychosocial damages are more prevalent in technological disasters, but they are difficult to calculate and are rarely considered for compensation.

Technological disasters rarely followed the disaster phases articulated by the dominant paradigm. Situations like those found in Love Canal, Legler, and numerous other contaminated communities are not sudden-onset events and have no clear beginning. As technological disasters unfold, they often follow a non-linear pattern wherein communities and survivors

Table 3.1 Comparison of natural and technological disaster characteristics

Natural Disasters	Technological Disasters
Etiology/Origins	
• Rooted in nature—meteorological, geological, hydrological, biological • Often predictable—geographic location, seasonality, frequency • Not preventable • Associated with perceived *lack* of control	• Caused by humans—identifiable parties to hold accountable • Result of technological malfunctions, human error, or "recreancy" • Not predictable but perceived to be preventable • Associated with perceived *loss* of control
Physical Damages	
• Casualties—deaths & injuries • Visible damage to the built environment (e.g., lifelines, buildings, roads, bridges) • Assess damages in monetary and other quantifiable terms • Consensus regarding damage	• Environmental contamination and toxic exposure are relatively invisible • Uncertainty regarding extent & nature of the damage—"ambiguity of harm" • Contested interpretations of damages
Disaster Phases	
1. Preparedness (planning & warning) 2. Response (pre-impact & post-impact) 3. Recovery (restoration & reconstruction) 4. Mitigation (hazard perceptions & adjustments)	• Difficult to pinpoint a beginning & an end—lack of finality/closure • Those affected often enter into a corrosive warning, threat, impact, & blame cycle with no clear path to recovery • "Secondary traumas" emerge & may become chronic
Post-disaster Processes	
• Agency & organization support & responses • Stafford Act • Insurance claims, low interest loans	• Compensation for 'legitimate' claims • Litigation (typically adversarial & protracted) against the primary responsible party • Prompts reexamination of government policies and new legislation
Vulnerability	
• Sociodemographic—age, gender, race/ethnicity, class, special needs populations • Geographic or place-based—exposure to natural hazards • Exposure—disaster experience, damages, & losses • Limited access to social & political capital	• Individuals potentially vulnerable irrespective of traditional sociodemographic characteristics • Geographic or place-based—proximity to technological hazards; environmental justice issues • Exposure to toxins—amount, duration, & type • Sociocultural & psychosocial relationships with the natural environment
Community Reactions	
• "Therapeutic" or "altruistic" community emerges; communities experience "post-disaster utopia" & "amplified rebound" • Collective definition of the situation—"community of sufferers" • "Lifestyle change" • Initial local response	• "Collective trauma" & emergence of a "corrosive community" • No collective definition of the situation—individuals forced to create their own • Social capital loss spirals • "Lifestyle change" & "lifescape change" • Grassroots responses
Individual Reactions	
• Short-term psychosocial stress & social disruption • Immediate, acute health impacts & injuries	• Short-term & chronic psychosocial stress & social disruption • Prolonged uncertainty • Reluctant resignation • Long-term negative health outcomes

become caught in a corrosive cycle of warning, threat, impact, and blame (Picou, Brunsma, & Overfelt, 2010). Survivors become uncertain of what constitutes recovery and how to determine when the disaster is over, leaving many citizens unable to achieve closure. Secondary traumas in the form of bureaucratized claims processes, litigation, and relocation often accompany technological disasters and prolong adverse sociocultural and psychosocial impacts.

Under the dominant disaster paradigm in the U.S., federal government responses to natural disasters are the purview of the Federal Emergency Management Agency (FEMA) and guided by the Stafford Act. States have similar emergency management agencies and most local governments and communities have some form of emergency management. Financial losses are generally covered by various forms of insurance, low interest loans, and other investments. Moreover, governments, non-profit organizations, and private entities are involved in mitigation and preparedness for natural hazard events for communities, businesses, households, and individuals. Conversely, responses to technological disasters usually involve the primary responsible party and some level of government oversight. Compensation for losses must be recouped from the primary responsible party. Because damages are difficult to quantify and calculate, limits to 'legitimate' claims are imposed and compensation for additional losses are typically sought through litigation, which becomes adversarial and protracted. Technological disasters force a reexamination of existing policies and regulations. At the federal level, when policies, regulations, and oversight have been deemed inadequate, new legislation is often introduced and passed (e.g., CERCLA, EPCRA, and OPA).

Technological disasters reveal forms of vulnerability beyond those initially identified in the dominant disaster paradigm. Although many of the individuals and groups vulnerable to natural disasters are also at risk to technological hazards and disasters, the latter have the potential to affect everyone in a community. As Beck (2006) maintains, risk has become increasingly delocalized, transcending spatial, temporal, and social boundaries. According to him, the causes and consequences of risk have increasingly become incalculable and non-compensable.

With that said, the literature shows that communities and people may be vulnerable with respect to their proximity to facilities that produce and use hazardous materials; corridors that transport these materials; and waste disposal sites. From an environmental justice perspective, this continues to disproportionately affect populations based on race and class.

The notion of exposure as a form of vulnerability provides another point of comparison between natural and technological disasters. In technological disaster research, the definition of exposure expands to include not only damages and losses of various kinds, but exposure to hazardous materials, as well. In this context, there are several aspects of exposure to consider, including extent or amount of exposure, duration, and to what types of toxins. For example, as noted in the environmental justice literature, some individuals may come into contact with hazardous materials by virtue of where they live and may be exposed for years. Others, such as individuals involved with post-disaster cleanup activities, may have a relatively short duration of exposure but to highly concentrated and more potent levels of contaminants. Research has shown that higher levels of exposure—including perceived exposure—adversely affects psychosocial outcomes.

Technological disasters reveal vulnerabilities based on cultural, social, and economic relationships to damaged/threatened environmental resources. For example, comparative work on community reactions to the *Exxon Valdez* oil spill and the *BP Deepwater Horizon* spill indicated that ties to damaged/threatened renewable natural resources had a more significant influence on adverse psychosocial outcomes than other, more standard sociodemographic vulnerability factors (Gill, Picou, & Ritchie 2012).

As previously noted, findings generated by the dominant paradigm suggested that

community reactions to disasters generate a therapeutic and altruistic social environment and an amplified rebound often emerges after recovery. Communities dealing with technological disasters often experience a "corrosive community" characterized by breakdowns in social networks and relationships, increased group and interpersonal conflict, self-isolation, and social capital loss spirals. Community corrosion is fueled by contested definitions of the situation, prolonged uncertainty, chronic resource loss, and a lack of understanding and empathy from outsiders. Grassroots responses may emerge after a technological disaster, but they can also contribute to a sharpening of differences within the community.

At the individual level, findings from technological disaster research suggested that the acute, short-term psychosocial impacts associated with natural disasters tended to become chronic, due in part to the prolonged uncertainty. Norris, Friedman, and Watson (2002) analyzed 160 distinct samples of disaster 'victims' from empirical studies conducted over two decades. They concluded that while disasters pose mental health challenges to many people, those who experience technological disasters are at greater risk of adverse mental health impacts than those who experience natural disasters. Perceptions of recreancy enhance feelings of anger, frustration, betrayal, and outrage. Ontological security can become threatened and individuals may alter their lifescape to cope with the events. Individual survivors of technological disasters may also experience long-term adverse health outcomes (e.g., disease, cancer, genetic damage) or live in fear of such outcomes.

As stated in our introduction many disasters have overlapping qualities and characteristics that cross the boundaries of any strictly dichotomous approach. Thus, considering the characteristics presented in Table 3.1 on a continuum is perhaps a more appropriate way to think about disasters. With this in mind, we now move to a discussion of natech events, using the characteristics described above as a framework to examine Hurricane Katrina focusing on the City of New Orleans.

3.6 Natech Disasters: Toward a Convergence of Perspectives

In the early 1990s, Showalter and Myers (1994) documented the rise of incidents where natural hazard events and disasters caused the release of hazardous materials. Identified as "na-tech events," Showalter and Myers sought to recognize the existence of the risk, assess preparedness and mitigation measures, and make recommendations for improvement of these measures. Sometimes referred to as cascading events or a domino effect, the possibility of a natech[1] event generates significant risks for unprepared countries and communities.

Within this context, Cruz, Steinberg, Vetere Arellano, Nordvik, & Pisano (2004) examined natech risk, risk management, and emergency response in Europe and the U.S. They observed that natech events are particularly troubling in urban areas because of increased population density, more at risk infrastructure, and a concentration of industrial facilities. They additionally noted that mitigation techniques for industrial facilities are rarely designed to account for a concurrent natural hazard event and governments lack regulations plainly dealing with such events.

The Tohoku earthquake and tsunami and Fukushima Daiichi nuclear meltdown provides an exemplar of a natech disaster. On March 11, 2011, a magnitude 9 earthquake occurred off the northeastern coast of Japan unleashing a devastating tsunami with waves reaching heights of more than 130 feet. The tsunami resulted in almost 16,000 deaths and displaced more than 300,000 people. In addition to the physical damages to the built infrastructure, the tsunami triggered a meltdown at the Fukushima Daiichi nuclear power plant. Estimates developed by the World Bank put costs associated with these events at approximately $235 billion (U.S. dollars).

Similar to Chernobyl, an extensive area surrounding the Fukushima plant was contaminated

[1] Although the term "na-tech" was initially hyphenated by Showalter and Myers, more recent literature typically does not hyphenate "natech."

and had to be evacuated for extended periods; some have yet to return to their homes, businesses, and farms. Threat of radiation on the U.S. Pacific Coast caused concern among U.S. residents and is still being monitored by the Environmental Protection Agency. Contested interpretations of the event and the nature and extent of its consequences are reminiscent of the aftermath of prior technological events—with the added twist of the event being clearly triggered by a natural disaster. This makes it an exemplar natech event.

3.6.1 The Katrina Disaster

The Katrina disaster, particularly as it unfolded in New Orleans, provides another example of a natech event—one that has generated more disaster scholarship than any other previous event. Using the seven major categories of characteristics discussed in the previous section, we briefly review this disaster. With respect to etiology, Katrina was a devastating combination of natural, technological, and social triggers. The storm itself struck the Louisiana/Mississippi coastline on the morning of August 29th, 2005. Its winds, rain, and 15-28 foot tidal surges led to levee failures that later flooded 80 percent of New Orleans. In New Orleans, the disaster was less a product of the hurricane and more a consequence of historical factors including racism, high unemployment rates, political disenfranchisement, and governmental incompetence (Alter, 2005; Fussell, 2006). Thus, Katrina became less of a 'natural,' disaster and more of one caused by institutional failures, human neglect, and environmental degradation, such as disappearing coastline and wetlands (e.g., see Brinkley, 2006; Freudenburg, Gramling, Laska, & Erikson, 2009; Hartman & Squires, 2006; Oliver-Smith, 2006; Picou et al., 2010; Smith 2006). As documented by Freudenburg and colleagues (2009) in *Catastrophe in the Making*, decades of U.S. Army Corps of Engineer projects reflecting interests of political and economic elites set the stage for this unprecedented disaster.

In terms of physical damages, over 1,800 deaths occurred, 90,000 square miles of the region were declared disaster zones, and more than 250,000 homes were damaged or rendered uninhabitable, with estimates of up to $200 billion in damages. Ultimately, more than one million residents were forced to evacuate from the Gulf area—the largest single forced migration and long-term relocation in American history. More than 8 million gallons of oil were released into the environment, and flood waters in New Orleans were described as a "toxic gumbo" (Frickel, 2006; Picou et al., 2010). These figures associated with losses and damages resulting from Katrina do not capture the full range of immediate and long-term impacts of the event. Both in New Orleans and outside the city, there were contested definitions of damage, particularly regarding insurance claims and responsibility for compensation.

Katrina defied many of the traditional conceptualizations of disaster phases (Gill 2007). Although there were elements of preparedness (planning and warning), as well as response measures, the situation overwhelmed the capacity of these efforts in New Orleans. This hindered advancement through the recovery phases (restoration and reconstruction), as well as mitigation efforts. Given the history of social conditions in New Orleans, this disaster began long before the hurricane made landfall. Likewise—as demonstrated by Kroll-Smith, Baxter and Jenkins (2015) more than a decade later—recovery as a "return to life rehabbed and set right" eludes residents of some New Orleans neighborhoods (p. 116). In this sense, it is difficult to pinpoint a beginning and an end to Katrina—one of the characteristics of a technological disaster. In both Louisiana and Mississippi, coastal residents experienced secondary traumas related to recovery in the aftermath of the hurricane.

In New Orleans, especially, many of these secondary traumas were associated with post-disaster processes and efforts to respond, restore, and rebuild. These processes revealed the ineffectiveness of FEMA to respond to an event of this magnitude and led to severe criticism of state and local responses to the disaster.

Insurance companies contesting claims left hundreds of thousands of survivors without the resources needed for timely recovery and rehabilitation, which constituted another form of secondary trauma. Low interest programs such as the "Road Home" were deemed a dismal failure. It was in this context that FEMA underwent reorganization and other state and local agencies reviewed their policies and procedures, as well.

Katrina's effects on New Orleans further highlighted understanding of the ways in which vulnerability is a multifarious combination of place-based, social, and political factors. Although the swath of the hurricane was far-reaching, certain populations—particularly those already living a precarious existence, navigating their social and political environments—were more adversely affected because of these factors. The social capital upon which they relied on a day-to-day basis in some cases inhibited evacuation and other responses, leading to greater vulnerability. In other cases, social capital enabled local response efforts. Short- and long-term relocation also increased vulnerabilities by reducing access to networks and social capital that had been crucial for survival in New Orleans long before Katrina. Those who were able to stay or return to New Orleans faced additional vulnerabilities through toxic exposure (Picou, 2009).

An examination of community reactions to Katrina in New Orleans offers additional insights into how this natech event manifested a permutation of what we might expect in the wake of both natural and technological disasters. Around the city and the region, there were various therapeutic and corrosive reactions, as well as collective trauma; impacts on social and human capital; competing definitions of the situation; and, lifestyle and lifescape changes—many of which led to immediate and long-term grassroots responses. The aforementioned ineffectiveness of FEMA and other official agency responses additionally reaffirmed that locals are often the first responders to a disaster event.

Individual reactions to the Katrina disaster had elements of both natural and technological perspectives. Some survivors experienced short-term psychosocial stress and social disruption, but others experienced and continue to experience chronic stress and long-term negative health outcomes. A substantial portion of the more negative individual reactions were associated with previously described aspects of social and geographic vulnerability and prolonged uncertainty, which were fueled by poorly coordinated and inadequate post-disaster processes. Thus, there was a lack of a clear path to restoration and recovery. Extended relocation also exacerbated adverse individual psychosocial reactions by prolonging social disruption.

Katrina revealed weaknesses in both the dominant and the alternative paradigms associated with disaster social science. In the context of Katrina, distinctions between natural and technological disasters became irrelevant. The Katrina disaster was embedded in society and the social structure of the region and New Orleans in particular.

In the early 1980s, the dominant disaster paradigm was criticized for ignoring the social context of disasters (Hewitt, 1983). Although both the dominant disaster paradigm and the emerging technological disaster perspective have increasingly recognized the social embeddedness of disasters, there remains much work to be done. Arguably, technological disaster research opened the door to this line of inquiry and understanding by demonstrating how technological disasters are a product of human agency (Perrow, 1984; Turner, 1978). Mileti's (1999) *Disasters by Design* was an exemplar of how the dominant paradigm considered the social embeddedness of hazards, risk, and disasters. More recently, Tierney's (2014) *Social Roots of Risk* significantly advanced understanding of the implications of ways in which the spectrum of disasters—natural, technological, and natech—are situated in the social world.

3.6.2 The Emergence of Techna Disasters

Beginning in 2009, the oil and gas industry in the State of Oklahoma increased its practices of deep

wastewater injection. This approach to disposing of the byproducts of hydraulic fracturing was directly followed by a dramatic increase in seismic activity in parts of the state where injection was prevalent. Prior to this practice, Oklahoma averaged fewer than 2 magnitude 3.0+ earthquakes per year. Between 2009 and 2016, Oklahoma has had more than 2,000 magnitude 3.0+ earthquakes. The causal relationship between deep wastewater injection and increased seismic activity illustrates a new way of categorizing hazards, risks, and disasters. Other human activities such as the construction of dams and mining have also been shown to induce seismic activity. Thus, techna events are those in which economic and energy development activities trigger natural hazard events. Therefore, climate change—to the extent that it is driven by human activity—can be conceptualized as a techna event.

Notably, both natech and techna events challenge traditional perspectives on blame and responsibility. For example, in Oklahoma, property owners who have experienced damage from induced seismicity are seeking legal redress by suing parties they deem responsible for their losses. It is unclear how the courts will rule on issues of liability and compensation. Similar to the technological disaster paradigm, claims and counter-claims regarding contested science play a significant role in assigning responsibility and increasing uncertainty. These unresolved issues also have global implications as nations contest the degree to which highly industrialized societies are responsible for environmental degradation and extreme events that affect populations in non-industrialized and developing countries.

3.7 Conclusions

Disaster social science has come a long way in the past several decades. Using Kuhn's concept of paradigm and scientific development, we identified a dominant disaster paradigm that provided an image of the subject matter, what should be studied, the questions that should be posed, how they should be asked, and how to interpret the data. Within this context, the dominant paradigm mainly focused on sudden-onset natural hazard events with substantive research questions aimed at mitigation, planning, response, and recovery.

This dominant disaster paradigm began to face challenges in the 1970s when anomalous events involving technological hazards revealed conceptual and theoretical gaps in 'normal' disaster social science. This was particularly the case when radiation and toxic contamination were involved. Social scientists with backgrounds in environmental sociology, the sociology of risk, medical sociology, psychology, and anthropology began to study these events. Unencumbered by structural-functional theories and organizational and collective behavior approaches to the subject matter, research on these technological and natech disasters introduced new concepts and produced empirical results that challenged the dominant disaster paradigm. The advent of techna hazards and disasters presents additional challenges to the paradigm.

We contend that the alternative paradigm derived from the study of technological hazards and disasters has not constituted a "revolution" as described by Kuhn. Rather, a paradigmatic "evolution" is occurring as the dominant and alternative paradigms compete to provide information and understanding of a broader range of hazards and disasters. This evolving disaster research paradigm is absorbing and blending ideas from both perspectives to attend to problems that, independently, neither is able to fully address.

In moving forward, we first propose a continued evolution of this blended paradigm that involves reimagining the subject matter to merge perspectives to include *all* natural, technological, natech, and techna hazards and disasters. We further recommend that this expansion of the scope of the subject matter include a more diverse range of audiences. How this is reimagined is related to the kinds of research questions that should be posed, as well as paying greater attention to the potential stakeholders for the results. The latter, especially, has implications for how we interpret, present, and disseminate

research findings. Combined, the subject matter, research questions, and intended users of the information should drive the methods, techniques, and approaches in the field.

With respect to the fundamental image of the subject matter, there is general agreement among scholars that hazards and disasters are embedded in societal structures and processes. This recognition necessitates that we rethink the appropriateness of employing existing frameworks (e.g., the disaster cycle of preparedness, response, recovery, and mitigation) and examine the utility of new ones. There is also general consensus that frameworks that identify various forms of capitals or community assets have the potential to increase understanding about the embeddedness of hazards and disasters in society. For example, Flora and Flora's Community Capitals Framework (CCF) (Flora & Flora, 1993; Flora, Emery, Fey, & Bregendahl, 2008; Ritchie & Gill, 2011) has been adopted by the National Institute of Standards and Technology for use in its Community Resilience Planning Guide (NIST, 2014). Originally based in community development research, the CCF delineates seven different forms of capitals: natural, built (physical), financial (economic), human, social, political, and cultural. In NIST's transdisciplinary approach to enhancing community resilience, a community capitals approach provides a lens through which to reimagine the subject matter of hazards and disasters. Furthermore, it affords an opportunity for innovative collaborations and insights among researchers from different backgrounds, as well as practitioners and community members.

Another issue in reimagining the subject matter is the need for conceptual clarity. Resilience, as just one example, poses challenges with respect to scale, scope, and what has become a common question: Resilience for whom and to what? Whatever kind of clarity we achieve on resilience—as well as on other critical concepts such as vulnerability and recovery—needs to consider the full range of hazards and disasters, including technological, natech, and techna events. Similarly, this evolving image of the subject matter invites new theoretical perspectives and reinvigorates existing ones. Advancing our understanding of techna events, for instance, may be facilitated by theories of grassroots social movements, environmental justice, social psychology, and political economy. Notably, the infusion of new ideas and perspectives should consider ways to integrate and build upon the findings of prior hazards and disaster studies.

The evolution of the disaster research paradigm further involves reexamining relevant research questions. Fundamentally, among the most pressing general questions is the following: *Given the complexity of the social structures and processes in which hazards and disasters arise, how do we create interdisciplinary collaborative approaches?* Responding to this question would attend to the expansion of the image of the subject matter by focusing on the social embeddedness of hazards and disasters.

With respect to technological, natech, and techna events more specifically, future research should address how we might further integrate what we know about these types of events into the disaster cycle framework. For example, *What does extant knowledge of the social impacts of natech events mean for preparation, response, recovery, and mitigation?* Additional lines of inquiry are: *How do technological, natech, and techna disasters fit into an all-hazards approach to emergency planning and management? How do we assess cumulative impacts across multiple hazards and with respect to various forms of vulnerability?* Questions that seek to inform ways in which first responders, emergency managers, and the public make decisions in these contexts are also relevant in the blended disaster research paradigm.

Across the complete spectrum of hazards and disasters, additional research questions include: *What are the best practices of risk communication when there is a lack of trust in science, media, and public officials? What are the best practices of risk communication given new and emerging forms of communication?* Research designed to address these questions is particularly salient in the context of technological, natech, and techna events where toxic releases elicit uncertainty about

environmental contamination and threats to public health are of substantial concern to those most directly affected by these disasters.

There are a number of outstanding research questions that are primarily associated with technological, natech, and techna disasters. For example, the social disruption typical in the aftermath of these human-caused events continues to reinforce the need to examine issues of blame and responsibility, and the distinct adverse impacts of these circumstances. *Who should be responsible for preventing and mitigating these types of events (i.e., who should pay for this)? Who is ultimately accountable for compensating for the adverse outcomes of these events? How can compensation processes be improved to help communities be more resilient and to recover more quickly in the face of these types of hazards and disasters?* Future research should explore these kinds of questions and others with the same depth and level of detail as did the early research on natural hazards and disasters.

Addressing new research questions requires a reexamination of methods and an introduction of new techniques and methodological approaches. Methodology is also directly tied to reimagining the subject matter. Overall, of paramount consideration is the need for a basic methodological shift beyond strictly event-driven research and analysis of human responses and impacts to look at pre-existing social structures and processes that generate vulnerabilities and influence resilience. Frameworks that focus, for example, on community capitals are best served by a mixed methods approach that combines qualitative and quantitative data. Such frameworks also allow us to examine dependencies and interdependencies within and across systems. This is not to suggest that we abandon disaster case studies—particularly those of technological, natech, and techna events. These circumstances call for research comprised of quasi-experimental designs, longitudinal data collection, and a greater incorporation of standardized indicators of disaster-related social disruption and chronic stress. Community-based participatory research holds additional promise for studies of technological, natech, and techna events.

Extending analytical approaches to include data from social media and other big data sources will also help to address emerging research questions associated with new subject matter. In advancing these and other methods, attention must continue to be paid to ethical concerns and cultural sensitivity—issues that may be overlooked in the rush to tap into new technologies as sources of information.

Although Kuhn's discussion of how data are interpreted focuses primarily on scientists, hazards and disaster research has always had a broader constituency. Among individuals and groups with vested interest in research findings are academicians, practitioners, and policy-makers associated with public and private entities. Given this array of stakeholders, the evolving disaster paradigm must find ways to deal with and reconcile contested interpretations of results and what they mean for various parties.

In some ways, what we face in contemporary society resembles that which occurred in post-WWII—a need to plan and prepare for new issues of both national and international concern. Today, the challenges are not world war, but those related to climate change, techna hazards and disasters, and resilience. Individually and combined, these issues make it increasingly apparent that we need additional paradigmatic evolution to address these matters.

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Studying Future Disasters and Crises: A Heuristic Approach

4

E.L. Quarantelli, Arjen Boin and Patrick Lagadec

Contents

4.1 Introduction

Disasters and crises are as old as when human beings started to live in groups. Through the centuries, new types have emerged. For instance, the development of synthetic chemicals in the 19th Century and nuclear power in the 20th Century created the possibility of toxic chemical disasters and crises from radioactive fallouts. Older crisis types did not disappear: ancient types such as floods and earthquakes remain with us. The newer disasters and crises are additions to older forms; they recombine elements of old threats and new vulnerabilities.

The literature on crisis and disaster research suggests that we are at another important historical juncture with the emergence of a new distinctive class of disasters and crises not often seen before (Ansell, Boin, & Keller, 2010; Helsloot, Boin, Jacobs, & Comfort, 2012; Tierney, 2014). In this chapter, we discuss the rise of transboundary crises and disasters. We seek to offer a heuristic approach to studying these new crises and disasters.

We offer a heuristic approach to understanding the disasters and crises of the future. It is presented primarily as an aid or guide to looking further into the matter, hopefully stimulating more investigation on conceptions of disasters and crises in the past, the present, and the future. Unlike in some areas of scientific inquiry, where seemingly final conclusions can be reached (e.g.,

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about the speed of light), the basic nature of the phenomenon we are discussing is of a dynamic nature and subject to change through time. The answer to the question of what is a disaster or crisis has evolved and will continue to do so (see Perry's chapter in this handbook).

4.2 Classic Phenomena

Human societies have always been faced with risks and hazards. Earthquakes, hostile inter- and intra-group relationships, massive floods, sudden epidemics, threats to take multiple hostages or massacre large number of persons, avalanches, fires and tsunamis have marked human history for centuries if not eons. Disasters and crises requiring a group reaction are as old as when human beings started to live in stable communities.[1]

The earliest happenings are attested to in legends and myths, oral traditions and folk songs, religious accounts and archeological evidence from many different cultures and subcultures around the world. For example, a "great flood" story has long existed in many places (Lang, 1985). As human societies evolved, new threats and hazards emerged.

To the old there have been added new dangers and perils that increasingly have become potentially dangerous to human groups. Risky technological agents have been added to natural hazards. These involve chemical, nuclear and biological threats that can accidentally materialize as disasters. Intentional conflict situations have become more damaging at least in the sense of involving more and more victims. The last 90 years have seen two World Wars, massive air and missile attacks by the military on civilians distant from battle areas, many terrorist attacks, and widespread ethnic strife. Genocide killed one million persons in Rwanda; millions have become refugees and tens of thousands have died in Darfur in the Sudan in Africa. While terrorism is not a new phenomenon, its targets have considerably expanded.

Some scholars and academics have argued that the very attempt to cope with increasing risks, especially of a technological nature, is indirectly generating new hazards. As the human race has increasingly been able to cope with such basic needs as food and shelter, some of the very coping mechanisms involved (such as the double edged consequences of agricultural pesticides), have generated new risks for human societies (Beck, 1999; Perrow, 1999). For example, in 2004, toxic chemicals were successfully used to eradicate massive locust infestations affecting ten Western and Northern African countries. Those very chemicals had other widespread negative effects on humans, animals and crops (IRIN, 2004). Implicit in this line of thinking is the argument that double-edged consequences from new innovations (such as the use of chemicals, nuclear power and genetic engineering) will continue to appear (Tenner, 1996).

We cannot say that the future will bring more disasters, as we have no reliable statistics on prior happenings as a base line to use in counting (Quarantelli, 2001). At present, it would seem safer to argue that some future events are qualitatively different, and not necessarily that there will be more of them in total (although we would argue the last is a viable hypothesis that requires a good statistical analysis).

4.3 Societal Interpretations and Responses

Societies for the most part have not been passive in the face of these dangers to human life and well-being. This is somewhat contrary to what is implicit in much of the social science literature especially about disasters. In fact, some of these writings directly or indirectly state that a fatalistic attitude prevailed in the early stages of societal development (e.g., Quarantelli, 2000). This was thought because religious beliefs attributed negative societal happenings to punishments or tests

[1]This seems to have occurred about five to six thousand years ago (see Lenski, Lenski, & Nolan, 1991). However, recent archeological studies suggest that humans started to abandon nomadic wanderings and settled into permanent sites around 9,500 years ago (Balter, 2005) so community recognized disasters and crises might have an even longer history.

by supernatural entities (the "Acts of God" notion, although this particular phrase became a common usage mostly because it served the interests of insurance companies). But prayers, offerings and rituals are widely seen as means to influence the supernatural. So passivity is not an automatic response to disasters and crises even by religious believers, an observation sometimes unnoticed by secular researchers.

In fact, historical studies strongly indicate that societal interpretations have been more differentiated than once believed and have shifted through the centuries, at least in the Western world. In ancient Greece, Aristotle categorized disasters as the result of natural phenomena and not manifestations of supernatural interventions (Aristotle, 1952). The spread of Christianity about 2,000 years ago helped foster the belief that disasters were "special providences sent directly" from "God to punish sinners" (Mulcahy, 2002, p. 110). In the Middle Ages, even scholars and educated elites "no longer questioned the holy origins of natural disasters" (Massard-Guilbaud, Platt, & Schott, 2002, p. 19). Starting in the 17th century, however, explanations started to be replaced by "ones that viewed disasters as accidental or natural events" (Mulcahy, 2002, p. 110). This, of course, also reflected a strong secularization trend in Western societies. Perhaps this reached a climax with the 1755 Lisbon earthquake which Dynes notes can be seen as the "first modern disaster" (2000, p. 10).

So far our discussion has been mostly from the perspective of the educated elites in Western societies. Little scholarly attention seems to have been given to what developed in non-Western social systems. One passing observation about the Ottoman Empire and fire disasters suggests that the pattern just discussed might not be universal. Thus, while fire prevention measures were encouraged in cities, they were not mandated "since calamities were considered" as expressions of the will of God (Yerolympos, 2002, p. 224). Even as late as 1826 an Ottoman urban building code stated that according to religious writing "the will of the Almighty will be done" and nothing can and should be done about that. At the same time, this code advances the idea that nevertheless there were protective measures that could be taken against fires that are "the will of Allah" (quoted in Yerolympos, 2002, p. 226). Of course, incompatibility between natural and supernatural views about the world are not unique to disaster and crisis phenomena, but that still leaves the distinction important.[2]

Even recently, an Australian disaster researcher asserted that in the 2004 Southwestern Asian tsunami most of the population seemed to believe that the disaster was "sent either as a test of faith or punishment" (McAneney, 2005, p. 3). Or as another writer noted, following the tsunami, religiously oriented views surfaced. Some were by: "fundamentalist Christians" who tend to view all disasters "as a harbinger of the apocalypse". Others were by "radical Islamists" who are inclined to see any disaster that "washes the beaches clear of half-nude tourists to be divine" (Neiman, 2005, p. 16). After Hurricane Katrina, some leaders of evangelical groups spoke of the disaster as punishment imposed by God for "national sins" (Cooperman, 2005).

In the absence of systematic studies, probably the best hypothesis that should be researched is that at present religious interpretations about disasters and crisis still appear to be widely held, but relative to the past probably have eroded among people in general. The orientation is almost certainly affected by sharp cross-societal difference in the importance attributed to religion as can be noted in the religious belief systems and practices as currently exist in the United States and many Islamic countries, compared to Japan or a highly secular Western Europe.

4.3.1 Societal Responses

Apart from the varying interpretations of the phenomena, how have societies behaviorally reacted to existing and ever-changing threats and risks? As a whole, human groups have evolved a

[2]For an interesting attempt to deal with these two perspectives see the paper entitled Disaster: a reality or a construct? Perspective from the East, written by Jigyasu (2005) an Indian scholar.

variety of formal and informal mechanisms to prevent and to deal with crises and disasters. But societies have followed different directions depending on the perceived sources of disasters and crises. Responses tend to differ with the perception of the primary origin (the supernatural, the natural or the human sphere).

For example, floods were seen long ago as a continuing problem that required a collective response involving engineering measures. Stories that a Chinese Emperor, 23 centuries before Christ, deepened the ever-flooding Yellow River by massive dredging and the building of diversion canals may be more legend than fact (Waterbury, 1979, p. 35). However, there is clear evidence that in Egypt in the 20th Century BC, the 12th Dynasty Pharaoh, Amenemher II completed southwest of Cairo what was probably history's first substantial river control project (an irrigation canal and dam with sluice gates). Other documentary evidence indicates that dams for flood control purposes were built as far back as 1260 B C in Greece (Schnitter, 1994, p. 1, 8–9). Such mitigatory efforts indicate both the belief that there was a long-term natural risk as well as one that could be coped with by physically altering structural dimensions.

Later, particular in Europe, there were many recurrent efforts to institute mitigation measures. For example, earthquake resistant building techniques were developed in ancient Rome, although "they had been forgotten by the middle ages" (Massard-Guilbaud et al., 2002, p. 31). The threats from floods and fires spurred mitigation efforts in Greece. Starting in the 15th Century, developing urban areas devised many safeguards against fires, varying from regulations regarding inflammable items to storage of water for fire-fighting purposes. In many towns in medieval Poland, dams, dikes and piles along riverbanks were built (Sowina, 2002). Of course, actions taken were not always successful. But, if nothing else, these examples show that organized mitigation efforts have been undertaken for a long time in human history.

There have been two other major behavioral trends of long duration that are really preventive in intent if not always in reality. One has been the routinization of responses by emergency oriented groups so as to prevent emergencies from escalating into disasters or crises. For example, in ancient Rome, the first groups informally set up to fight fires were composed of untrained slaves. But when a fire in 6 A.D. burned almost a quarter of Rome, a Corps of Vigiles was created that had full-time personnel and specialized equipment. In more recent times, there are good examples of this routinization in the planning of public utilities that have standardized operating procedures to deal with everyday emergencies so as to prevent them from materializing into disasters. In the conflict area, there are various UN and other international organizations, such as the International Atomic Energy Agency and the European Union (EU), that also try to head off the development of crises. In short, societies have continually evolved groups and procedures to try to prevent old and new risks and threats from escalating into disasters and crises.

A second more recent major trend has been the development of specific organizations to deal first with wartime crises and then with peacetime disasters. Societies for about a century have been creating specific organizations to deal first with new risks for civilians created by changes in warfare, and then improving on these new groups as they have been extended to peacetime situations. Rooted in civil defense groups created for air raid situations, there has since been the evolvement of civilian emergency management agencies (Blanchard, 2004). Accompanying this has been the start of the professionalization of disaster planners and crisis managers. There has been a notable shift from the involvement of amateurs to educated professionals.

Human societies adjusted not only to the early risks and hazards, but also to the newer ones that appeared up to the last century. The very existence of the human race is testimony to the social coping mechanisms of humans as they face such threats. Here and there a few communities and groups have not been able to cope with the manifestations of contemporary risks and hazards (Diamond, 2005). But these have been very rare cases.

Neither disasters nor crises involving conflict have had that much effect on the continuing existence of cities anywhere in the world. Throughout history, many cities have been destroyed. They have been: "sacked, shaken, burned, bombed, flooded, starved, irradiated and poisoned", but in almost every case they have phoenix-like been reestablished (Vale & Campanella, 2004, p. 1). Around the world, from the 12th to the 19th Century, only 42 cities were "permanently abandoned following destruction" (Vale & Campanella, 2004, p. 1). The same analysis notes that large cities such as Baghdad, Moscow, Aleppo, Mexico City, Budapest, Dresden, Tokyo, Hiroshima and Nagasaki all suffered massive physical destruction and lost huge numbers of their populations due to disasters and wartime attacks. All were rebuilt and rebounded. At the start of the 19th Century, "such resilience became a nearly universal fact" about urban settlements around the world (Vale & Campanella, 2004, p. 1). Looking at these cities today as well as Warsaw, Berlin, Hamburg and New Orleans, it seems this recuperative tendency is very strong (see also Schneider & Susser, 2003).

In the Hiroshima museum that now exists at the exact point where the bomb fell, there is a 360-degree photograph of the zone around that point, taken a few days after the attack. Except for a few piles of ruins, there is nothing but rubble as far as the eye can see in every direction. There were statements made that this would be the scene at that location for decades. But a visitor to the museum today can see in the windows behind the circular photograph, many signs of a bustling city and its population (for a description of the museum see Webb, 2006). Hiroshima did receive much help and aid to rebuild. But the city came back in ways that observers at the time of impact did not foresee.

4.4 Systematic Studies of Disruptive Events

Early efforts to understand and to cope with disasters and crises were generally of an ad hoc nature. With the strong development of science in the 19th Century, there was the start of understanding the physical aspects of natural disasters, and these had some influence on structural mitigation measures that were undertaken. However, the systematic social science study of crises and disasters is about a half-century-old (Fritz, 1961; Kreps, 1984; Quarantelli, 1988, 2000; Schorr, 1987; Wright & Rossi, 1981).

In short, there is currently a solid body of research-generated knowledge developed over the last half century of continuing and ever increasing studies around the world in different social science disciplines. To be sure, such accounts and reports are somewhat selective and not complete. There are now case studies and analytical reports on natural and technological disaster (and to some extent on other crises) numbering in the four figures. In addition, there are numerous impressions of specific behavioral dimensions that have been derived from field research (for summaries and inventories see Alexander, 2000; Cutter, 1994; Dynes, DeMarchi, & Pelanda, 1987; Dynes & Tierney, 1994; Farazmand, 2001; Helsloot, Boin, Jacobs, & Comfort, 2012; Mileti, 1999; Oliver-Smith, 1999; Perry, Lindell, & Prater, 2005; Rosenthal, Boin, & Comfort, 2001; Rosenthal, Charles, & 't Hart, 1989; Tierney, Lindell, & Perry, 2001; Turner, 1978).

What are the distinctive aspects of the newer disasters and crises that are not seen in traditional ones? To answer this question, we considered what social science studies and reports had found about behavior in disasters and crises up to the present time. We then implicitly compared those observations and findings with the distinctive behavioral aspects of the newer disasters and crises.

4.4.1 Different Conceptions of Disasters and Crises

One issue that has always interested researchers and scholars is how to conceptualize disasters and crises. There is far from full agreement that all disasters and crises can be categorized

together as being relatively homogeneous phenomena (Quarantelli, 1998; Perry & Quarantelli, 2005). This is despite the fact that there have been a number of attempts to distinguish between, among and within different kinds of disasters and crises. However, no one overall view has won anywhere near general acceptance among self-designated disaster and crisis researchers. To illustrate we will briefly note some of the major formulations advanced.

For example, one attempt has been to distinguish between natural and technological disasters (Erikson, 1994; Picou & Gill, 1996). The basic assumption was that the inherent nature of the agent involved made a difference. Implicit was the idea that technological dangers or threats present a different and more varying kind of challenge to human societies than do natural hazards or risks. Most researchers have since dropped the distinction as hazards have come to be seen as less important than the social setting in which they appear. In recent major volumes on what is a disaster (Quarantelli, 1998; Perry & Quarantelli, 2005), the distinction was not even mentioned by most of the two dozen scholars who addressed the basic question.

Other scholars have struggled with the notion that there may be some important differences between what can be called "disasters" and "crises". The assumption here is that different community level social phenomena are involved, depending on the referent. Thus, some scholars distinguish between consensus and conflict types of crises (Stallings, 1988 tries to reconcile the two perspectives). In some research circles, almost all natural and most technological disasters are viewed as consensus types of crises (Quarantelli, 1998). These are contrasted with crises involving conflict such as are exemplified by riots, terrorist attacks, and ethnic cleansings and intergroup clashes. In the latter type, at least one major party is either trying to make it worse or to extend the duration of the crisis. In natural and technological disasters, no one deliberately wants to make the situation worse or create more damage or fatalities.

Now, there can be disputes or serious disagreements in natural or technological disasters. It is almost inevitable that there will be some personal, organizational and community conflicts as, for example, in the recovery phase of disasters, where scapegoating is common (Bucher, 1957; Drabek & Quarantelli, 1967, 1969; cf. Boin, McConnell, & 't Hart, 2008). In some crises, the overall intent of major social actors is to deliberately attempt to generate conflict. In contrast to the unfolding sequential process of natural disasters, terrorist groups or protesting rioters not only intentionally seek to disrupt social life, they modify or delay their attacks depending on perceived countermeasures.

Apart from a simple observable logical distinction between consensus and conflict types of crises, empirical studies have also established behavioral differences. For example, looting behavior is distinctively different in the two types. In the typical disaster in Western societies, almost always looting is rare, covert and socially condemned, done by individuals, and involves targets of opportunity. In contrast, in many conflict crises looting is very common, overt and socially supported, undertaken by established groups of relatives or friends, and involves deliberately targeted locations (Quarantelli & Dynes, 1969). Likewise, there are major differences in hospital activities in the two kinds of crises, with more variation in conflict situations. There are differences also in the extent to which both organizational and community-level changes occur as a result of consensus and conflict crises, with more changes resulting from conflict occasions (Quarantelli, 1993). Finally, it has been suggested that the mass media system operates differently in terrorism situations and in natural and technological disasters (Project for Excellence in Journalism, 1999, 2001).[3]

Both the Oklahoma City bombing and the 9-11 World Trade Center attack led to sharp clashes between different groups of initial organizational responders. There were those who saw these happenings primarily as criminal attacks necessitating closure of the location as a crime

[3]For a contrary view that sees terrorist occasions as more or less being the same as what behaviorally appears in natural and technological disasters (Fischer, 2003).

scene, and those who saw them primarily as situations where priority ought to be on rescuing survivors. In the 9-11 situation, the clash continued later into the issues of the handling of dead bodies and debris clearance.

All this goes to show that crises and disasters are socially constructed. Whether it is by theorists, researchers, operational personnel, politicians or citizens, any designation comes from the construction process and is not inherent in the phenomena itself. This is well illustrated in an article by Cunningham (2005) where he shows that a major cyanide spill into the Danube River was differently defined as an incident, an accident, or a catastrophe, depending on how culpability was perceived and who was doing the defining.

Still other distinctions have been made. Some advocate "crisis" as the central concept in description and analysis (see the chapter of Boin, Kuipers and 't Hart in this handbook). In this line of thinking, a crisis involves an urgent threat to the core functions of a social system. A disaster is seen as "a crisis with a bad ending" (Boin, 2005). This is consistent with the earlier expressed idea that while there are many hazards and risks, only a few actually manifest themselves. But the crisis idea does not differentiate among the manifestations themselves as the consensus and conflict distinction does.

This is not the place to try and settle conceptual disagreements and we will not attempt to do so. Anyone in these areas of study should acknowledge that there are different views and different proponents should try to make their positions as explicit as possible so people do not continue to talk past one another. It is perhaps not amiss here to note that the very words or terms used to designate the core nature of the phenomena are etymologically very complex with major shifts in meaning through time.[4] We are far from having standardized terms and similar connotations and denotations for them.

4.4.2 New Kinds of Disasters and Crises

A conceptual question that has come increasingly to the fore in the last decade or so is the question: Have new kinds of crises and disasters began to appear? We think it is fair to say that there are new types of risks and hazards. There are also structural changes in social settings. Together, they raise the prospect of new types of disasters and crises.

For example, we have seen the breakdown of modern transportation systems (think of the volcanic ash crisis that paralyzed air traffic in 2010; Kuipers & Boin, 2015). There have been massive information system failures either through sabotage or as a result of technical breakdowns in linked systems. There have been terrorist attacks of a magnitude and scale not seen before. We are living with the prospect of widespread illnesses and health-related difficulties that appear to be qualitatively different from traditional medical problems. We have just lived through financial and economic collapses that cut across different social systems around the world.

Many of these "new" disruptions have both traditional and non-traditional features: think of the heat waves in Paris (Lagadec, 2004) and Chicago (Klinenberg, 2002), the ice storms in Canada (Scanlon, 1998), but also the genocide-like violence in Africa and the former Yugoslavia.

The Chernobyl radiation fallout (1986) led some scholars and researchers to start asking if there was not something distinctively new about that disaster. The fallout was first openly measured in Sweden. Officials were mystified in that they could not locate any possible radiation source in their own country. Later radiation effects on vegetation eaten by reindeer past the Arctic Circle in northern Sweden were linked to the nuclear plant accident in the Soviet Union. The mysterious origins, crossing of national boundaries, and the emergent involvement of

[4]See Safire (2005) who struggles with past and present etymological meanings of "disaster", "catastrophe", "calamity" and "cataclysm"; also see Murria (2004) who looking outside the English language found a bewildering set of words used, many of which had no equivalent meanings in other languages.

many European and transnational groups was not something researchers had typically seen together in other prior disasters.

Looking back, it is clear that certain other disasters also should have alerted all of us to the probability that new forms of adversity were emerging. In November 1986, water used to put out fire in a plant involving agricultural chemicals spilled into the river Rhine. The highly polluted river went through Switzerland, Germany, France, Luxembourg and the Netherlands. A series of massive fire smog episodes plagued Indonesia in 1997 and 1998. Land speculations led to fire-clearing efforts that, partly because of drought conditions, resulted in forest fires that produced thick smog hazes that spread over much of Southeast Asia (Barber & Schweithelm, 2000). These disrupted travel, which in turn affected tourism as well as creating respiratory health problems, and led to political criticism of Indonesia by other countries as multi-nation efforts to cope with the problem were not very successful. Both of these occasions had characteristics that were not typically seen in traditional disasters.

4.4.3 Characteristics of Transboundary Crises and Disasters

In the original version of this chapter, we spoke about "trans-system social ruptures". This term was an extension of the earlier label of "social ruptures" advanced by Lagadec (2000, 2004). The term "transboundary" has since become the more conventional way to describe crises and disasters that jump across different societal boundaries disrupting the social fabric of different social systems (Ansell et al., 2010).

The two prime and initial examples we used in the original chapter were the Severe Acute Respiratory Syndrome (SARS) and the SoBig computer F virus spread, both of which appeared in 2003. The first involved a "natural" phenomenon, whereas the second was intentionally created. Since there is much descriptive literature available on both, we here provide only very brief statements about these phenomena.

The new infectious disease SARS appeared in the winter of 2003. Apparently jumping from animals to humans it originated in southern rural China, near the city of Guangzhou. From there it moved through Hong Kong and Southeast Asia. It spread quickly around the world because international plane flights were shorter than its incubation period. At least 774 infected persons died. It hit Canada with outbreaks in Vancouver in the West and Toronto far away in the East. In time, 44 persons died of the several hundred that got ill, and thousands of others were quarantined. The city's healthcare system virtually closed down except for the most urgent of cases with countless procedures being delayed or cancelled. The result was that there was widespread anxiety in the area resulting in the closing of schools, the cancellation of many meetings and, because visitors and tourists stayed away, a considerable negative effect on the economy (Commission Report, 2004, p. 28). The Commission Report notes a lack of coordination among the multitude of private and public sector organizations involved, a lack of consistent information on what was really happening, and jurisdictional squabbling on who should be doing what. Although SARS vanished worldwide after June 2003, to this day it is still not clear why it became so virulent in the initial outbreak and why it has disappeared (Yardley, 2005).

The SoBig computer F virus spread in August 2003 (Schwartz, 2003). It affected many computer systems and threatened almost all computers connected to the internet. The damage was very costly. A variety of organizations around the world, public and private, attempted to deal with the problem. Initially uncoordinated, there eventually emerged in an informal way a degree of informational networking on how to cope with what was happening (Koerner, 2003).[5]

What can we generalize from not only these two cases, but also others that we looked at later

[5]In May 2017, the so-called WannaCry virus affected millions of computers across the world with ransomware. Many hospitals were affected.

(Ansell et al., 2010)? The characteristics we depict are stated in ideal-typical terms; that is, from a social science perspective, what the phenomena would be if they existed in pure or perfect form.

First, the threat jumps across many international and national/political governmental boundaries. It crosses functional boundaries, jumping from one sector to another, and crossing from the private into public sectors (and sometimes back). There was, for example, the huge spatial leap of SARS from a rural area in China to metropolitan Toronto, Canada.

Second, a transboundary threat can spread very fast. Cases of SARS went around the world in less than 24 hours with a person who had been in China flying to Canada quickly infecting persons in Toronto. The spread of the SoBig F virus was called the fastest ever (Thompson, 2004). This quick spread is accompanied by a very quick if not almost simultaneous global awareness of the risk because of mass media attention.

Third, there is no known central or clear point of origin, at least initially, along with the fact that the possible negative effects at first are far from clear. This stood out when SARS first appeared in Canada. There is much ambiguity as to what might happen. Ambiguity is of course a major hallmark of disasters and crises (Turner, 1978). It is more pervasive in transboundary crises as information about causes, characteristics and consequences is distributed across the system.

Fourth, there are potentially if not actual large number of victims, directly or indirectly. The SoBig computer virus infected 30% of email users in China, that is about 20 million people and about three fourths of email messages around the world were infected by this virus (Koerner, 2003). In contrast to the geographic limits of most past disasters, the potential number of victims is often open ended in disruptions that span across boundaries.

Fifth, traditional "solutions" or approaches – embedded in local and/or professional institutions – will not always work. This is rather contrary to the current emphasis in emergency management philosophy. The prime and first locus of planning and managing cannot be the local community as it is presently understood. International and transnational organizations must typically be involved very early in the initial response (Boin, Ekengren, & Rhinard, 2013). The nation state may not even be a prime actor in the situation.

Sixth, although responding organizations and groups are major players, there is an exceptional amount of emergent behavior and the development of many informal ephemeral linkages. In some respects, the informal social networks generated, involving much information networking, are not always easily identifiable from the outside, even though they are often the crucial actors at the height of the crisis.

4.5 Transboundary Scenarios

In this section, we sketch several future scenarios that most likely would create transboundary disasters. Even though some of the scenarios discussed might seem to be science fiction in nature, the possibilities we discuss are well within the realm of realistic scientific possibilities.

The most obvious scenario revolves around asteroids or comets hitting planet Earth (Di Justo, 2005). This has, of course, happened in the past, but even more recent impacts found no or relatively few human beings around. There are two major possibilities with respect to impact (McGuire, 2000; Wisner, 2004). A landing in the ocean would trigger a tsunami-like impact in coastal areas. Just the thinking of the possibility of how, when and where ahead of time coastal population evacuations might have to be undertaken, is a daunting thought. Statistically less likely is a landing in a heavily populated area. But a terrestrial impact anywhere on land would generate very high quantities of dust in the atmosphere, which will affect food production as well as creating economic disruption. This would be akin to the Tambora volcanic eruption in 1813, which led to very cold summers and crop failures (Post, 1977). The planning and management problems for handling something like this would be enormous.

The explosion of space shuttle *Columbia* scattered debris over a large part of the United States. This relatively small disaster – compared to a comet or asteroid impact – involved massive crossing of boundaries, a large number of potential victims, and could not be managed by local community institutions. The response required that an unplanned effort coordinating organizations that had not previously worked with one another and other unfamiliar groups, public and private (ranging from the US Forest Service to local Red Cross volunteers to regional medical groups), be informally instituted over a great part of the United States (Beck & Plowman, 2013; Donahue, 2003).

A second scenario is the inadvertent or deliberate creation of biotechnological disasters. Genetic engineering of humans or food products is currently in its infancy. The possible good outcomes and products from such activity are tremendous (Morton, 2005) and are spreading around the world (Pollack, 2005). But the double-edged possibilities mentioned earlier are also present. There is dispute over genetically modified crops, with many European countries resisting and preventing their use and spread in their countries. While no major disaster or crisis from this biotechnology has yet occurred, there have been many accidents and incidents that suggest that this will be only a matter of time. For example, in 2000, StarLink corn, approved only for animal feed is found in the food supply, such as taco shells and other groceries. The same year farmers in Europe learned that that they had unknowingly been growing modified canola using mixed seed from Canada. In 2001, modified corn was found in Mexico even though it was illegal to plant in that country. That same year, experimental corn that had been engineered to produce a pharmaceutical that was found in soybeans in the state of Nebraska. In several places, organic farmers found that it was impossible for them to keep their fields uncontaminated (for further details about all these incidents and other examples, see Pollack, 2004). Noticeable is the leaping of boundaries and uncertainty about the route of spreading. It does not take much imagination to see that a modified gene intended for restricted use, could escape and create a contamination that could wreak ecological and other havoc.

Perhaps even more disturbing to some is genetic engineering involving human beings. The worldwide dispute over cloning, while currently perhaps more a philosophical and moral issue, does also partly involve the concern over creating flawed human-like creatures. It is possible to visualize not far-fetched worst-case scenarios that could be rather disastrous.

It should be noted that even when there is some prior knowledge of a very serious potential threat, what might happen is still likely to be as ambiguous and complex as when SARS first surfaced. This can be seen in the continuing major concern expressed in 2004 to mid-2005 about the possible pandemic spread of avian influenza, the so called "bird flu" (Nuzzo, 2004; Thorson & Ekdahl, 2005). Knowledge of the evolution and spread of new pandemics, their effects and whether presently available protective measures would work, may well be very limited. Knowledge that it might occur provides very little guidance on what might actually happen.

It is possible to imagine the destruction of all food supplies for human beings either through the inadvertent or deliberate proliferation of very toxic biotechnological innovations for which no known barriers to spreading exists. These potential kinds of global disasters are of relatively recent origins and we may expect more such possibilities in the future. The human race is opening up potentially very catastrophic possibilities by innovations in nanotechnology, genetic engineering and robotics (Barrat, 2013; Joy, 2000; Makridakis, 2017). A potential is not an actuality. But it would be foolish from both a research as well as a planning and managing viewpoint to simply ignore these and other doomsday possibilities.

The question might be asked if there is a built-in professional bias among disaster and crisis researchers and emergency planners to look for and to expect the worst (see Mueller, 2004 for numerous examples).

In the disaster and crisis area, this orientation is reinforced by the strong tendency of social

critics and intellectuals to stress the negative.[6] It would pay to look at the past, see what was projected at a particular time, and then to look at what actually happened. The worldwide expectations about what would happen at the turn of the century to computers are now simply remembered as the Y2K fiasco. It would be a worthy study to take projections by researchers about the future of ongoing crises and disasters, and then to look at what actually happened.

In the 1960s, in the United States, scholars made rough analyses about the immediate future course of racial and university riots in the country. Their initial appearances had not been forecasted. Moreover, there was a dismal record in predicting how such events would unfold (no one seemed to have foreseen that the riots would go from ghetto areas to university campuses), as well as that they rather abruptly stopped. We should be able to do a better job than we have so far in making projections about the future. But perhaps that is asking more of disaster and crisis researchers than is reasonable. After all, social scientists with expertise in certain areas, to take recent examples, failed completely to predict or forecast the non-violent demise of the Soviet Union, the peaceful transition in South Africa, or the development of a market economy in communist China (cf. Tetlock, 2005).

4.6 Increased Vulnerability and Changing Social Settings

A disaster or crisis always occurs in some kind of social setting. By social setting we mean social systems. These systems can and do differ in social structures and cultural frameworks.

There has been a bias in disaster and crisis research towards focusing on specific agents and specific events. Thus, there is the inclination of social science researchers to say they studied this or that earthquake, flood, explosion and/or radioactive fallout. At one level that is nonsense. These terms refer to geophysical, climatological or physical happenings, which are hardly the province of social scientists. Instead, those focused on the social in the broad sense of the term should be studying social phenomena. Our view is that what should be looked at more is not the possible agent that might be involved, but the social setting of the happening. This becomes obvious when researchers have to look at such happenings as the 2004 Southeast Asia tsunami or locust infestations in Africa. Both of these occasions impacted a variety of social systems as well as involving social actors from outside those systems. This led in the tsunami disaster to sharp cultural clashes regarding on how to handle the dead between Western European organizations who came into look mostly for bodies of their tourist citizens, and local groups who had different beliefs and values with respect to dead bodies (Scanlon, personal communication with first author).

The residents of the Andaman Islands lived at a level many would consider “primitive”. At the time of the 2004 tsunami in Southeast Asia, they had no access to modern warning systems. But prior to the tsunami, members of the tribal communities saw signs of disturbed marine life and heard unusual agitated cries of sea birds. This was interpreted as a sign of impending danger, so that part of the population got off the beaches and retreated inland to the woods and survived intact (ICPAC Report, 2006).

There is a need to look at both the current social settings as well as certain social trends that influence disasters and crises. In no way are we going to address all aspects of social systems and cultural frameworks or their social evolution, either past or prospective. Instead, we will selectively discuss and illustrate a few dimensions that would seem to be particularly important with respect to crises and disasters.

What might these be? Let us first look at existing social structures around the world. What differences are there in authority relationships, social institutions and social diversity? As examples, we might note that Australia and the United States are far more governmentally decentralized than France or Japan (Bosner,

[6]For example, Rees (2004), a cosmologist at Cambridge University, gives civilization as we know it only a 50-50 chance of surviving the 21st Century.

2002; Schoff, 2004). This affects what might or might not happen at times of disasters (it is often accepted that top-down systems have more problems in responding to crises and disasters). But what does it mean for the management of transboundary disruptions, which require increased cooperation between and across systems? Will decentralized systems be able to produce "emergent" transboundary cooperation?

As another example, mass media systems operate in rather different ways in China compared with Western Europe. This is important because to a considerable extent the mass communication system (including social media) is by far the major source of "information" about a disaster or a crisis. They play a major role in the social construction of disasters and crises. For a long time in the former Soviet Union, even major disasters and overt internal conflicts by way of riots were simply not openly reported (Berg, 1988). And only late in 2005 did Chinese authorities announce that henceforth death tolls in natural disasters would be made public, but not for other kinds of crises (Kahn, 2005).

Another social structural dimension has to do with the range of social diversity in different systems (Bolin & Stanford, 2006). Social groupings and categories can be markedly different in their homogeneity or heterogeneity. The variation, for instance, can be in terms of life styles, class differences or demographic composition. The aging population in Western Europe and Japan is in sharp contrast to the very young populations in most developing countries. This is important because the very young and the very old incur disproportionately the greatest number of fatalities in disasters.

Human societies also differ in terms of their cultural frameworks. As anthropologists have pointed out, they can have very different patterns of beliefs, norms, and values. As one example, there can be widely held different conceptions of what occasions disasters and crises. The source can be attributed to supernatural, natural, or human factors as indicated earlier. This can markedly affect everything from what mitigation measures might be considered to how recovery and reconstruction will be undertaken.

Norms indicating what course of action should be followed in different situations can vary tremendously. For example, the norm of helping others outside of one's own immediate group at times of disasters and crises ranges from full help to none. Thus, although the Kobe earthquake was an exception, any extensive volunteering in disasters was very rare in Japan (for a comparison of the US and Japan, see Hayashi, 2004). In societies with extreme cross-cultural ethnic or racial differences, volunteering to help others outside of one's own group at times of disasters or crisis is almost unknown.

Social structures and cultural frameworks of course are always changing. To understand future disasters and crises, it is necessary to identify and understand trends that may be operative with respect to both social structures and cultural frameworks. In particular, for our purposes, it is important to note trends that might be cutting across structural and cultural boundaries.

Globalization has been an ongoing force. Leaving aside the substantive disputes about the meaning of the term, what is involved is at least the increasing appearance of new social actors at the global level. With respect to disaster relief and recovery, there is the continuing rise of transnational or international organizations such as UN entities, the European Union, religiously oriented groupings, and the World Bank (Boin et al., 2013). With the decline of the importance of the nation state (Guéhenno, 1995; Mann, 1997), more and new social actors, especially of an NGO nature, are to be anticipated.

The rise of the information society has enabled the development of informal social networks that globally cut across political boundaries. This trend will likely increase in the future. Such networks are creating social capital (in the social science sense) that will be increasingly important in dealing with disasters and crises.

At the cultural level, we can note the greater insistence of citizens that they ought to be actively protected against disasters and crises (Beck, 1999). This is part of a democratic ideology that has spread around the world. That same ideology carries an inherent paradox: the

global citizen may not appreciate government interference in everyday life, but expects government to show up immediately when acute adversity hits.

Finally, there has been the impact of the 9/11 attacks especially on official thinking not just in the United States but elsewhere also. This happening has clearly been a "focusing event" (as Birkland, 1997 uses the term) and changed along some lines, certain values, beliefs and norms (Smelser, 2004; Tierney, 2005). There is a tendency, at least in the US after 9/11, to think that all future crises and disasters will be new forms of terrorism. One can see this in the creation of the US Department of Homeland Security, which repeated errors in approach and thinking that over 50 years of research have shown to be incorrect (e.g., an imposition of a command and control model, assuming that citizens will react inappropriately to warnings, seeing organizational improvisation as bad managing, see Dynes, 2003). These changes were accompanied by the downgrading of FEMA and its emphasis on mitigation (Cohn, 2005). Valid or not, such ideas influence thinking about transboundary disasters and crises (and not just in the United States).

The ideas expressed above and the examples used were intended to make several simple points. They suggest, for instance, that an earthquake of the same magnitude in France to one in Iran will probably be reacted to differently. A riot in Sweden will be a different phenomenon than one in Myanmar. To understand and analyze such happenings requires taking into account the aspects just discussed. It is hard to believe that countries that currently have no functioning national government, such as Somalia and the Democratic Republic of the Congo or marginally operatives ones such as Afghanistan, will have the same reaction to disasters and crises as societies with fully functional national governments. Different kinds of disasters and crises will occur in rather different social settings. In fact, events that today are considered disasters or crises were not necessarily so viewed in the past.

In noting these cross-societal and cross-cultural differences, we are not saying that there are no universal principles of disaster and crisis behavior. There is considerable research evidence supportive of this notion. We would argue, for example, that many aspects of effective warning systems, problems of bureaucracies in responding, the crucial importance of the family/household unit are roughly the same in all societies. To suggest the importance of cross-societal and cross-cultural differences is simply to suggest that good social science research needs to take differences into account while at the same time searching for universal principles about disasters and crises. This is consistent with those disaster researchers and scholars (e.g., Oliver-Smith, 1994) who have argued that studies in these areas have badly neglected the historical context of such happenings. Of course, this neglect of the larger and particularly historical context has characterized much social science research of any kind (Wallerstein, 1995); it is not peculiar to disaster and crisis studies.

4.7 The Social Amplification of Disasters and Crises

One trend that affects the character of modern crises and disasters is what we call the social amplifications of crises and disasters. Pidgeon, Kasperson, and Slovic (2003) described a social augmentation process with respect to risk. To them, risk not only depends on the character of the dangerous agent itself but how it was seen in the larger context in which it appeared. The idea that there can be social amplification of risk rests on the assumption that aspects relevant to hazards interact with processes of a psychological, social, institutional, and cultural nature in such a manner that they can increase or decrease perceptions of risk (Kasperson & Kasperson, 2005). It is important to note that the perceived risk could be raised or be diminished depending on the factors in the larger context, which makes it different from the vulnerability paradigm which

tends to assume the factors involved will be primarily negative ones.

We have taken this idea and extended it to the behaviors that appear in disasters and crises. Extreme heat waves and massive blizzards are hardly new weather phenomena (Burt, 2004). There have recently been two heat waves, however, that have new elements in them. In 2003, a long lasting and very intensive heat wave battered France. Nearly 15,000 persons died (and perhaps 22,000–35,000 in all of Europe). Particularly noticeable was that the victims were primarily socially isolated older persons. Another characteristic was that officials were very slow in accepting the fact that there was a problem and so there was very little initial response (Lagadec, 2004). There was a similar earlier happening 1995 in Chicago not much noticed until reported in a study seven years later (see Klinenberg, 2002). It exhibited the same features, that is, older isolated victims, bureaucratic indifference, and mass media uncertainty.

At the other temperature extreme, in 1998, Canada experienced an accumulation of snow and ice that went considerably beyond the typical. The ice storm heavily impacted electric and transport systems, especially around Montreal. The critical infrastructures being affected created chain reactions that reached into banks and refineries. At least 66 municipalities declared a state of emergency. Such a very large geographic area was involved that many police were baffled that "there was no scene", no "ground zero" that could be the focus of attention (Scanlon, 1998). There were also many emergent groups and informal network linkages (Scanlon, 1999).

In some ways, this was similar to what happened in August 2003, when the highly interconnected eastern North American power grid started to fail when three transmission lines in the state of Ohio came into contact with trees and short circuited (Townsend & Moss, 2005). This created a cascade of power failures that resulted in blackouts in cities from New York to Toronto and eventually left around 50 million persons without power, which, in turn, disrupted everyday community and social routines (Ballman, 2003). It took months of investigation to establish the exact path of failure propagation through a huge, complex network. Telecommunication and electrical infrastructures entwined in complex interconnected and network systems spread over a large geographic area with multiple end users. Therefore, localized disruptions can cascade into large-scale failures (for more details, see Townsend & Moss, 2005).

Such power blackouts have occurred among others in Auckland, New Zealand in 1998 (Newlove, Stern, & Svedin, 2002); in Buenos Aires in 1999 (Ullberg, 2004); in Stockholm in 2001 and 2002; in Siberian cities in 2001 (Humphrey, 2003); in Moscow in 2005 (Arvedlund, 2005); in Brazil in 2009 (Brooks, 2009); in Bangladesh in 2014 (Al-Mahmood, 2014), and in Sri Lanka in 2016 (LBO, 2016). All of these cases initially involved accidents or software and hardware failures in complex technical systems that generate severe consequences creating a crisis with major economic and often political effects. These kinds of crises should have been expected. A National Research Council report (1989) forecast the almost certain probability of these kinds of risks in future network linkages.

Blackouts can also be deliberately created either for good or malevolent reasons having nothing to with problems in network linkages. Employees of the now notorious Enron energy company, in order to exploit Western energy markets, indirectly but deliberately took off line a perfectly functioning Las Vegas power plant so that rolling blackouts hit plant-dependent northern and central California with about a million residences and businesses losing power (Egan, 2005). In the earliest days of electricity in New York City, the Mayor ordered the power cut off when poor maintenance of exposed and open wires resulted in a number of electrocutions of citizens and electrical workers (Jonnes, 2004). One should not think of blackouts as solely the result of mechanical or physical failures creating chain-like cascades.

4.8 Traditional Disasters and Crises Remain Dominant

Most disasters are still traditional ones. For example, four major hurricanes hit the state of Florida in 2004. We saw very little in what we found that required thinking of them in some major new ways, or even in planning for or managing them. The problems, individual or organizational, that surfaced were the usual ones, and how to successfully handle them is fairly well known. More important, emergent difficulties were actually somewhat better handled than in the past, perhaps reflecting that officials may have had exposure to earlier studies and reports. Thus, the warnings issued and the evacuations that took place were better than in the past. Looting concerns were almost non-existent and less than ten percent indicated possible mental health effects. The pre-impact organizational mobilization and placement of resources beyond the community level was also better. The efficiency and effectiveness of local emergency management offices were markedly higher than in the past.

Not everything was done well. Long known problematical aspects and failures to implement measures that research had suggested a long time ago were found. There were major difficulties in interorganizational coordination. The recovery period was plagued by the usual problems. Even the failures that showed up in pre-impact mitigation efforts were known.

The majority of contemporary disasters in the United States are still rather similar to most of the earlier ones. What could be seen in the 2004 hurricanes in Florida was rather similar to what the Disaster Research Center (DRC) had studied there in the 1960s and the 1970s. As the electronic age goes beyond its birth and as other social trends continue, new elements may appear creating new problems that will necessitate new planning. If and when that happens, we may have rather new kinds of hurricane disasters, but movement in that direction will be slow.

As the famous sociologist Herbert Blumer used to say in his class lectures a long time ago, it is sometimes useful to check whatever is theoretically proposed against personal experience. In 2005, an extensive snowstorm led to the closing of almost all schools and government offices in the state of Delaware. This was accompanied by the widespread cancellations of religious and sport events. There was across the board disruption of air, road and train services. All of this resulted in major economic losses in the millions of dollars. There were scattered interruptions of critical life systems. The governor issued a state of emergency declaration and the state as well as local emergency management offices fully mobilized. To be sure, what happened did not fully rival what surfaced in the Canadian blizzard discussed earlier. But it would be difficult to argue that it did not meet criteria often used by many to categorize disasters. What happened was not that different from what others and we had experienced in the past. In short, it was a traditional disaster.

Finally, at the same time we were thinking about the Florida hurricanes and the Delaware snowstorm, we also observed other events that many would consider disasters or crises. Certainly, a BP Texas plant explosion in 2005 would qualify. It involved the third largest refinery in the country. More than a hundred were injured and 15 persons died. In addition, there was major physical destruction of refinery equipment and nearby buildings were leveled. There was full mobilization of local emergency management personnel (Franks, 2005). At about the same time, there were landslides in the state of Utah and California; a stampede with hundreds of deaths in a Bombay, India temple, train and plane crashes in different places around the world, as well as large bus accidents; a dam rupture which swept away five villages, bridges and roads in Pakistan; recurrent coal mine accidents and collapses in China; recurrent false reports in Asia about tsunamis that greatly disrupted local routines; sinking of ferries with many deaths, and localized riots and hostage takings. At least based on press reports, it does not seem that there was anything distinctively new about these occasions. They seem to greatly resemble many such prior happenings.

Unless current social trends change very quickly in hypothetical directions (e.g., marked changes as a result of biotechnological advances), for the foreseeable future there will continue to be many traditional local community disasters and crises (such as localized floods and tornadoes, hostage takings or mass shootings, exploding tanker trucks or overturned trains, circumscribed landslides, disturbances if not riots at local sport venues, large plant fires, sudden discoveries of previously unknown very toxic local waste sites, most airplane crashes, stampedes and panic flights in buildings, etc.).

Mega-disasters and global crises will be rare in a numerical and relative sense, although they may generate much mass media attention. For example, the terrorist attacks in European cities (Madrid in 2004; London in 2005; Paris in 2015; Brussels, Nice, Munich Berlin in 2016; Stockholm and Manchester in 2017) were certainly major crises and symbolically very important, but numerically there are far more local train wrecks and car collisions everyday in many countries in the world. The more localized crises and disasters will continue to be the most numerous, despite the rise of transboundary crises and disasters.

4.9 Implications

What are some of the implications for planning and managing that result from taking the perspective we have suggested about crises and disasters? If our descriptions and analyses of such happenings are valid, there would seem to be the need for new kinds of planning and preparation for the management of future crises and disasters (Ansell et al., 2010). Non-traditional disasters and crises require some non-conventional processes and social arrangements. They demand innovative thinking "outside of the box" (Boin & Lagadec, 2000; Lagadec, 2005).

This does not mean that everything has to be new. As said earlier, all disasters and crises share certain common dimensions or elements. For example, if early warning is possible at all, research has consistently shown that acceptable warnings have to come from a legitimately recognized source, have to be consistent, and have to indicate that the threat or risk is fairly immediate. These principles certainly pertain to the management of transboundary disruptions.

Actually, if traditional risks and hazards and their occasional manifestations were all we needed to be worried about, we would be in rather good shape. As already said several times, few threats actually manifest themselves in disasters. For example, in the 14,600 plus tornadoes appearing in the United States between 1952 and 1973, there were casualties in only 497 of them, and 26 of these occasions accounted for almost half of the fatalities (Noji, 2000). Similarly, it was noted in 1993 that while about 1.3 million people had been killed in earthquakes since 1900, over 70% of them had died in only 12 occurrences (Jones, Noji, Smith, & Wagner, 1993, p. 19).

We can say that risks and hazards and their relatively rare manifestations in crises and disasters are being coped with much better than they ever were even just a half-century ago. For example, there has been a remarkable reduction in certain societies of fatalities and even property destruction in some natural disaster occasions associated with hurricanes, floods and earthquakes (see Scanlon, 2004 for data on North America). In the conflict area, the outcomes have been much more uneven, but even here, for example, the recurrence of world wars seems very unlikely.

But transboundary crises and disasters require some type of transboundary cooperation. For example, let us assume that a health risk is involved. If international cooperation is needed, who talks with whom about what? At what time is action initiated? Who takes the lead in organizing a response? What legal issues are involved (e.g., if health is the issue, can health authorities close airports?)? There might be many experts and much technical information around; if so, and they are not consistent, whose voice and ideas should be followed? What should be given priority? How could a forced quarantine be

enforced? What of ethical issues? Who should get limited vaccines? What should the mass media be told and by who and when?

At a more general level of planning and managing, we can briefly indicate, almost in outline form, a half dozen principles that ought to be taken into account by disaster planners and crisis managers.

First, a clear connection should be made between local planning and transboundary managing processes. There usually is a low correlation between planning and managing, even for traditional crises and disasters. But in newer kinds of disasters and crises, there are likely to be far more contingencies. Planning processes need to be rethought and enhanced to help policymakers work across boundaries.

Second, the appearance of new emergent social phenomena (including groups and behaviors) needs to be taken into account. There are always new or emergent groups at times of major disasters and crises, but in transboundary events they appear at a much higher rate. Networks and network links have to be particularly taken into account.

Third, there is the need to be imaginative and creative. The response to Hurricane Katrina suggests how hard it can be to meet transboundary challenges. But improvisation can go a long way. A good example is found in the immediate aftermath of 9/11 in New York. In spite the total loss of the New York City Office of Emergency Management and its EOC facility, a completely new EOC was established elsewhere and started to operate very effectively within 72 h after the attack. There had been no planning for such an event, yet around 750,000 persons were evacuated by water transportation from lower Manhattan (Kendra & Wachtendorf, 2016; Kendra, Wachtendorf, & Quarantelli, 2003).

Fourth, exercises and simulations of disasters and crises must take into account transboundary contingencies. Most such training and educational efforts along such lines are designed to be like scripts for plays. That is a very poor model to use. Realistic contingencies, unknown to most of the players in the scenarios, force the thinking through of unconventional options. Even more important, policymakers need to be explicitly trained in the management of transboundary crises and disasters.

Fifth, planning should be with citizens and their social groups, and not for them. There is no such thing as the "public" in the sense of some homogenous entity (Blumer, 1948). There are only individual citizens and the groups of which they are members. The perspective from the bottom up is crucial to getting things done. This has nothing to do with democratic ideologies; it has instead to do with getting effective and efficient planning and managing of disasters and crises. Related to this is that openness with information rather than secrecy is mandatory. This runs against the norms of most bureaucracies and other organizations. The more information the mass media and citizens have, the better they will be able to react and respond. However, all this is easier said than done.

Finally, there is a need to start thinking of local communities in ways different than they have been traditionally viewed. Up to now, communities have been seen as occupying some geographical space and existing in some chronological time. Instead, we should visualize the kinds of communities that exist today are in cyberspace. These newer communities must be thought of as existing in social space and social time. Viewed this way, the newer kinds of communities can be seen as very important in planning for and managing disasters and crises that cut across national boundaries. To think this way requires a moving away from the traditional view of communities in the past. This will not be easy given that the traditional community focus is strongly entrenched in most places around the world (see United Nations, 2005). But "virtual reality communities" will be the social realities in the future.

4.10 Looking at the Future

Assuming that what we have written has some validity, what new research should be undertaken in the future on the topic of future disasters and crises? In previous pages, we suggested some future studies on specific topics that would be worthwhile doing. However, in this section we want to outline research of a more general nature.

For one, practically everything we discussed ought to be looked at in different cultures and societies. As mentioned earlier, there is a bias in our perspective that reflects our greater familiarity with and awareness of examples from the West (and even more narrowly Western Europe, the United States and Canada). In particular, there is a need to undertake research in developing rather than only developed countries. And that includes at least some of these studies being undertaken by researchers and scholars from the very social systems that are being studied. The different cultural perspectives that would be brought to bear might be very enlightening, and enable us to see things that presently we do not see, being somewhat a prisoner of our own culture.

Second, here and there in this chapter, we have suggested that it is important to study the conditions that generate disasters and crises. But there has to be at least some understanding of the nature of X before there can be a serious turn to ascertaining the conditions that generate X. We have taken this first step in this chapter. Future work should focus more on the generating conditions. A general model would involve the following ideas. The first is to look at social systems (societal, community and/or organizational ones), and to analyze how they have become more complex and tightly coupled. The last statement would be treated as a working hypothesis. If that turns out to be true, it could then be hypothesized that systems can break down in more ways than ever before. A secondary research thrust would be to see if systems also have developed ways to deal with or cope with threatening breakdowns. As such, it might be argued that what ensues is an uneven balance between resiliency and vulnerability.

In studying contemporary trends, particular attention might be given to demographic ones. It would be difficult to find any country today where the population composition is not changing in some way. The increasing population density in high risk areas seems particularly important. Another value in doing research on this topic is that much demographic data are of a quantitative nature.

We mentioned financial and economic collapses cutting across different systems. How can financial collapse conceivably be thought of as comparable in any way to natural disasters and crises involving conflict? One simple answer is that for nearly a hundred years, one subfield of sociology has categorized, for example, panic flight in theater fires and financial panics as generic subtypes within the field of collective behavior (Blumer, 1939; Smelser, 1963). Both happenings involve new, emergent behaviors of a non-traditional nature. In this respect, scholars long ago put both types of behavior into the same category.

Although disaster and crisis researchers have not looked at financial collapses, maybe it is time that they did so. These kinds of happenings seem to occur very quickly, are ambiguous as to their consequences, cut across political and sector boundaries, involve a great deal of emergent behavior and cannot be handled at the community level. In short, what has to be looked for are genotypic characteristics not phenotypic ones (Perry, 2004). If whales, human beings, and bats can all be usefully categorized as mammals for scientific research purposes, maybe students of disasters should also pay less attention to phenotypic features. If so, should other disruptive phenomena like AIDS also be approached as disasters? Our overall point, is that new research along the lines indicated might lead researchers to seeing phenomena in ways different than they had previously seen.

Finally, we have said little at all about the research methodologies that might be necessary to study transboundary ruptures. Up to now, disaster and crisis researchers have argued that the methods they use in their research are indistinguishable from those used throughout the

social sciences. The methods are simply applied under circumstances that are relatively unique (Stallings, 2002).

In general, we agree with that position. But two questions can be raised. First, if social scientists venture into such areas as genetic engineering, cyberspace, robotics and complex infectious diseases, do they need to have knowledge of these phenomena to a degree that they presently do not have? This suggests the need for actual interdisciplinary research. Social scientists ought to expand their knowledge base before venturing to study certain disasters and crises, especially the newer ones. There is something here that needs attention. In the sociology of science there have already been studies of how researchers from rather different disciplines studying one research question, interact with one another and what problems they have. Researchers in the disaster and crisis area should look at these studies.

Our view is that the area of disasters and crises is changing. This might seem to be a very pessimistic outlook. That is not the case. There is reason to think, as we tried to document earlier, that human societies in the future will be able to cope with whatever new risks and hazards come into being. To be sure, given hazards and risks, there are bound to be disasters and crises. A risk free society has never existed and will never exist. But while this general principle is undoubtedly true, it is not so with reference to any particular or specific case. In fact, the great majority of potential dangers never manifest themselves eventually in disasters and crises.

Finally, we should note again that the approach in this chapter has been a heuristic one. We have not pretended that we have absolute and conclusive research-based knowledge or understanding about all of the issues we have discussed. This is in line with Alexander (2005, p. 97) who wrote that scientific research is never ending in its quest for knowledge, rather than trying to reach once-for-all final conclusions, and therefore "none of us should presume to have all the answers".

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Part II

Contemporary Issues in Disasters

Resilience and Disasters

5

James M. Kendra, Lauren A. Clay and Kimberly B. Gill

Contents

5.1 Introduction

Disaster scientists and policymakers have intensified their attention to resilience over about the last fifteen years. Scholars have been interested in whether social, built, or natural systems can withstand or quickly recover from some shock or disturbance, or whether these systems can avoid their own collapse due to some internal vulnerability. Policymakers and officials have sought assessment tools to quantify resilience in support of their institutional mandate for disaster preparedness: an application that has alarmed some critics of the idea of resilience, who think that resilience is a diversion, either a waste of time by scientists or a rhetorical strategy that allows governments to sidestep their roles in disaster management. As with many ideas in the social science of disaster, resilience has taken on a variety of meanings and has filled different research and policy purposes. For researchers interested in the topic, it is an explanatory framework for systems functioning under stress. For policymakers and officials charged with managing disaster, resilience is an aspirational state to which they might target capacity-building initiatives. Resilience, too, is a positive expression, as opposed to vulnerability, which suggests incapacity or lack of agency. And resilience and the closely-associated idea of vulnerability have seemed to provide, either alone or together, unifying frameworks for drawing together streams of scientific findings on what makes people more or less able to deal with risk, or the manifestation of risk as disaster.

The over-fifty-year history of organized disaster research tells us much about the role of such parameters as social class, location, family and household structure and characteristics,

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preparedness and mitigation, governance, improvisation and creativity, health, and economy. The concept of resilience has seemed to offer the hope for extracting a set of defining principles to determine what factors make a community more or less able to withstand and recover from disaster. A theory of disaster has long been a goal of disaster scientists, many of whom have been concerned that disaster studies have been a jumbled collection of topics: disparate, non-integrative, and disconnected from foundational interests in traditional disciplines (Alexander, 1993; Tierney, 2007). Though not stated explicitly, resilience seems to satisfy the desire to gather the threads together, evidenced by the vast growth of literature in the field and the many funding initiatives targeted to the study of resilience, such as the US National Science Foundation's programs Disaster Resilience for Rural Communities, Resilient Interdependent Infrastructure Processes and Systems, and Critical Resilient Interdependent Infrastructure Systems (NSF, 2010, 2014, 2016).

As with other main ideas in the disaster-oriented fields, such as crisis, disaster, or vulnerability, multiple definitions of resilience abound. Some concepts of resilience tend to generate unsatisfactory juxtapositions of ideas, or show that the qualities are contingent, contextual, and possibly not generalizable. Other challenges include debate over the scales at which to consider resilience (e.g., individual, household, community) or the systems to which they apply (e.g., infrastructure, ecological, social) and to what extent these are distinct, additive, or disconnected. Meanwhile, attempts to develop metrics to measure resilience, an extensive area of current research (Cutter, 2016), are plagued not only by the theoretical murkiness of the term but by the inadequacy of much of the data that is available for this purpose.

This chapter will review the state of the art of thinking about resilience. The literature is now too vast to easily address (Alexander, 2013) and scholars have expressed frustration with the number of different perspectives. Thus our purpose in this chapter is not to define what resilience "is" or "isn't," nor is it to decipher which one or another list of resilience ingredients is correct. The purpose, rather, is to account for the theoretical development of the term from different intellectual directions, to state where matters stand now, and to highlight how, in spite of theoretical discord, the pursuit of resilience is significant to the disaster field. While it must introduce the origin of the term as it is used presently (most scholars reach back to Holling's (1973) ecological theory of resilience, but even this is contested), this introductory material will mainly focus on the works on resilience that provide some of the intellectual foundations for present approaches in the context of disasters as treated in broad domains such as organizational, social psychological, community/place-based and integrative approaches. Next, we will discuss the elements of resilience and notable efforts to quantify and measure resilience, which is currently a significant focus area of the field. Lastly, this chapter will review the usefulness of the concept of resilience and current debates in the field, including the critical perspective. This last direction is especially important because a number of scholars argue that resilience is a blind alley, leading only to a recycling of existing ideas and a diversion of research support and administrative attention. Chief among these critics are Aguirre and Best (2015), Dombrowsky (2010) and Tierney (2015). These latter scholars are especially noteworthy in their criticism because Aguirre, Dynes, Kendra, and Connell (2005) advanced a powerful argument for considering resilience of systems in the face of new hazards and Kathleen Tierney was a key figure in an early resilience measures project (Bruneau et al., 2003). Both of these works are argued to be foundational pieces in contemporary resilience research, and thus these critics' misgivings are striking given their earlier work on the topic.

Nevertheless, despite these conceptual and methodological challenges, we assert that the concept is valuable. To begin with, disaster resilience is about one of the oldest concerns of human society: engagement with natural hazards, "one of the master tasks of civilization" (Mitchell, 2016, p. 11). Are structures and systems going to last? Resilience has compelled

researchers to take broader systems approaches in understanding the function of communities. It has compelled researchers to integrate fundamental ideas—vulnerability, adjustment, adaptation, improvisation, emergence—into overall theories of disaster, rather than just as explanatory variables for disaster management outcomes. Thus, the emphasis on resilience has forced consideration of cause, effect, contingency, and context in disaster. And the interest in resilience has stimulated truly interdisciplinary research across the social, natural, and engineering sciences (Kendra & Nigg, 2014).

The main story that we will tell is of a concept that is important, that has been key in reworking research and policy agendas, but has become fraught, contested, and discordant. We will see that resilience is an old story, but one which has become renewed in recent years. Yet in that very renewal it has drawn the antagonism of critics who blame it for its lack of newness. In that antagonism we can see the essence of paradox: the social sciences are often keen on overturning theories, but the quest for resilience is a foundational one; all societies have sought insight on how to endure, and resilience is part of that ongoing search for survival.

5.2 Development of Resilience

5.2.1 History

As a very brief summary of some of the history of resilience, most scholars generally start in the early 1970s with Holling's (1973) analysis of the recovery of ecosystems. He defined resilience as "*a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables*" (Holling, 1973, p. 14). However, as Alexander (2013) has noted, the idea actually has a history dating to antiquity, from the Latin *resilire*, to bounce, evolving over time to mean recovering from adversity, or "fortitude," a meaning that tallies well with present-day interests in such themes as *hardihood* or *grit* (Alexander, 2013; Duckworth, Peterson, Matthews, & Kelly, 2007). By the 1850s, notes Alexander, observers of the 1854 earthquake in Japan used the term "resiliency" to describe the survival capacities of the impacted population. Of course, this early use does not constitute a theory of resilience as is now sought, but it should be heartening to resilience theorists to see such a recognizable prototype for their object of study. It is only in 1858, Alexander (2013) further argues, that the word was used in an engineering sense to describe a quality of materials. This means that, interestingly, the socially-oriented meaning of the term predates the strength-of-materials usage which is now often used as the metaphor for explaining social resilience: bending, rebounding, restoring.

Alexander (2013) provides a very useful tracing of the term in more modern times, arguing that its usage in anthropology (circa 1950s, and stemming from ecological studies) was how it then moved into psychology in the 1970s. Interest in resilience spread in all directions, capturing attention based on scientific discipline and particular researchers' focal area. Resilience is simple to express—the idea of rebounding—but scholars have worked with the idea at many different social scales, and the connections between scales and the routes by which the term moved from field to field can be mapped only imprecisely.

5.2.2 Individual Resilience

At the level of individual coping capacities, much work on resilience focused on the impact of childhood experiences on subsequent emotional development. What distinguished the different trajectories of children from various upbringings? In those studies, the goal was to determine why some children, for example, who lived in distressing environments characterized by poverty or abuse did not go on to exhibit destructive behavior (Masten, Best, & Garmezy, 1990). In attributing such an outcome to a quality of resilience, psychologists sought to identify certain personality features which they in turn expressed as various factors such as Sagor's

(1996) CBUPO theory of *competence*, *belonging*, *usefulness*, *potency*, and *optimism*. While metaphors abound in writing on resilience, usually based either in strength-of-materials or ecological definitions, Sagor used a different metaphor for resilience: "an antibody that enables them to ward off attackers that might stop even the most formidable among us," and defines resilience "as the set of attributes that provides people with the strength and fortitude to confront the overwhelming obstacles they are bound to face in life" (Sagor, 1996, p. 38). Similarly, Masten et al. (1990) defined resilience as "the process of, capacity for, or outcome of successful adaptation despite challenging or threatening circumstances" (p. 425).

The emphasis on successful experiences is also one of the hallmarks of Bandura's self-efficacy school of thought, which is distinguishable from a parallel focus on self-esteem. That is, while "building self-esteem" relies on exhortations, self-efficacy relies on authentic successful experiences. "Instilling positive feelings in students will not result from pep talks or positive self-image assemblies but, rather, from planned educational experiences" (Sagor, 1996, p. 39). What is especially important about Sagor's formula is that resilience is a quality that can be built and nurtured over time through specific experiences as an active task that engages teachers and parents. Although it can be argued that transferring principles of resilience across social scales is difficult (Alexander, 2013), some scholars connect individual resilience, e.g., stress coping ability among emergency responders, as being important to the overall emergency system performance (Paton, 2003). And Weick (1990, 1993) connects individual personality characteristics and leadership approaches to organizational reliability and ability to avert failure.

5.2.3 Organizational Resilience

An early organizational look at resilience did not actually address the topic specifically. Perrow's (1984) classic *Normal Accidents* was one of the earlier modern looks at organizational failures. As is generally known, his ideas of interactive complexity and tight coupling have stimulated decades of debate on crises and accidents. Nevertheless, resilience is an implicit idea behind his writing; some systems would inevitably fail (nuclear power plants, maritime transport) but others, such as the air traffic control system, were less prone to failure (Perrow, 1984).

A different line of research, often considered to be in opposition to Perrow's Normal Accidents theory, is the theory of High Reliability Organizations (HRO) (see the energetic debate in the 1996 special issue of the *Journal of Contingencies and Crisis Management* (Rochlin, 1996)). HROs are organizations that were deemed to be especially good at detecting danger, either from internal failure or external disturbance, and responding to lessen the danger. Scholars such as La Porte (1996), Roberts (1990), Weick (1993), Weick, Sutcliffe, and Obstfeld (1999) and others developed theories of organizational behavior that explained why some organizations were alert for possible failures and adaptive to changes in the environment. For these writers, resilience was a component of reliability, consisting of norms of communication, improvisation and shifts of decision-making power to people close to the action. In this formulation, resilience in an organization was part of the capacities needed to manage risk.

Karl Weick is one of the pre-eminent thinkers on group and organizational resilience and adaptability (Weick, 1993; Weick et al., 1999). In a classic study of group cognition and environmental sensemaking, using as a case study the deaths of a dozen wildland firefighters in 1947, Weick (1993) distilled four attributes that should lead to an organization's ability to perceive environmental change, process challenges and solutions across organizational members, and develop creative and effective solutions to problems at hand. The first is *improvisation*. In the Mann Gulch fire, as the flames were gathering on the team, the fire boss suddenly built an escape fire and told the crew to get into the ashes. Why

they did not is a matter of some dispute, but Weick contends that the strategy was new to them, that they hadn't had much time to develop a rapport with the team leader that would have enabled them to trust his unorthodox maneuver, and moreover that his command to "drop your tools" and run created a tension for them: if they drop their tools they lose their identity as firefighters, but they could not run as fast with their tools. They kept their tools and perished.

Virtual role systems mean that all members of an organization know something about what everyone else is doing; knowledge and information are shared; and everyone is alert, active, and engaged. In this way someone can fill in for someone who is absent, but it also means that everyone in the organization can estimate how an unfolding situation will affect their colleagues; thus, they are able to back someone up if they are becoming overwhelmed (Weick, 1993). *Wisdom* is an appreciation for boundaries of knowledge: understanding what one knows and what one does not know; an appreciation for how present circumstances might be the same or different from previous experience. Weick's final characteristic of resilience is *respectful interaction*. From Weick's perspective, built up in numerous works (e.g., Weick, 1995), organizations are "talked into existence." They do not exist without communication between their component parts. People must be free to give accurate information and they must trust their colleagues to do the same (Weick, 1995). For example, in the 1977 crash of two 747 jets at Tenerife the copilot of one of the planes was hesitant in correcting the pilot's erroneous perception that the runway was clear; the pilot sped down the runway for takeoff and collided with another plane. Nearly all aboard the two aircraft died (Weick, 1990). In looking at these findings of organizational resilience, we would hypothesize that organizations that appreciate free exchange of information, where creativity is valued so that improvisation can be deployed where needed and where everyone is expected to be alert and ready to speak up if something seems awry, would be more resilient than organizations where individual creative thinking and transparent communication is not present or supported.

Kendra and Wachtendorf (2001) argue that some aspects of creativity and resourcefulness will depend, in part, on an individual's capacities, their ability to apply them, and also their belief in their ability to apply them. Mallak (1998a) provides some evidence for that broad proposition. Mallak (1998a) conducted a study that sought to understand the organizational resilience of hospitals. Resilience should, in his view, lead to improved outcomes such as better treatment results. He surveyed nursing executives, probing for features of resilience in attributes of the hospital workspace. His findings cross social scales, and include both individual characteristics as well as organizational ones that are reflected in procedures and norms of acceptable behavior. For example, he found certain individual tendencies contributed to overall resilience. These included *perceiving experiences constructively and perform[ing] positive adaptive behaviors*. He also found a number of organizational norms that enabled individual action. These include such characteristics as *goal-directed solution seeking*, which means that personnel set "goals and a vision to guide creative processes in seeking solutions to problems" (Mallak, 1998b, p. 151); gathering information from diverse sources to enhance understanding, referred to as *multiple source reliance*; and *resource access*, meaning that personnel can get the equipment they need without asking permission (Mallak, 1998b). These findings further suggest that attributes such as creativity and improvisation foster a resilient organization.

5.2.4 Community Resilience

In the context of disaster research, interest on resilience is primarily focused at the community level. Although transferring concepts of resilience across scales and domains is theoretically

and methodologically challenging (Kulig, Edge, Townshend, Lightfoot, & Reimer, 2013), we can see linkages and nesting of these capacities. Adger (2000), for example, illustrates the connection between ecological and social resilience in finding that characteristics of social resilience are key to how communities acclimate to environmental change, especially in places where economic stability depends on ecological and environmental resources. Kendra and Wachtendorf (2003) argued that community resilience should be understood with regard to the resilience of the organizations within the community, and vice versa. In their view:

> resilient communities provide the context in which organizations themselves become more resilient. An economically strong community is better able to respond to disastrous events than one that is economically troubled. At the same time, organizations provide the infrastructure for a community's resilience, in that organizational resources, networks and overall capacity are what make coordinated community-wide response possible…. The relationship is iterative and telescoping, played out across multiple scales within organizations, between organizations and between organizations and the community (p. 48).

Aguirre et al. (2005) argued for the need to take an *institutional* approach in theorizing disaster resilience. In their study of disaster preparedness in hospitals, they sought to address hazards that were not bounded by space or time. "These hazards have amorphous time and space coordinates, subtle and hardly perceptible modes of initiation, cannot be easily distinguished in terms of their relative seriousness, and are typically large scale complex events that impact simultaneously multiple value systems" (Aguirre et al., 2005, p. 2). Resilience, then, would lie in the interplay of multiple systems of social life, including those systems that compose the cultural elements of the community: its systems of governance. Menoni et al. (2000) also argued for a larger contextual view of hospital resilience, asserting that those systems could not be separated from the functioning of other infrastructural systems.

There are not precise switching points from one scale to another; rather we can see dominant clusters of intellectual activity around the topic of resilience. The progression of thinking was not linear. Vulnerability, to which resilience is often counterposed, sprang from geographic and anthropological traditions, heavily influenced by political interpretations of environmental mismanagement and power relations that created a hazard. Resilience arose from both interest in psychological health and emotional thriving, and from interest in systems.

Comfort (1999) also shows how resilience can cross scales, describing what systems need in order to identify danger, to comprehend it institutionally, and to implement activities for mitigation and response. Drawing on a number of research traditions, she argues that the following conditions are required for communities to develop a sense of "shared risk" and, therefore, to be able to act collectively to minimize it: "'discovery' of a common threat;" "'common understanding among the affected group' of the problem;" "mechanisms of information exchange and feedback;" "means of integrating information;" and "means of evaluating performance and incorporating this information into a common knowledge base that informs the next decision in the evolving process" (Comfort, 1999, p. 31). She further argues that "[e]ach of these conditions, and the interaction among them, contributes to collective learning and creates shared knowledge, the basis for collective action" (p. 32) and notes the importance of "the instinctual drive for creative acts of self-expression" (p. 59). Comfort (1999, p. 22) refers to "the edge of chaos" to describe how impending breakdown also stimulates inspiration, a space where auto-adaptive, self-organizing systems have high capacity and creativity functioning. Disaster response, and thus disaster resilience, is therefore a creative process. The community has been affected; it is now in a creative mode to re-envision its future and move toward its new form.

Interest in resilience at the community scale vectored in from other theoretical directions as

well. Through vulnerability as a linkage, anthropologists and geographers adopting political ecological approaches saw environmental degradation, pollution, and hazard all as the result of political and economic systems that pulled resources from the environment and left people with the waste. In their view, which they advanced as a corrective to hazard studies focusing on risk and decision-making, people were exposed to hazard not because of their ignorance but because of economic and social conditions that limited their choices. Here, in the space of a few years, we see the appearance and hypothesized relationships of several different ideas relating vulnerability and resilience. According to Dow (1999, p. 76):

> Vulnerability is the differential susceptibility of ecosystems, households, or social groups to losses. This susceptibility is a function of three dimensions: exposure, resistance, and resilience. Resistance and resilience together are referred to as coping abilities. *Exposure* is the degree of risk of an event experienced in everyday life, from the probability of a hazard to actual occurrences of events of all sizes… *Resistance* is the ability to withstand the impacts and continue to function… *Resilience* is the ability to recover, ranging in degree from simply achieving stability at any level of functioning to recovering the full range of resources and positive momentum that existed prior to the event.

Resilience in the case Dow (1999) studied (an oil spill damaging a local fishery in Malaysia) included changes from working in fisheries to working in hotels, relying on family, expending savings, and occasional small-scale farming. Here we see portrayed such characteristics of resilience as redundancy, multiple employment opportunities, and diverse industries in a place (Dow, 1999). Another example of an approach to examine institutional principles of resilience was developed by the Centre for Community Enterprise, which considered such features of a community as the amount of locally owned industry, the availability of banking and a diversity of employment and industry (Rowcliffe, Lewis, & Port, 2000). In addition, they look at the strength of civil society and participatory and responsive norms of governments. Also taking an institutional approach, Aguirre et al. (2005) considered resilience as arising from the functioning of 17 different sectors, such as utilities, healthcare, education, and others, where they argue that the higher performing the sectors are, the more resilient the community.

5.3 Current Approaches to Resilience

5.3.1 U.S. Disaster Resilience Policy

A number of scholars have argued that resilience is not yet operationalized and have struggled with what operationalizing resilience might look like (Balboni, Kaniewski, & Paulison, 2011; Mayunga, 2007; Porfiriev, 2009). But, meanwhile, resilience has been drawn strongly into the disaster policy milieu. As an example, the 2007 Homeland Security Presidential Directive 21, issued by President George W. Bush on Public Health and Medical Preparedness (Bush, 2007) describes resilience as follows:

> Where local civic leaders, citizens, and families are educated regarding threats and are empowered to mitigate their own risk, where they are practiced in responding to events, where they have social networks to fall back upon, and where they have familiarity with local public health and medical systems, there will be community resilience that will significantly attenuate the requirement for additional assistance. The Federal Government must formulate a comprehensive plan for promoting community public health and medical preparedness to assist State and local authorities in building resilient communities in the face of potential catastrophic health events (p. 4).

The Directive mandated a coordinated effort from the U.S. Departments of Health and Human Services, Defense, Veterans Affairs, and Homeland Security to ensure a trained public health workforce to address the needs of households and institutions and to provide opportunities for citizen involvement in building community resilience. The Directive allowed 270 days for identified parties to operationalize the Directive

into a comprehensive plan. Key elements of resilience emphasized in the directive include *community education*, *community empowerment*, *practice*, *social networks*, and *familiarity with local services* (Moore, Chandra, & Feeney, 2012). By 2010, resilience was central to US disaster policy. In 2010, the Quadrennial Homeland Security Report included resilience as one of three critical components for comprehensive homeland security and identified working to ensure disaster resilience as one of the five mission areas of the Department of Homeland Security (Department of Homeland Security, 2010).

In March of 2011, President Barack Obama issued Presidential Policy Directive 8 on National Preparedness, which framed preparedness efforts to be "aimed at strengthening the security and resilience of the United States through systematic preparation for the threats that post the greatest risk to the security of the nation" (p. 1). The Directive provided 180 days for the Secretary of Homeland Security to develop a National Preparedness Goal and 240 days to develop a National Preparedness System of integrated plans for prevention, protection, mitigation, response, and recovery that address the needs of businesses, communities, families, and individuals. President Obama defined resilience in PPD-8 as "the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies" (Obama, 2011, p. 6). The Centers for Disease Control and Prevention (CDC) (2011) also provided guidance to states on resilience in the March 2011 release of the *Public Health Preparedness Capabilities National Standards for State and Local Planning*. The guidance outlined 15 public health preparedness capabilities required for states. Community resilience was included as one of the 15 areas and highlights focusing efforts on community engagement and community-derived approaches.

As policy in the United States and elsewhere has moved towards integrating the concept of resilience into the policy and practice landscape, scholars have not achieved consensus on a definition of resilience or metrics for pre-event or post-event disaster resilience (Cutter, Ash, & Emrich, 2014). The following two sections of this chapter will review current thinking on the components that are central to the concept of community resilience (elements of resilience) and efforts to measure and quantify resilience (resilience metrics), both of which dominate the present-day research focus of this area of study.

5.3.2 Elements of Resilience

Elements of resilience that are repeatedly discussed in the theoretical literature can be grouped broadly into nine types of *capitals* or *capacities*. Displayed in Fig. 5.1 are the nine elements of resilience: social, economic, human, institutional, political, and community capital, improvisation, natural resources, and physical resources. For each element of resilience, examples of how the capital or capacity has been operationalized in disaster research are detailed. Each element also includes a letter indicating the level at which the capital accumulates: individual (I), community (C), or both (I/C).

One in particular stands out: social capital. Presently, social capital is at the forefront of thinking about resilience, and many disaster scholars have pointed to social capital as a vital, perhaps even decisive attribute of social systems in places that influence a community's ability to respond and recover from an event. These include Dynes (2003) who highlighted familiarity and connections in the 9/11 emergency response; Nakagawa and Shaw (2004) who found that differences in social capital portended different recovery trajectories; and Aldrich (2012) who identified social capital as more significant than resources in explaining recovery. As always, though, the picture is complicated. Much interest in social capital owes to Robert Putnam's (2000) influential studies of social relationships, and their connection to regional and national prosperity, in Italy and the US. But DeFilippis (2001) argued forcefully against Putnam's entire concept of social capital, asserting instead that real capital is more important in understanding the economic fortunes of places.

Im **I/C**
Improvisation
Skill in recognizing appropriateness of a plan, need for a new plan, need for a plan (Wachtendorf, 2004); Technical knowledge (Mendonca & Wallace, 2007); Motivation (Amabile, 2013); Supportive organizational or institutional climate (Kendra & Wachtendorf, 2016)

Ph **C**
Physical/Infrastructural Resources
Number, quality, and location of housing, industry, shelters, lifelines, critical infrastructure (Mayunga, 2007); Lifelines and critical infrastructure, transportation networks, residential housing stock and age, commercial and manufacturing establishments (Cutter et al., 2008); Housing units, vacant rentals, principle arterial miles per square mile, housing age, hotels/motels per square mile, public schools per square mile (Cutter et al., 2010); Medical care capacity, housing stock type and quality, temporary shelter availability, evacuation routes, school restoration potential, industrial re-supply potential, internet infrastructure (Cutter et al., 2014)

Co **C**
Community Capital
Local understanding of risk, counseling services, health and wellness (low rather of mental illness, stress related illness), quality of life, counseling services (Cutter et al., 2008); Community action, critical reflection and problem solving skills, flexibility and creativity, collective efficacy and empowerment, political participation (Norris et al., 2008); Net international migration, place attachment (population born in state still residing in state), voter participation, religious adherence, population employed in creative class (Cutter et al., 2010); Place attachment, political engagement, citizen preparedness and response skills (Cutter et al., 2014)

Na **C**
Natural Resources
Water, air, and soil quality, wetlands, forest, and national and local parks (Mayunga, 2007); Local food suppliers, natural flood barriers, efficient energy use, pervious surfaces, efficient water use (Cutter et al., 2014)

In **C**
Institutional Capital
Emergency and critical infrastructure in place, back up resources, replacement inventories of critical equipment, alternative water supplies, intergovernmental division of labor for emergency response, plans and resources for response and coping (Bruneau et al., 2003); Participation in hazard reduction programs (NFIP, Storm Ready), hazard mitigation plans, emergency services, zoning and building standards, emergency response plans, interoperable communications, continuity of operations plans (Cutter et al., 2008); Population covered by hazard mitigation plan, municipal expenditure on emergency services, participation in Community Rating System for Flood, number of governments and special districts, number of paid disaster declarations, population covered by Citizen Corps programs, population in Storm Ready communities (Cutter et al., 2010); Mitigation spending, flood insurance coverage, jurisdictional coordination, disaster aid experience, local disaster training, proximity of county seat to state capital, population stability, nuclear plant accident planning, crop insurance coverage (Cutter et al., 2014)

Po **I/C**
Political Capital
Capable governance, fair distribution of resources, ability to vote, access to people in leadership or distributing resources (Abramson et al., 2015)

Fig. 5.1 Elements of resilience

Hu **I/C**

Human Capital

Education attainment, health, population density, population growth, demographic characteristics, access to transportation services, household characteristics, housing quality, and dependence ratio (Mayunga, 2007); Access to medical care, education, training, expert knowledge, temperament, optimism, self-efficacy, coping, psychobiological, parenting (Abramson et al., 2015)

Ec **I/C**

Economic Capital

Excess economic capacity, alternative power and water supply, pre-event arrangement of government reimbursement (Bruneau et al., 2003); Household income, property value, employment, investments (Mayunga, 2007); Fairness of risk and vulnerability to hazards, level and diversity of economic resources, equity of resource distribution (Norris et al., 2008); Employment, median household income, creative class occupation, corporate tax revenues, income equity, education level, net business gain/loss rate, occupational diversity, urban influence (Sherrieb et al., 2010); Home ownership, employment, GINI coefficient, sector employment dependence, female labor force participation, ratio of large to small businesses, physicians per population (Cutter et al., 2010); Home ownership, employment rate, income equality, non-dependence on primary/tourism sectors, gender income equality, business size, federal employment, large retail stores per population (Cutter et al., 2014); Median household income, tax revenues, employment, occupational diversity, savings, access to credit (Abramson et al., 2015)

So **I/C**

Social Capital

Alternative power, water, food supplies, volunteers for acute care, plans and resources for meeting community needs (Bruneau et al., 2003); The World Bank's Integrated Questionnaires for the Measurement of Social Capital (Nakagawa & Shaw, 2004); Number of non-profit organizations, voluntary associations, religious organizations, voter participation and registration, newspaper readership, sport and recreation clubs, involvement in public affairs, public meetings, and informal sociability and trust (Mayunga, 2007); Received and perceived social support, social embeddedness, organizational linkages and cooperation, citizen participation, sense of community, and attachment to place (Norris et al., 2008); Demographics, social networks and social embeddedness, community values-cohesion, faith-based organizations (Cutter et al., 2008); Social support, ratio of 2 parent households to 2 parent plus single parent households, social participation (number of arts, sport, civic, organizations, religious adherence, voter participation), community bonds (net migration, crime rate) (Sherrieb et al., 2010); Sense of community, place attachment, and citizen participation (Cutter et al., 2010); Local voluntary organizations, voting rates, levels of trust and volunteerism, membership and participation in local events and festivals (Aldrich, 2012); Education attainment equality, pre-retirement age, households with at least one vehicle, communication capacity (telephone service), English language competency, population without special needs, health insurance coverage, mental health services, food provisioning capacity, physician access (Cutter et al., 2014); Social networks, social status, social cohesion, perceived social support (Abramson et al, 2015)

Fig. 5.1 (continued)

Clay (2014), in a study of community social institutions that function after a disaster, found that social capital may be more relevant for community recovery, while, at the household level, employment and education played a stronger role. However, Kendra and Wachtendorf (2007, 2016), in their study of the improvised evacuation of Manhattan on 9/11, found that a strong sense of shared identity and longstanding acquaintance and familiarity were essential in the maritime community taking on new emergency management tasks.

Taking all this into account, the preponderance of evidence suggests the value of social capital and warrants its inclusion in any model. At the same time, social capital does not "do" anything and does not by itself yield resilience. Rather, it suggests the presence of relationships that will facilitate certain kinds of disaster activities. That is, it facilitates emergence, enhances the prospect of finding resources, bolsters learning, and enables trust across disaster management organizations and sectors. These different capitals, though sometimes expressed in slightly different terminology, are the elements of resilience that are the focus of measurement efforts. The idea is that once we know what resilience seems to be "formed of," then we can assess or predict resilience by measuring the magnitude of the constituent parts.

5.3.3 Resilience Metrics

Reliable and valid measures of community characteristics remain methodologically challenging, thus limiting the use of indicators to measure community resilience and consequently impairing action to bolster community resilience. Despite these challenges, several metrics for community level resilience processes and outcomes have been developed in recent years taking a critical first step towards actionable data on resilience. Overwhelmingly, the resilience literature and metrics focus on the community level. Metrics have been applied in individual case studies for the most part. The next step in the science of resilience has been to apply resilience metrics to compare across geographies, hazard types, community size, and historical disaster experience. This section of the chapter reviews predominant models in the science of measuring resilience.

Bruneau et al. (2003) posit in the **MCEER Resilience Framework** that there are four dimensions of resilience that can be measured: *robustness*, *resourcefulness*, *redundancy*, and *rapidity*. *Robustness* refers to "strength, or the ability of elements, systems, and other units of analysis to withstand a given level of stress or demand without suffering degradation or loss of function" (p. 737). *Resourcefulness* refers to "the capacity to identify problems, establish priorities, and mobilize resources when conditions exist that threaten to disrupt some element, system, or other unit of analysis" (p. 737). *Redundancy* refers to "the extent to which elements, systems, or other units of analysis exist that are substitutable, i.e., capable of satisfying functional requirements in the event of disruption, degradation, or loss of functionality" (p. 737). And, *rapidity* refers to "the capacity to meet priorities and achieve goals in a timely manner in order to contain losses and avoid future disruption" (p. 738). A specific formula for measurement is not included in the framework but the four components are a landmark in the literature on disaster resilience.

The **Disaster Resilience of Place (DROP) model** presents an integrated concept of vulnerability and resilience that is argued to be grounded in theory, quantifiable, and applicable to diverse problems and places (Cutter et al., 2008). It was designed to assess resilience to natural hazards but can apply to other hazard types as well. DROP focuses on community level resilience, and while it focuses on the social resilience of places, there is also recognition that this cannot be entirely separate from social processes. Further, this model assumes that external factors, such as local, state, and federal policies will have an influence on community level resilience. The DROP model takes into consideration antecedent conditions in the natural, social, and built environment systems that highlight community vulnerability and resilience. The immediate

impact of the event is affected by preparedness and mitigation measures as well as by the coping response of a community. Once the event happens and the immediate impact is filtered through antecedent conditions, coping, mitigation, and preparedness measures, the impact of the disaster is realized. This impact is then modified through the absorptive capacity of the community. The greater the absorptive capacity of the community, the higher the degree of recovery a community will achieve. In this model, there are two ways in which a hazard event becomes a disaster. First, if the event is so large that it overwhelms the community or second, if a community lacks sufficient coping capacity, preparedness, and mitigation measures resulting in an inability to absorb the shock to the system. If either of these takes place and a community's absorptive capacity is exceeded, a community may utilize adaptive resilience, which encompasses improvisation and social learning, to cope with the disaster. Improvisation refers to taking action to aid in the recovery process and social learning refers to improvised actions that are institutionalized for use in future events. These adaptive resilience behaviors increase a community's resilience for the next event. The community resilience indicators considered in this model include ecological, social, economic, institutional, infrastructural, and cultural competence variables.

The **Qualitative Model of Community Resilience and Vulnerability** presents a set of benchmarks or indicators and introduces *qualitative* criteria that measure adaptive capacity which is considered to be the key element for resilience and vulnerability. This model incorporates the number of people and assets exposed, structural adjustments, availability and effectiveness of warning systems, the capability of emergency response, awareness of personnel responding to a crisis, availability of financial resources for response and recovery, logistical and management capacity, and the media coverage of event at local, regional, and national level in community assessments (Porfiriev, 2009).

The **Baseline Resilience Index for Communities (BRIC)** is based on the DROP model described above (Cutter et al., 2008). BRIC is a composite indicator used to measure community level resilience. This approach is viewed as useful from a government and policy-making perspective because indicators can be compared across time and communities. Proxy criteria are used to calculate this metric using national-level publicly available data. The use of nationally available data is also a limitation as it confines the data eligible for inclusion in the metric to only those data which are collected nationally and systematically excludes the use of data at a finer geographic scale or using non-administrative definitions of community. To calculate the BRIC metric, raw data are transformed from 36 variables into comparable scales. The BRIC consists of variables across five categories: social (demographics and social capacity), economic (housing capital, income equity, business size), institutional (prior disaster experience, planning), infrastructural (response and recovery capacity), and community (place attachment, citizen participation) capital resilience (Cutter, Burton, & Emrich, 2010).

The **Community Resilience Self-Assessment** was commissioned by the US Roundtable on Sustainable Forests and contains eight domains of resilience and recommended metrics for assessment. The eight resilience domains include *community resources*, *development of community resources*, *engagement of community resources*, *active agents*, *collective action*, *strategic action*, *equity*, and *impact*. Some examples of metrics that can be used to assess these eight domains of resilience include: extent to which community members believe that community change will happen, new businesses or employment opportunities developed over a period of time, community organization involvement in leadership, community involvement in groups and events, engagement of community members in decision-making, involvement of community members in community planning, access of community groups to natural resources, and changes in community capacity over time (Magis, 2010).

The **Resilience Activation Framework** was developed by the Resilience Working Group (RWG) made up of researchers working on Deepwater Horizon Oil Spill research as part of the Gulf Coast Research Consortia. The Resilience Activation Framework outlines an approach to examine the influence of access to social capital or social resources on adaptability or reduced stress for individuals exposed to a disaster. The framework is based on the idea that communities or individuals that can access social resources when faced with a stressor or challenges are more resilient. The framework includes human, economic, social, and political capital as primary predictors of resilience, accounts for moderators such as race, culture, and mobility, and posits that resilience will mediate the relationship between disaster or stress exposure and mental health outcomes. This framework is one of the few that accounts for both individual level and community level capitals and resources (Abramson et al., 2015).

The **Composite of Post-Event Well-being (COPEWELL)** is a pre-event predictor of post-disaster community functioning. The Centers for Disease Control and Prevention funded the development of the COPEWELL conceptual and computational system dynamics models to serve as a decision support tool for communities working to increase resilience and to assess resilience for all US counties. The conceptual model includes ten domains of pre-event community functioning: *communication*, *economy*, *education*, *food and water*, *government*, *housing*, *health care and public health*, *nurturing and care*, *transportation*, and *well-being*; six event modifying domains: *natural systems*, *engineered systems*, and *countermeasures* as components of prevention and mitigation and *vulnerability*, *inequality*; *deprivation* as population factors; and three recovery related domains: *social capital and cohesion*, *preparedness and response*, and *external resources*. The computational model uses a system dynamics methodology to compute prediction of the resilience trajectory of a community when a hazard event is simulated (Links et al., 2017).

An interesting feature of the above mentioned models, and one which is challenging for the overall growth of a science of resilience, is that they do not build on successive findings. Although they broadly encompass the elements of resilience that we derived from the literature, they are largely independent efforts that reflect disciplinary or policy norms. They strive for the same thing, but are indexed to different features of the community, applying different data, and with different analytical methods. Thus the MCEER model derives from sociological and engineering theories; the DROP model hailed from geographic origins with its place-based approach, while the Community Resilience Self-Assessment scans different community sectors. Meanwhile the MCEER model makes no attempt at calculation; rather, it presents a framework for how resilience might be measured; the BRIC model, by contrast, is a computational model, as is the COPEWELL model, which uses a system dynamics approach to determine rates of change of a recovery trajectory.

As the concept of community resilience has increased in popularity, there has also been an increase in the number of assessment tools developed in communities, not only in the U.S. but around the world. While some of the most prominent are described here, it is not an exhaustive list; others include the Australian Social Capital Framework (Stone, 2001), the Community Capitals Framework (Flora, Flora, & Fey, 2007), the Community Disaster Resilience Index (Mayunga, 2007), and the Socioeconomic Resiliency in Washington Counties assessment tool (Daniels, & Pacific Northwest Research, 2004).

5.3.4 Challenges of Resilience

The goal of research on resilience metrics is to try to bring more precision to the social and technical aspects that other studies have shown to be important in lessening or managing disaster. For example, in the COPEWELL model (Links et al., 2017), emergent behavior and

improvisation are prominent features of a community's post-disaster trajectory. But for many years these features remained outside of formal modeling efforts; their importance was known, but difficult to account for. The main difficulty with measuring resilience is that models have a thirst for data that is meant to reflect community functioning, but which can only do so indirectly or suggestively; yet nevertheless the hope is that these data can be analyzed to show the nearly infinite complexities of community. Much of community lies in the interstices of what can be observed, while these hidden-from-view features could have much to tell about resilience.

We know that communities are not single, monolithic entities. They are, instead, complex ecologies (Peacock & Ragsdale, 1997), and it is reasonable to guess that even well-connected people who live there do not fully understand their community. Two arguments made by Mitchell (2006) are key: one is that hazard interpretations vary widely. "For example, among others a hurricane like Katrina may be simultaneously regarded as a disaster, a natural experiment, an aesthetic spectacle, a manifestation of divine power, an indicator of anthropogenic climate change, a mechanism of societal differentiation, a test of societal resilience, a device for redistributing economic and political resources…" (p. 247). The other is that cities fill diverse functions, such as *metabolic*, *regulatory*, and *creative* functions (Mitchell, 2006, p. 245). Given these arguments, the source of the danger to which one would wish to be resilient can vary, suggesting different resilience strategies. At the most fundamental level, challenges are epistemological. Disasters implicate every aspect of community functioning almost by definition. But every aspect of the functioning of a community cannot be known. The object, then, is to try to develop a plausible understanding of community functions, hoping that the effects of what cannot be measured are implicitly accounted for. What we mean here is that the function of any community is rarely known with any exactitude. The idea of community itself is disputed. If we apply the classic sociopolitical ecology frame, we know that any community is formed of many networks of power, finances, and access. If these are not picked up in the data important features are not captured thus affecting any conclusions about resilience that might be drawn.

5.3.5 Relativistic Aspect of Disaster

It is difficult to develop a concept of resilience that is universal. Instead, resilience implicitly embraces ideas about system functioning that are contingent, local, and particular. While limited resources and expectations coupled with traditional environmental knowledge (Berkes, Colding, & Folke, 2000) allow many indigenous communities to show flexible and responsive adaptation to the environment following hazards events, by another (Western) standard they are poor and they recover only to the same "low" level of functioning relative to other types of communities. Ideas about resilience contain multiple cycles of contradiction and tension, which must take into account both objective observations of system capacity and recovery in a manner indexed to local norms. Dombrowsky (1998) and Oliver-Smith (2009) have long considered disasters to be failures of safeguards that were considered appropriate within the particular cultural setting experiencing the environmental disturbance. Teasing out disaster effects from underlying social, economic, and political conditions is difficult; these are themselves causes of the disaster as well as complications during response and limits to recovery. Conceptualizations and measurement of resilience, resistance, and recovery must consider cultural context.

5.3.6 Challenges to Resilience Fads?

Even as studies of resilience have advanced in the scholarly domain and became prominent in policy discourses on disaster management, critics have emerged to challenge the usefulness of the concept. One of the sternest critics is Dombrowsky (2010) who argues that resilience is a fad, a come-and-go concept that is more the product of scientists seeking exciting names to win the favor of funding agencies.

> To survive the rat-race for funds and grants brands and slogans gain higher significance than their factual relevance behind. 'Resilience' is one of these shimmering slogans from the wording-mint, 'Vulnerability' another one. They come and go like most other terms in the field, attracting attention for a while and being replaced when 'their' programs are phased out and others are going to be launched, eager for catchy words attracting attention again…Yes, 'resilience' is a buzz-word, a shibboleth in the beginning. Its coining and its first application guarantee pioneering profits and distinguish from the outdated paradigm of old fogeys. The followers identify themselves with their new shibboleth, convinced to understand and explain 'reality' better than before and others. In many cases the buzz-words click [with] the politicians and administrators behind the R&D programs (p. 1–2).

Aguirre and Best (2015) argue similarly:

> A significant proportion of the literature on resilience to disasters shows faddist traits, with authors who are members of scientific communities throughout the world acting under the influence of the emotions of fear and hope and showing enthusiasm in the belief that they have found or are in the way of finding lasting and effective solutions to the pressing societal problems caused by disasters (p. 217).

They go on to argue even more explicitly:

> A frequent element of the current fad of resilience is the importance it gives to estimating numerical indices of resilience of communities, regions and societies, and to the correlates of resilience, a response to the needs of government planners rather than being a real scientific problem (p. 218).

In other words, from this perspective, resilience represents the interests of government agencies trying to fulfill their institutional mandates; it's not a genuine idea in and of itself. Moreover, it diverts attention away from doing the things that would actually lessen susceptibility to disaster. Resilience also figures into a kind of blame shifting. Dombrowsky (2010) and Tierney (2015) argue that one of the institutional outcomes of resilience-oriented policies is an emphasis on community capacity as a lever to decouple government support for disaster reduction activities. These critics contend that resilience policies leave people to fend for themselves against the power of large economic and political forces.

5.3.7 Neoliberal Co-optation

Scholars such as Tierney (2015) are concerned that resilience, and its sometimes celebration of local capacities, is co-opted by political observers who see a justification for the withdrawal of government support for emergency management, or even of support for social welfare programs more broadly that may also bear on reducing vulnerabilities. The danger in the neoliberal appropriation of resilience is that resilience becomes a substitute for the hard and expensive work of building actual capacity. Perhaps the U.S. Critical Infrastructure Protection Program is a case in point. Substantial expense and ingenuity are devoted to protecting infrastructure from security threats, while the actual infrastructure is crumbling away. Even worse, resilience is something to be competed for. Agencies such as FEMA rationed out resilience to communities in the Project Impact program through competitive grants (Witt, 1998). The Rockefeller Foundation, too, with its 100 Resilient Cities initiative, encouraged applications and then awarded resilience support (Rockefeller Foundation, 2016). In the U.S., communities are pitted against each other as they vie for limited disaster-oriented funding. Resilience, paradoxically, is not for everyone, but for those who are best equipped to compete in the demanding milieu of government and philanthropic funding mechanisms.

5.3.8 Measurement

These are, indeed, compelling arguments against the concept of resilience and how it has been drawn into institutional disaster reduction initiatives. Still, it is worthwhile to try to separate efforts to understand organizational and community capacities from the integration of these ideas into institutional mandates that disengage government from attending to the causes of hazard generation and the implications of low wealth, limited resources, and marginal political power. It is certainly true that governments have caught the resilience wave, but that is a different conceptual challenge from trying to understand the abilities of social systems to modulate or recover from hazard.

The pedigree of resilience is such that it can hardly be called a fad, with a provenance of some forty years' duration or more. As we noted earlier, social scientists have been working with ideas of resilience for decades now - hardly a timeframe that suggests a meaningless or ephemeral idea. Similarly, Dombrowsky criticizes vulnerability - yet the idea of vulnerability in the hazards' literature stems from the seminal anthology *Interpretations of Calamity* (Hewitt, 1983), a work that was itself intended as a corrective to what the authors considered to be the "dominant" view of hazard generation as arising from people's bad choices. Again, an idea with such longevity hardly seems like a fad. Although Tierney (2015) argues that this focus has generated potentially harmful policy ramifications, she emphasizes that the idea of resilience is not meaningless. It is doubtful, too, that Hewitt and his colleagues thought they were engaged in a pointless enterprise of wordsmithing that would cruelly transfer blame onto local communities - quite the opposite.

Instead, what might be a more accurate assessment of present affairs is that some kinds of application or attempts to operationalize constituents of resilience have taken on fad-like characteristics. In other words, while perhaps resilience has swept into the policy domain as a fad, these are longstanding scientific questions in the social sciences - and in human philosophizing about the nature of societies. Resilience reaches across all scales, from the individual's psychology to the ability of nations, civilizations, maybe even the planet, to survive. The challenge we face is less about the value of resilience as an idea and more about what resilience contains and how the theory is operationalized in research and policy settings.

Considerations of scale are critical in bringing precision to any concept of resilience, but resilience parallels some of the conceptual ambiguities we see in other kinds of analyses of hazard. For example, some writings on resilience emphasize the community, but this may potentially be at odds with individual and household attributes of resilience. Households may bolster their resilience through adjustments such as migration away from hazard - mobility as a feature of resilience. If many choose that option, the community vanishes, or perhaps leaves those who stay behind in a place with a faltering economy and tax base.

Among the challenges of theorizing and measuring resilience has been that there is often a highly contingent and ephemeral quality to the survival capacities of both individuals and communities. Some communities, though perhaps lacking in material resources, nevertheless show considerable adaptability in disaster. The "spirit" of a place is the culture, customs, lifeways, and patterns of living, architecture, cuisine and music that make places distinctive, and by which we recognize one place from another (Wilkie, 1994). Easy indicators for these qualities are not available via the large datasets that are needed for model building that can cover every region in a country, and at any rate any such measures are bound to be provisional at best.

5.3.9 Future Research

Apart from studies on theoretical developments and improved computational models or assessment methods, policy-oriented studies are needed as well. These might follow up on Tierney's (2015) assessment that resilience is actually drawing attention or resources from more useful

programs, or Dombrowsky's (2010) argument that it shifts responsibility onto people instead. From this perspective we might see that rhetorics of resilience actually construct people as deviant risk objects, failing in their individual risk management duties and thus generating collective risks (Hilgartner, 1992; Kendra & Wachtendorf, 2007). This reconstituting of people as risk objects aligns with an argument made by Elliott (2002):

> [T]he individual is increasingly viewed today as an active agent in the risk monitoring of collectively produced dangers; risk-information, risk-detection and risk-management is more and more constructed and designed as a matter of private responsibility and personal security… Risk is desocialized; risk exposure and risk-avoidance is a matter of individual responsibility and navigation (p. 304–5).

Present resilience studies that seek wide comparative coverage of many places suffer from a major disadvantage: they have to rely on publicly available datasets, none of which were gathered for the specific purpose of assessing resilience. Scholars are thus trying to build models from whatever is available. A useful project might be one that engages resilience adherents in specifying the data that is needed - that is, needed based on a robust theoretical model - and joining forces with policymakers and others to try to get that data. Resilience cannot "be" whatever data are available, no matter how cleverly mixed. Anticipatory measures would seem to be valuable in enhancing recovery, such as pre-disaster recovery planning (Wu & Lindell, 2004), but preparedness activities in general need much greater evaluation and comparison. To what extent does household preparedness facilitate recovery? What about community-scale planning, training, and exercising?

Further research might also tackle the cross-cultural challenges of resilience. Social capital has emerged as a key feature of resilience in several different contexts, and it would be hard to imagine that that is not nearly universal. But such a proposition should be widely tested. To what extent can other ideas of resilience extend across places and across levels of economic development? Are there any prospects for local engagement in setting the terms of resilience debates? Nearly all research shows that people of limited resources and with other challenges of health and economy do worse in disaster, and there is no benefit in saying otherwise. How can theories of resilience be validated in a way that is sensitive to local conditions but that still maintains scientific circumspection?

5.4 Conclusions - The Value of Resilience

The study of resilience has inspired integrative and holistic thinking across disciplinary boundaries. The advantages of such interdisciplinary approaches are evidenced in disaster research. Scholars working on the earthquake hazard, for example, began to form connections in recognition that the built environment combined social and technical elements and that management of hazard demanded awareness of interactions (Kendra & Nigg, 2014). Social science research findings can inform how best to characterize seismic risk in informing the public or how people will interpret risk in such decisions as home purchases or mitigation. U.S. National Science Foundation funding programs, shepherded by the late William Anderson and his acumen at scientific diplomacy, advanced interdisciplinary research as an imperative in studies of hazard. One formal expression of this imperative was the establishment of the Multidisciplinary Center for Earthquake Engineering Research (MCEER). In looking at hazard systems, scholars at MCEER and the Disaster Research Center were thus primed to bring engineering and social science concepts together in a more unifying model of system adaptability and survival potential - that is,

of resilience (Kendra & Nigg, 2014). As they argued:

> Thus, the topic of resilience proved to be a key concept in driving research and theory building that was conceptually integrated at an intellectual level, not merely allied from a policy perspective or joined by work output in the research process. Interest in this topic fostered deeper intellectual integration across social sciences and engineering than was theretofore achieved (p. 20).

An interdisciplinary theory of disaster has been a longstanding desire in the field (Alexander, 1993) and thus research on resilience can be seen as following in that vein: that is, not a fad, but a research program well-aligned with longstanding theoretical objectives. The topic of resilience is vast, but fundamentally is concerned with some dimension of survival, at the same or preferably better level than existed before. Unfortunately, the subject is bedeviled by conceptual ambiguities, contradictions of scale, and an often morally - or politically-situated subtext that makes precise analyses difficult or impossible. In addition, as others have noted, "resilience" often emerges as a goal of disaster-oriented agencies who desire metrics for organizing their own activities or deploying resources - a rationale that many critics decisively reject. At the same time, there is broad interest in understanding processes of mitigation and preparedness - the things that make disaster less likely or its manifestation more manageable - and recovery, or how a community restores or even improves its systems afterward. In our view, taken together, these concepts compose what is generally regarded as resilience.

In itself the ideas behind resilience are not new. Resilience, broadly understood, has always been the collective concern of the hazards and the disaster field. The name of a concept is less important than what is brought within its ambit. The COPEWELL model (Links et al., 2017), for example, is less a model of resilience per se than a model of disaster: a theory of disaster that hypothesizes interactions among its constituent parts. Critics of resilience are distracted by whether the idea is "new," sidelining the recognition that resilience is the word for something that we knew but were hard-pressed to express: hazard and disaster as interactive phenomena of social and technical systems distributed over geographic space. Resilience captures the classical idea of the milieu: systems and places as mutually constitutive, and projects their interactions toward or away from adaptability and wellbeing. As is often the case in the social sciences, new insights are often disregarded as things "we knew all along," but that in reality were obscured by observational ambiguities or which suffered from fragmentation that prevented their full exploration. Vulnerability was one such example. Was anyone really surprised to learn that being poor limited one's choices, or left one at greater risk? Likely not, but that wasn't the point. Rather, the concept pulled together bits and pieces of insights that lay scattered throughout the research literature and that were, in a manner of speaking, in the collective scientific consciousness. Vulnerability redirected thinking and shifted research emphases.

Of course, people within the community may well resent any assessment of their community by external observers, and with their local knowledge can rebut an ill-conceived claim about their resilience. Matrices, indices, and aggregate scales attract not only criticism and skepticism, but hostility from those who insist that such efforts obscure the characteristics of a place that cannot be captured in large data sets. Analysts are on the strongest possible ground if they are working with a theoretically sound model of resilience, with data closely aligned to the theory. At present, much resilience studies rely on data that are poor compromises for what is really needed.

Owing to the wide range of interpretations of disaster, the relevant attributes of resilience are equally vast. One area where resilience might be of innovative conceptual value is in helping to advance a theory of disaster itself. If, as Dombrowsky (1998) has argued, a disaster is a collapse of culturally accepted protections, then resilience would be the quality that makes that collapse less likely. But, as the hazards' scholar Wenger (2016) argued recently, there is still a need for a "theory of disaster." The search for

such a theory has engaged scholars for some quarter of a century now, at least since Alexander's preeminent work *Natural Disasters*. In that volume, he argued for an "'interdisciplinary discipline' dedicated to the understanding of disastrous natural phenomena and their effects, and hence to the service of humanity" (Alexander, 1993, p. xvii). Regardless of the name, resilience would seem to offer such an interdisciplinary theory of disaster.

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6 The Cultural Turn in Disaster Research: Understanding Resilience and Vulnerability Through the Lens of Culture

Gary R. Webb

Contents

6.1 Introduction

When it was released in May, 2015, *San Andreas*, a movie about a massive earthquake, the big one, striking California, topped the box office charts. Enhanced by state of the art special effects technologies, the film, like many before it, featured scenes of total devastation, pandemonium, and the complete breakdown of social order. While the film may have been wildly off base in terms of how such an event would actually unfold, its financial success underscores two important points: the continuing appeal and profitability of the disaster movie genre and, more importantly, the central role that disasters occupy in popular culture.

In the first edition of this volume, it was suggested that the field of disaster research had begun taking a cultural turn (Webb, 2006). Ten years later, it can be said that the turn has been made and scholars are now fully embracing a cultural perspective on disasters (Krüger, Bankoff, Cannon, Orlowski, & Schipper, 2015). They are interested, for example, in understanding how disasters are framed and interpreted, remembered and memorialized, and represented and portrayed through folklore, songs, movies, and other media. This is in sharp contrast to an earlier era in which researchers were mostly concerned about the impacts disasters had on social systems (Fritz, 1961). While there is still a need for that kind of research, it has become abundantly clear to researchers, policy makers, and practitioners that the key to achieving future societal resilience is gaining a deeper understanding of the role of culture in both *producing* and *preventing* disasters.

In fact, this heightened awareness of and emphasis upon culture, which may have started as a scholarly movement, is now being put into practice. For example, the International Federation of Red Cross and Red Crescent Societies (2014) focused its annual *World Disasters Report* on the complex and reciprocal

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relationship between culture and risk - namely, understanding how culture affects disaster risk reduction and how disasters and risk can impact culture. Similarly, the United Nations Office for Disaster Risk Reduction (2016), through the International Strategy for Disaster Reduction, aims to shift our emphasis from disaster response to a greater focus on disaster reduction by promoting a "culture of prevention." As these efforts clearly demonstrate, reducing future disaster risks will require more than just advances in technology and engineering; instead, it will require us to appreciate and understand the importance of culture and how it shapes people's lives.

Thus, the primary purpose of this chapter is to discuss and elaborate upon the relationship between culture and disasters. Specifically, it describes the shift that has occurred in the field of disaster research from being concerned primarily about issues related to social structure to focusing much more on the cultural dimensions of disasters. The chapter also discusses the role of culture in influencing how disasters are socially constructed, interpreted, and framed to promote various interests. This is followed by a discussion of culture as a source of resilience that protects communities from the impacts of disasters. Next, the chapter focuses on how culture can also be a source of vulnerability and may actually contribute to the occurrence of disasters. Finally, the chapter concludes by offering some insights on the importance of culture moving forward for the academic field of disaster research, for the profession of emergency management, and for future disaster risk reduction efforts.

6.2 The Cultural Turn in Disaster Research

To say that the field of disaster research, or any other field for that matter, has had a structural bias or has taken a cultural turn requires some explanation of what is meant by those terms. At the most basic level, social structure refers to the ways in which societies are organized, while culture is, "the complex system of meaning and behavior that defines the way of life for a given group or society" (Andersen & Taylor, 2011, p. 27). Examples of social structure include statuses and roles that individuals occupy, formal and informal groups and organizations, and major social institutions such as the economy, government, and educational systems. Culture, on the other hand, includes norms and values, beliefs and ideologies, morals and laws, customs, language, and other shared elements that bind people together. In addition to these non-material phenomena, culture also includes the material products of society, including buildings and other structures, consumable products, art and literature, monuments and memorials, and many other tangible objects.

In both the broader discipline of sociology and the more specialized field of disaster research, there has historically been a balancing act, if not a tension, between those perspectives that focus more heavily on structure and those that place greater emphasis upon culture. As its name denotes, for example, the structural functionalist perspective examines how society is structured, while symbolic interactionism studies the meanings people attach to things and how they make sense of the world around them. As described in this section, disaster studies have been informed by both of these perspectives and each has been present to varying degrees throughout the field's history. In the early years, it was the structural perspective that was more evident, but in more recent years the cultural approach has become much more noticeable.

For much of its history the field of disaster research has been dominated by a structural perspective. Scholars in the area have long sought to understand the impacts disasters have on social structures and how those structures respond to such large-scale systemic disruptions (Fritz, 1961; Kreps, 1989). Embedded in that perspective is the assumption that disasters, rather than being produced by human beings, are external events that impose themselves on societies in an arbitrary and indiscriminate manner. That assumption led researchers to focus their

efforts on developing a better understanding of the ways in which human societies prepare for and respond to disasters. Ignored was the role of human agency in the production of disasters, and, as a consequence, so too were measures to reduce or prevent these events from occurring in the first place.

From the vantage point of today's increasing global focus on disaster risk reduction, this early emphasis on disasters as external events imposing themselves on unsuspecting social systems and the prioritization of questions about social structure seems extremely limiting. However, at the time of the field's emergence in the early 1950s, it made sense. As has been documented, much of the early work on disasters was done by sociologists (Quarantelli, 1994). Not surprisingly, they were interested in the social aspects of disasters - not the psychological, political, or economic dimensions. And, at that time, structural functionalism was the prevailing theoretical perspective in sociology (Turner, 1986). This perspective views societies as social systems, akin to organisms in the biological sciences, in which various subsystems must function harmoniously to achieve a functional state of equilibrium. From this perspective, the social structure - including social institutions, organizations, and role sets - is vital to the survival of the system.

Another factor that contributed to the structural and response-focused bias of the field was the funding source for the research (Quarantelli, 1987; Webb, 2007). After World War II, the United States military sought to understand how communities could be expected to respond to an enemy attack. At that time, the primary concern was over a possible nuclear attack from the Soviet Union. To shed light on that question, the military began funding researchers to conduct field studies of communities struck by disasters. The types of events studied varied widely, including tornadoes, blizzards, chemical plant explosions, airplane crashes, and others. What they all had in common, though, was that they were sudden and unexpected events thought to resemble a surprise attack by an enemy.

Among the first recipients of the military funding was a team led by Charles Fritz at the University of Chicago's National Opinion Research Center (NORC). According to Fritz (1961, p. 654), in addition to serving the practical need of understanding how communities might respond to an enemy attack, disasters also provided social scientists, "a realistic laboratory for testing the integration, stamina, and recuperative power of large-scale social systems." Reflecting the structural functionalist influence of the time, he also developed a definition of disaster that has persisted for decades, one that viewed disasters as discrete events that overwhelm the capacities of social systems and prevent them from functioning normally. Fritz (1961, p. 655) defined disasters as events, "…concentrated in time and space, in which a society…incurs such losses… that the social structure is disrupted and the fulfillment of all or some of the essential functions of the society is prevented."

With that, the stage was set. On the basis of the early work by Fritz and others, the field of disaster research would develop in a manner that focused primarily on the response phase of disaster and that mainly emphasized the effects of disasters on elements of the social structure. Dynes (1970), for example, published his influential book, *Organized Behavior in Disaster*, which detailed the various ways in which organizations adapt their structures and alter their tasks to meet the heightened demands of disasters. Specifically, he identified four common types of organizational responses to disasters: established, expanding, extending, and emergent. Established organizations such as police and fire departments maintain their existing structure and perform their normal tasks, while expanding organizations such as the Red Cross also perform their usual tasks but rely on a new, greatly expanded structure comprised largely of volunteers. Extending organizations, conversely, maintain their existing structure but adopt new tasks such as a construction crew participating in debris removal activities. Finally, emergent organizations, which do not exist prior to a disaster and form only after the event, both rely on a

new structure and perform new tasks. An example of an emergent organization is an informal search and rescue team comprised of neighbors formed after a tornado strikes.

Later, two edited volumes, one titled *Social Structure and Disaster* (Kreps, 1989) and the other titled *Organizing, Role Enactment, and Disaster* (Kreps & Bosworth, 1994), examined the complementary responses of organizations and role systems to disasters. These researchers identified four key attributes - domains, tasks, resources, and activities - that are present in all organizations and whose sequencing determines whether a response is formally organized or spontaneous and emergent. They also developed a model of role enactment comprised of three dimensions: status-role nexus, role linkages, and role performance. Taken together, these dimensions help determine whether a disaster response is planned or improvised.

This line of research, which is far more expansive than the few illustrative examples mentioned here, has been profoundly important and has measurably improved organizational and community preparedness and response efforts. However, it has also resulted in a fairly one-sided view of disasters. And that view has primarily emphasized social structure over culture.

In fairness, though, it should be noted that there has always been a cultural strain present in the field throughout its history. However, that strain has obviously been overshadowed by the structural bias. Fritz, in an unpublished paper in 1952, for example, acknowledged very early on that disasters occupy a prominent role in the folklore, literature, and culture of every society. Taylor (1978) later called attention to the importance of people's religious interpretations of disasters. And Quarantelli (1985) wrote decades ago about the role of disaster movies in shaping people's perceptions and knowledge of disasters and perpetuating harmful myths about human behavior under stress.

In fact, Quarantelli, who was a member of the NORC research team and a pioneer in the field of disaster research, was the first to call for more research on what he called the popular culture of disaster (see Quarantelli & Davis, 2011; Webb, 2006; Webb, Wachtendorf, & Eyre, 2000). Arguably, in fact, it was Quarantelli's efforts that precipitated the cultural turn in disaster research. He suggested that serious attention be paid by disaster researchers not just to movies but also to many other disaster-themed cultural phenomena, including graffiti, jokes and humor, t-shirts, spontaneous memorials, board games, and others. And, in direct response to his call for more culturally focused research, a special issue of the *International Journal of Mass Emergencies and Disasters* was published that explored the cultural dimensions of disasters (Eyre, Wachtendorf, & Webb, 2000). Several years later, the topic of the popular culture of disaster was also addressed in the first edition of this *Handbook* (Webb, 2006).

Since that time, the cultural turn has progressed and research in the area has flourished. Illustrating this turn and providing some measure of the degree to which a cultural perspective has been embraced, a recent issue of the Natural Hazards Observer (2016) was dedicated to the issues of culture, community, and disaster. Additionally, several recently published books provide further evidence of the turn. For example, *Cultures and Disasters: Understanding Cultural Framings in Disaster Risk Reduction* explores the ways in which culture can facilitate or impede disaster risk reduction efforts (Krüger et al., 2015). Another recent book, *Consuming Catastrophe: Mass Culture in America's Decade of Disaster*, examines the media's coverage of several recent major disasters (Recuber, 2016), including Hurricane Katrina and the mass shooting at Virginia Tech. Finally, *Standing in the Need: Culture, Comfort, and Coming Home after Katrina*, focuses on the importance of understanding culture to the success of long-term disaster recovery efforts (Browne, 2015).

As these titles clearly demonstrate, the cultural turn in disaster research has advanced significantly. That is not to say that studies of social structure have ceased or are no longer relevant. To the contrary, those studies are still being done and continue to provide insights on how best to equip our communities to respond to disasters.

Increasingly, though, researchers are balancing that emphasis on structure with an approach that recognizes that culture is also central to improving our understanding of disasters, particularly in the areas of mitigation and disaster risk reduction.

6.3 Culture and the Social Construction of Disasters

One area in which a cultural perspective is particularly important is in understanding disasters as socially constructed phenomena. Rather than being objective and obvious, disasters are subject to interpretation, framed and packaged in certain ways, and sometimes hotly contested and debated (Dove & Khan, 1995). As with the social construction of reality more generally, culture is part and parcel of the process through which certain historical occurrences, extreme events, or harmful episodes are defined as disasters. Culture, for example, provides a normative basis for judging something as positive or negative or as desirable or undesirable. And, although it rarely provides a ready-made script, culture also serves as a roadmap by equipping us with behavioral and collective action repertoires that are enacted to solve the social problems we collectively define.

To illustrate the socially constructed and contested nature of disasters, consider the water crisis that has been unfolding in Flint, Michigan since 2014 when the city switched water sources from Lake Huron to the Flint River (Bosman, 2016). As a result of the change, water supply pipes throughout the city became contaminated with lead, leaving residents without access to safe, clean drinking water and forcing them to rely exclusively on bottled water, much of which has been donated from across the country. Months into the controversy, a prominent national television news host, Rachel Maddow, said in a live broadcast on MSNBC that what was needed in Flint was a "FEMA-style" response to what many considered to be an obvious disaster (The Rachel Maddow Show, 2016). Despite that plea, the situation in Flint was never officially declared a disaster, despite causing severe harm to residents and serious financial harm to the city, state, and region, and the "FEMA-style" response never materialized.

The Flint case raises a very important question -namely, what is a disaster? This is a question that has challenged researchers for many years, as discussed in Chap. 1 of this volume, and yet the answer to the question remains elusive (Perry & Quarantelli, 2005; Quarantelli, 1998). In part, disasters are recognizable on the basis of their physical properties and the damage they cause, and they are also recognizable in terms of the social disruption they cause and the impacts they have on the social structure. Importantly, disasters are also socially constructed (Kroll-Smith & Couch, 1991). From this perspective, what is considered to be a disaster is a matter of perspective and debate. While societies may encounter numerous harmful episodes, not all of them are considered to be disasters, and certainly not all of them result in official disaster declarations. They may be viewed as accidents, emergencies, crises, or tragedies, but not disasters. Conversely, some events may be perceived as so harmful that they rise to the level of a catastrophe or even a calamity.

Such observations raise a number of important questions about disasters. Most notably, why are some episodes perceived and defined as disasters while others are not? What is the process through which disasters are socially constructed? Who are the primary actors involved in defining disasters? Are certain interests served by defining some episodes as disasters but not others?

While these questions may seem rather abstract and academic on the surface, they are critically important and have numerous practical implications. As Boin, Hart, Stern, and Sundelius (2005, pp. 82–83) point out, "Those who successfully 'frame' what a crisis is all about hold the key to defining the appropriate strategies for resolution." They go on to say that, "…the very act of labeling a particular set of conditions a 'crisis' is in itself a major communicative act with potentially far-reaching political consequences." And that, "It makes quite a difference whether one labels events in terms of an

'incident,' an 'accident,' a 'tragedy,' a 'disaster,' or a 'crisis.'"

Constructions of disaster, then, arise from a contested terrain in which various actors, including politicians, the media, safety experts, and ordinary citizens, make assertions about events and hope their definitions of those events prevail. In some cases, there is consensus on what has transpired, but in other cases there may be competing and contradictory claims made. In instances of disagreement, some actors are better positioned than others to succeed in defining the events, either because of the resonance of their rhetoric with various constituents or due to their access to power and resources. In the case of Flint, for example, the residents, who certainly considered themselves the victims of a disaster, did not prevail in defining the episode as a disaster, even with the help of a high-profile national TV news host. While there has been a federal response, it has not resembled the outpouring of help that typically follows a disaster, and it has not been undertaken with the same sense of urgency that a natural disaster would normally precipitate.

Efforts to socially construct - or frame - disasters are engaged in by multiple groups and organizations with diverse interests and for many different reasons. In his study of the earthquake threat in California, for example, Stallings (1995) identified an "earthquake establishment," consisting of engineers, safety experts, and others, and documented its efforts to define earthquakes as a pressing social problem and convince lawmakers to make preparedness and mitigation a policy priority. Shedding light on the role of the media in defining disasters, Monahan (2010, p. xii) examined how the media turned the events of 9/11 into a "public drama," a style of news which he argues bears, "greater resemblance to popular fiction than to journalism." Similarly, Dynes and Rodriguez (2010, p. 35) studied the role of the media in framing Hurricane Katrina, particularly its emphasis on, "portraying a state of chaos and anarchy," while at the same time, "…neglecting emergent prosocial behavior characterized by altruism, cooperation, and social cohesion." Others have pointed out that the media's perpetuation of disaster myths, namely, widespread panic, looting, and social breakdown, is not only inaccurate, but it may also promote particular interests, including those of the private security industry and those seeking to further militarize and privatize disaster response functions (Tierney, 2003; Tierney, Bevc, & Kuligowski, 2006).

Based on this discussion, there is a clear and compelling relationship between culture and disasters. In particular, culture plays a major role in shaping how we perceive environmental conditions and define various harmful episodes. Disasters are not always obvious, and they do not always evoke the same kinds of responses. In some cases, definitions align and people rally to support victims, while in other cases competing constructions emerge, harmful conditions may be ignored or denied, and victims may be left to suffer.

In addition to influencing how disasters are defined, culture is also important to understanding how communities cope and deal with extreme natural and technological events. Paradoxically, culture can serve as a source of both resilience and vulnerability in the face of hazards and disasters. On the one hand, as a source of resilience, culture makes us aware of the threats we face, it provides a framework for understanding them, and it serves as a roadmap for avoiding or managing those threats. But, on the other hand, culture can also make us more vulnerable by leading us to ignore some threats or providing us rationalizations for not taking measures to mitigate those threats, and ultimately producing the very disasters that cause harm to us.

6.4 Culture as a Source of Resilience

In recent years, researchers have devoted considerable attention to the concept of resilience (Tierney, 2014). For example, the National Academies (2012) recently published a report, titled *Disaster Resilience: A National Imperative*, which argued that a primary way to reduce disaster impacts on the nation is to invest in

enhancing resilience. It defined resilience as, "the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events" (National Academies, 2012, p. 16). Achieving resilience requires the protection of the built environment, critical infrastructure systems, the economy, computer networks, and, of course, human societies.

Interestingly, the first systematic disaster studies, initiated in the early 1950s, also emphasized the importance of societal resilience. In an early publication, for example, Fritz (1961, p. 694) argued that, "…disaster studies show that human societies have enormous resilience and recuperative power when they are confronted with direct challenges to their continued existence." He went on to say that, "The further study of the regenerative mechanisms of disaster-struck societies may help the social scientist achieve a better understanding of the crises of everyday life and the basic processes of social reconstruction."

Since its inception, in fact, the field of disaster research has sought to better understand and promote societal resilience. In doing so, researchers have emphasized the contributions of both social structure and culture to achieving that resilience. Social structure, for example, contributes to resilience by becoming flexible and adaptive in responding to the heightened demands brought on by disasters. Existing organizations may assume new or unfamiliar tasks, and, in some case, new organizations, which did not exist previously, may form to carry out essential response-related tasks, such as neighborhood search and rescue teams (Dynes, 1970).

As discussed previously, while the early studies were primarily concerned with issues of social structure, there was also a cultural strain present in the work. Fritz (1961), for example, wrote about the emergence of new values and norms in the post-disaster environment, which led to the formation of a therapeutic community among survivors. The key elements of the therapeutic community involve agreement on the nature of the problem, consensus on what to do about it, and an overwhelming outpouring of sympathy and support from others. These emergent values are so powerful and motivating that many disaster-stricken communities become overwhelmed by the massive influx of volunteers, supplies, equipment, and aid, referred to by Fritz and Mathewson (1957) as the problem of convergence behavior. While some research has suggested that these same patterns are not present during the community response to technological disasters, the emergence of altruistic values and helping behavior has been firmly established in the research literature on natural disasters, and it underscores the importance of culture, in this case emergent norms and values, to achieving resilience.

Another cultural source of resilience involves what have been termed disaster subcultures (Wenger and Weller, 1973). For many communities, the presence of a hazard is constant in the daily lives of people, and over time members of the community learn to cope with and adapt to the threat. In areas known as "tornado alley" and "earthquake country," for example, people become deeply ingrained with knowledge of the hazards they face and intimately familiar with the precautionary measures they should take in the event of an actual disaster. That knowledge becomes tacit, or taken for granted, and is transmitted across generations from one to the next. That knowledge, then, serves as a roadmap and toolkit for those living with hazards.

In the realm of organizational studies, culture has also been shown to be a source of resilience and safety. More specifically, researchers who study a unique type of organization, known as high-reliability organizations (HROs), have argued that the development of a safety culture is central to the success of these organizations (Roberts, Bea, & Bartles, 2001). HROs are those that deal with complex and risky technologies, such as nuclear power production and air traffic control, which manage to largely avoid accidents, mistakes, and disasters. While technology and system redundancy are major contributors, these organizations also succeed in large measure because they foster, promote, and enforce a culture of safety among their members.

Disaster subcultures in communities and safety cultures in organizations are both examples of ways in which culture contributes to resilience prior to the onset of a disaster. In both instances, culture equips people with awareness of threats and knowledge of how to avoid or minimize harm if something happens. People living in tornado alley, for example, learn from an early age to seek shelter in the lowest level of their homes, nearest the center, and away from windows. Within high reliability organizations, such as offshore drilling rigs and air traffic control towers, workers are socialized to value safety, reprimanded for violations, and well-versed on what to do in the event of an accident.

Culture can also serve as a valuable source of resilience after disasters have occurred. Researchers, for example, have documented the importance of disaster memorials and their role in facilitating community recovery from a disaster (Eyre, 2006). Others have studied the use of humor in helping people cope with past events and future uncertainty (Couch & Wade, 2003). In some cases, songs are written and recorded to memorialize past disasters, pay tribute to victims, and recount stories of loss and heroism (Scanlon, Johnston, Vandervalk, & Sparling, 2012).

As all of these examples demonstrate, culture is an important source of resilience. Prior to disasters, communities rely on disaster subcultures and organizations rely on safety cultures to educate, inform, prepare, and equip their members with knowledge in case something goes wrong. In the immediate aftermath of natural disasters, communities often experience the emergence of a therapeutic community in which new norms and values promoting altruism and helping behavior emerge. And, over the longer term, past events are remembered and victims honored through informal and formal disaster memorials, anniversary ceremonies, songs, and other forms of cultural expression.

6.5 Culture as a Source of Vulnerability

Although in many ways culture contributes significantly to societal resilience, it can also in some cases increase social vulnerability to disasters. Some groups, for example, may hold fatalistic beliefs that disasters are inevitable or the product of divine intervention and therefore unpreventable and beyond human control. In other cases, profit is valued so highly that safety may be compromised and resulting disasters assumed to be merely the cost of doing business. Cultural values, then, shape our perceptions of risk, the decisions we make about those risks, and the actions we take toward them.

Perhaps the most salient example of culture as a source of vulnerability is when demands for economic growth and increased profits clash with expectations of safety. While profit is an imperative of the economic system, it is also a cultural value and therefore something that is related to and sometimes in competition with other cultural values, including safety. In his book, *Disasters by Design*, Mileti (1999) places the clash between safety and the persistent push for increased growth and development at the center of his analysis, suggesting sustainability as framework for resolving the conflict. From this perspective, economic growth and development is still pursued but balanced against safety concerns, quality of life issues, and equity considerations. More recently, Tierney (2014), in her book, *The Social Roots of Risk*, argues that disasters, rather than being caused by forces beyond human control, result from an accumulating process of risk buildup driven by the constant demand for growth and facilitated by various powerful institutional actors.

From this perspective, the key to reducing disasters is curtailing risk buildup and reorienting ourselves toward an approach that invests in and values resilience measures. In other words, what

is needed, at least in part, is a change in culture. As Tierney (2014, p. 7) states, "The origins of disaster lie not in nature, and not in technology, but rather in the ordinary everyday workings of society itself." Thus, she argues, we need to shift to a "…fuller understanding of the role that social, political, economic, and cultural factors play in making events disastrous."

Another example of culture being a source of vulnerability can be seen in the impacts that technological disasters can have on communities. Rather than precipitating the outpouring of support characteristic of natural disasters, technological disasters often produce conflict, distrust, chronic stress, and litigation (Gill & Picou, 2008; Picou, Marshall, & Gill, 2004). In contrast to the therapeutic community that often emerges after natural disasters, researchers have used the term corrosive community to describe the aftermath of technological disasters (Freudenburg, 1997). Instead of bringing people together and enhancing social solidarity, these events tend to erode the collective sense of community, spark arguments and debates over what has happened and who is to blame, and undermine people's trust in government, corporations, and other social institutions (Erikson, 1976).

Interestingly, disaster subcultures, which were discussed in the previous section as a source of resilience, can also be a source of vulnerability. In some cases, the knowledge that is transmitted from one generation to the next is based on myth, not fact, and can actually place people in grave danger. In "tornado alley," for example, many people believe that a highway overpass is a safe place to seek shelter during a storm, but in fact that can be a very dangerous, even deadly, action to take. Because of this kind of misinformation and harmful knowledge being transmitted, organizations such as the National Weather Service (2017) must devote time and resources to combating myths, educating people, and attempting to promote safer behavior.

Disaster researchers have sought to debunk disaster myths for decades (Quarantelli, 1960). The most persistent have been the erroneous beliefs, held by many, including some public officials, that disasters induce panic among victims, incite widespread crime and looting, produce debilitating shock and stress among survivors, and induce emergency response workers to abandon their roles when they are needed most during the response period (Fischer, 2008). Unfortunately, these myths, which have been rebuked by research, are frequently perpetuated by the media, including in disaster movies like the one mentioned at the beginning of this chapter.

Disaster subcultures can also become a source of vulnerability when they lead to complacency and risky behaviors. An example of this problem is when groups of people ignore evacuation orders and instead stay behind to attend "hurricane parties" (Drabek, 2013). People who do this often assume that since they have survived past events they know best and are safe to stay put and ride out the storm. In that sense, rather than sensitizing them to the risk and making them more aware and proactive, the disaster subculture desensitizes people to risk, leads to complacency, and actually encourages greater risk taking behavior.

Just as disaster subcultures can serve as sources of both resilience and vulnerability so too can organizational cultures. The previous section described how HROs are successful largely because of the safety cultures they foster and promote. While that may the case in some cases, in other instances organizational culture can in fact become an impediment to safety (Sagan, 1993). Organizational researchers, for example, have pointed out how some organizations promote a culture of silence that stifles dissent, rewards conformity, and conceals risky, unethical, or even illegal conduct (Beamish, 2000). In other instances, adverse or negative information may not be intentionally concealed but ignored or neutralized nonetheless because different units or departments fail to communicate, a phenomenon known as structural secrecy (Vaughan, 1999). Another problem for many organizations is their lack of imagination and their "failures of foresight," which lead them to underestimate the potential adverse consequences of their actions (Turner, 1976). Even when they do consider the possibilities,

organizations often develop "fantasy plans" that are unrealistic, based on best case rather than worst case scenarios, and aimed mostly at appeasing regulators and easing public anxiety (Clarke, 1999). In sharp contrast to the safety cultures of HROs, many organizational cultures are dysfunctional, dangerous, and disaster-inducing.

As demonstrated in this section and the one that preceded it, culture is somewhat of a paradox. On the one hand, many aspects of culture serve as an important source of resilience. Therapeutic communities, disaster subcultures, safety cultures, and various forms of cultural expression, including humor, songs, and memorials, help us understand the hazards we confront, inform us about what to do if something goes wrong, and help us cope and adapt when disasters strike. But, on the other hand, various aspects of culture, including fatalistic beliefs, valuing profit above safety, corrosive communities, disaster myths, and cultures of silence and secrecy, can drastically increase our vulnerability to disasters.

On the basis of this paradox, it may be tempting to conclude that we simply need to educate people about the hazards they face, change their minds in terms of how they think about risks, and, ultimately, put an end to practices such as developing in hazard-prone areas that lead to disasters. However, culture is incredibly diverse across the globe, pervasive and deeply entrenched, and strongly resistant to change. It is particularly problematic when one group, even and perhaps especially one that possesses power, authority, and scientific or technical expertise, attempts to alter the beliefs, values, and practices of another. As Habermas (1973, p. 70) points out, "The cultural system is peculiarly resistant to administrative control. There is no administrative production of meaning."

Does this mean that social and cultural change is impossible and that future societal resilience is out of reach? Of course it does not. But it does mean that future efforts to promote resilience and enhance the safety of our world must be aware of, sensitive to, and respectful of cultural diversity (Krüger et al., 2015). For example, in many of the poorest nations in the world, people are entirely reliant on agriculture and fishing for their survival, and, as a result, must live in hazardous areas that may be prone to cyclones, tsunamis, and frequent flooding. It would be unrealistic and culturally insensitive to suggest that the solution to the problem is simply to move or relocate them out of harm's way. As part of their culture, people develop attachments to places, some of which are hazardous, and it is incumbent upon researchers, practitioners, and policy makers to be mindful of, sensitive to, and respectful toward those local cultures as they consider alternative measures to promote safety and resilience (Shriver & Kennedy, 2005).

6.6 Conclusion

The field of disaster research has evolved and grown since its founding in the middle of the 20th Century. In its early stages, the field focused much of its efforts on answering questions about social structure - namely, how it was maintained and transformed in response to large-scale disasters. In the 1990s, researchers in the field began placing much greater emphasis on social inequality, seeking to better understand how factors such as race, class, and gender shaped peoples' exposure to hazards and their vulnerability to disasters. Most recently, the field's focus has shifted to promoting and enhancing societal resilience, which enables communities to absorb the effects of disasters and rebound from them more quickly and effectively.

Another important development in disaster research, which was described in this chapter, has been the cultural turn. Although the field has long had a cultural strain, reflected in such concepts as therapeutic communities and disaster subcultures and especially in the work of anthropologists (e.g., Hoffman & Oliver-Smith, 2002), only in recent years has the field begun to fully embrace a cultural perspective. And, as discussed in this chapter, that embracement has

deepened our conceptual understanding of both vulnerability and resilience. What we have also learned is that that policy makers and practitioners must also embrace a cultural perspective for their ongoing disaster risk reduction efforts to succeed.

Fortunately, that message is being translated into practice, and various organizations, including the United Nations Office for Disaster Risk Reduction and the International Federation of Red Cross and Red Crescent Societies, have begun to recognize and emphasize the importance of culture. In their efforts to persuade nations around the world to shift their focus from increasing disaster response and recovery spending to investing in risk reduction measures, mitigation, and enhanced resilience, these organizations understand that culture can both facilitate and impede progress on those fronts. And they recognize that there is tremendous cultural diversity across the globe, and that one size does not fit all. Disaster risk reduction must be pursued in a way that is mindful of that diversity, respectful, and culturally sensitive.

In addition to practitioners and policy makers, researchers also stand to benefit from the cultural turn. Future studies, for example, can shed further light on the most basic question plaguing the field, namely, what is a disaster? As described in this chapter, episodes such as the Flint water crisis, challenge preconceived and taken for granted notions of what disasters look like and raise a host of important questions. Why are some events widely perceived as disasters while others are not? Who is involved in framing events as disasters, what strategies do they employ, and whose definitions usually prevail?

To answer these and other questions, another opportunity for future research on the cultural aspects of disasters is presented by the ever-growing use of social media. In addition to studying their effectiveness in improving disaster warnings and allowing public officials to communicate with and engage citizens, researchers can also study the ways in which people use social media to make sense of disasters and other harmful episodes, express grievances about the governmental responses to those events, and exhibit solidarity or conflict in the wake of such events.

As described in this chapter, researchers have long debated the similarities and differences between community responses to natural versus technological disasters. On the one hand, some argue that both types of events have unifying, even therapeutic, effects. On the other hand, some suggest that while natural disasters may bring people together technological disasters more often create conflict and corrosion. At their core, these are questions about culture and the different ways in which disasters affect not the structure of a community but its way of life.

This chapter has attempted to bring the relationship between culture and disaster into sharper focus. In doing so, it has traced the history of the field of disaster research from its early emphasis on social structure to its cultural turn in more recent years. It has also underscored the point that international organizations have become more aware of and sensitive to culture and are attempting to incorporate that awareness into their policies and programs. As disasters continue to occur more frequently in the future, as they grow in complexity, and as they increase in severity and financial costs, researchers and practitioners will likely need to rely even more heavily upon a cultural perspective to understand their root causes and ameliorate their devastating effects.

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Terrorism as Hazard and Disaster

7

William L. Waugh, Jr.

Contents

Modern terrorism research has focused on revolution and rebellion and, in more recent decades on the use of terrorist violence by state and non-state actors. The big questions initially focused the utility of terrorism as an instrument of warfare and, then, on the precipitants of terrorist violence. What social, economic, and political conditions give rise to such violence and what motivations encourage the choice of terrorism over other forms of social or political action? The initial studies were largely of terrorism as experienced during the post-World War II anti-colonial and civil wars. The violence in China, Egypt, Greece, Palestine, Indo-China, Cyprus, Algeria, Mozambique, Ghana, Indonesia, Cuba, and other areas of the world served as models, including models of the methods used to combat the violence.

Were the campaigns of terrorist violence ultimately successful? Brian Crozier's *The Rebels* (1960), used interviews of rebel leaders to study the adoption of terrorism as a tool of war during and after WWII. Frantz Fanon's *The Wretched of the Earth* (1963) suggested that the violence, at least in Algeria, was a justifiable response to colonialism – a necessary response to free people psychologically from colonial oppression. Ted Robert Gurr's *Why Men Rebel* (1971) looked at the reasons for the violent protests and attacks in the 1960s and Ivo Feiereabend, Rosalind Feierabend, and Ted Robert Gurr's *Anger, Violence, and Political Theories and Research* (1972) began putting together answers for the violence. An excellent bibliographic essay outlining the development of the terrorism literature can be found in Walter Laqueur's *The New Terrorism: Fanaticism and the Arms of Mass Destruction* (1999, p.283–299). Professor Laqueur's review includes the literature on terrorist violence leading up to the 9-11 attacks which ushered in a new era of terrorism and related policy research.

Scholars had refined conceptualizations, created typologies, and built models during the early period and adjusted to the "new terrorism" of the new century. However, there is still vagueness in many analyses of and commentaries on terrorist violence. "One man's terrorist is another man's freedom fighter," as the saying goes. In some cases, terrorism continues to be defined explicitly

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or implicitly as violence by "enemy" groups or the opposition. When the concepts and typologies were refined in the 1970s, 1980s, and 1990s, large datasets were constructed. Edward Mickolus' dataset for the Central Intelligence Agency in the 1970s provided the basis for numerous reports on terrorist tactics and targets. In 1980, Mickolus published a volume of statistics on terrorist attacks based upon the dataset and an annotated bibliography on terrorism (Mickolus, 1980). The CIA data and conceptualizations were used by numerous scholars. For example, I (Waugh 1980, 1982) used the Mickolus models and gathered ten years of event data to examine the resolution of hostage cases (kidnappings, skyjackings, and barricade and hostage events) and the authorities' willingness to negotiate. His conclusion was that refusing to negotiate greatly increased the likelihood of hostage deaths and, in some cases, failing to train for hostage negotiation prior to the event often lead to negotiation failures resulting in many casualties. In essence, the policy of "no negotiation, no compromise" fails to take into account that negotiation does not necessarily mean substantive compromise. Negotiation can help authorities manage the event and find a solution with minimal risk to hostages and counterterrorism forces or identify signs that an immediate armed intervention is necessary to save lives. This was one of many social science analyses using large datasets focusing on terrorist incidences, organizations, and tactics. That was the fashion in political science at the time and data was available through the U.S. Department of Justice, the U.S. Department of State, the Central Intelligence Agency, and other agencies, as well as through news organizations. There are sources of terrorism data today, such as the Terrorism & Extreme Violence in the U.S. Database at the National Consortium for the Study of Terrorism and Responses to Terrorism (START) (a Department of Homeland Security Center of Excellence) led by the University of Maryland, but getting access today can be much more complicated than it was decades ago.

After the 9/11 attacks and the creation of the U.S. Department of Homeland Security, the so-called "War on Terror" began and very little data was made available to researchers and journalists. Even other government agencies had difficulty securing data. The U.S. Department of State's annual reporting of international terrorist attacks and terrorism-related casualties became difficult to use because of the lack of clarity in the classifications of deaths (U.S. Department of Homeland Security, 2005). Casualty figures from the conflicts in Iraq and Afghanistan were included without distinction between those resulting from terrorist attacks and those resulting from non-terrorist attacks. With the exception of the 9/11 attacks themselves, remarkably few Americans were killed or injured by international terrorists during this period (Waugh, 2003a). In some measure, terrorism evolved from a law enforcement problem to a military problem, hence the growing national security focus of policy.

In the immediate aftermath of 9/11, there were studies of the social-psychological impact of the attacks (see, Foner, 2005; Pangi, 2003), the media roles in publicizing the attacks and in informing the public about how to prepare for them (see, e.g., Hess & Kalb, 2003, Nacos, 2007), economic recovery from large-scale attacks (see, Chernick, 2003), the vulnerability of mass transit and civil aviation (see, Waugh, 2004b), and other issues. Similarly, after Hurricane Katrina, response and recovery efforts were examined by scholars in anthropology, sociology, political science, public administration, geography, engineering, and other fields to assess social, cultural, political, and economic costs. An initial question for researchers was whether officials, the public, and affected populations view the risk of terrorism differently than they view the risks posed by other hazards. A START study in 2014 looked at American attitudes toward terrorism and counterterrorism measures (Taylor, 2014), for example.

The all-hazards approach to terrorism was slow in coming (Waugh, 1990), although the

9/11 attacks did focus attention on preparedness for violent attacks, response to bombings and active shooters, and recovery from catastrophic attacks. Mitigation was lost in the translation of the policy problem from a social and legal issue to a national security issue. Indeed, "mitigation" was buried in the Homeland Security definition of the policy and program process in favor of "protection." Over the past decade, terrorism had become a hazard associated with the socio-cultural environment as well as the political environment, and such "unnatural" disasters have become a focus of emergency management. While anti-terrorism policy may still be driven largely by national security and law enforcement interests, social science scholars are untangling the details of terrorist attacks and trying to draw meaning from them. The overwhelming focus of policy in the United States had been on protection, preventing terrorist attacks, with little attention to reducing their impact and facilitating recovery from their effects. The work of START and other U.S. Department of Homeland Security Centers of Excellence is expanding the body of social science research on terrorism. Now we can back-up and examine terrorism as a human-made hazard and "unnatural" disasters.

7.1 The History and Politics of Terrorism

Terrorism is an ancient hazard, one that has plagued human societies from their very beginnings. The threat of terrorism was a tool of political control in early communities. For example, Walter (1969) discussed terrorism as practiced in primitive African villages. It has also been a common tactic in warfare for centuries to intimidate enemies. Today, the frequency of terroristic acts, the lethality, and destructiveness represent a hazard that is having increasing impact upon the lives of people all over the world. The risk, real or imagined, influences public policies and elections, encouraging trade-offs between security and freedom, and encouraging internecine violence. The costs of terroristic violence can be enormous in terms of loss of life, economic loss, and the expense of recovery. The costs also include expenditures for security measures. The classic tradeoff is between security and civil liberties. Terrorist violence today is affecting civil aviation, tourism, building construction, and any number of other aspects of our lives. The threat, real or not, is also being used as an excuse for the suppression of political opposition and as a tool for the enforcement of societal conformity. For example, characterizing whole ethnic or religious groups as "terrorist" can create a climate of intolerance and can encourage violence against presumed enemies. It should be noted that, because the United States is buffered by oceans, the biggest threat has tended to be from domestic rather than international terrorists.

Since World War II, violence in the name of colonialism, anti-colonialism, and ideology, has given way to violence in the name of religion and resource scarcity. Colonial and ideological conflicts remain, but terrorism today is more closely associated with religious differences and conflicts over resources such as petroleum and, increasingly, water. The weaponry has become more lethal and, more importantly, combatants have shown increasing willingness to kill hundreds to millions of people in the pursuit of their goals. Recent acts of terrorist violence have also had tremendous economic impacts, as the September 2001 attacks in New York, Pennsylvania, and Washington, DC, demonstrated. The fragility of modern societies affords terrorists opportunities to disrupt and damage economies, communities, and political systems. Increasingly, however, affected communities have chosen to demonstrate their resilience by returning to normality as quickly as possible. "Boston Strong" has become the symbol to the April 2013 Boston Marathon bombing that killed three and injured hundreds. Security at subsequent marathons and other large events has also been stepped up to prevent future attacks. Security checks are all too familiar today.

The nature of the hazard, the probability of attacks, and the means of preventing the violence and/or mitigating its impact are subjects of intense political debate. The potential risk from immigrant populations or those hiding among the immigrants and the most effective strategy for dealing with external threats were hotly debated during the American presidential election in 2016, as they have been in previous elections. In Europe, officials are similarly debating the need to restrict immigration and limit the number of refugees permitted into their countries in order to reduce the potential for radicalized immigrants to commit acts of violence and the potential for terrorists to hide among the refugees fleeing from the violence in Syria, Afghanistan, Iraq, and other nations. It must also be mentioned that there are also refugees from criminal violence, particularly in Central and South America, and economic failures and weather disasters, such as drought and famine in central Africa. The number of climate change refugees is increasing. As immigrant and refugee populations increase so does the incidence of nativist and racist violence.

In Germany, for example, officials are trying to draw lessons from a suicide bombing in Ansbach, a massacre in Munich, and an attack on a train near Würzburg, as well as terrorist attacks in Nice, France, and in Brussels, Belgium, all in 2016. Eight-four people died in the Nice attack. Forty-nine people died in an attack at a club in Orlando, Florida and 19 people were killed in a facility for the disabled near Tokyo, as well. While the U.S. and Japanese attacks are not considered acts of political terrorism, the frequency of mass-casualty violence is fueling the debate (Spiegel Online International, 2016b).

Germans are wondering whether terrorist violence can be prevented and there are fears that the risk of violence might frighten tourists and locals away from major cultural and sporting events, including the legendary Munich Oktoberfest. The attack in France occurred during that nation's Bastille Day holiday (Spiegel Online International, 2016c). Thomas de Maizière, the German interior minister and a member of Angela Merkel's conservative Christian Democratic Union (CDU) party, commented that "We will have to get used to more intensive security precautions at major public events like Carnival parades, football matches, church congresses or Oktoberfest" (Spiegel Online International, 2016a). De Maiziére suggested that the German people prepare for such threats much as they would for other kinds of disasters, including making sure that they have at least ten days of food and water stored in case of emergencies. He described the violence as "a fact of life" (Spiegel Online International, 2016c). The minister's party has been less philosophical. A document, the "Berlin Declaration," circulated among other CDU ministers and Christian Social Union members (in Bavaria) quoting Wilhelm von Humboldt, a Prussian philosopher, "Without security, there is no freedom," and proposing increases in the number of police, expansion of the powers of the armed forces, data retention, banning the burqa, and other measures. The focus is on new immigrants and those holding dual citizenship. Merkel's CDU lost seats to an anti-immigrant party in state elections in September 2016. Clearly, the issue is heating up and the German experience is very similar to what has gone on in the United States. The recent presidential campaign has been greatly influenced by the issue of immigration, as well as the threat of terrorist and non-terrorist gun violence.

7.2 The Nature and Purpose of Terrorism

Terrorism is difficult to discuss without some attention to its nature and forms. The threat of catastrophic terrorism was not new in 1993 when the World Trade Center (WTC) was bombed and certainly was not new in 2001 when hijacked aircraft hit the WTC towers and the Pentagon. Hundreds of terrorist attacks occur every year and terrorist violence has caused millions of deaths and countless physical and psychological injuries for millennia. Ancient armies massacred civilian populations to frighten and demoralize opposing armies (and vice versa). Medieval armies flung plague-ridden bodies over city walls

and dropped animal carcasses into wells to frighten and sicken residents. Villagers were slaughtered and crops burned to discourage resistance to foreign and indigenous rulers. In short, terrorism is an ancient tactic of warfare and political conflict and it has remained a weapon in modern warfare and politics. Terroristic violence has commonly been used by combatants on all sides in ancient and modern conflicts. The aerial bombings of London, Dresden, Tokyo, Hiroshima, and Nagasaki, as well as other population centers, during World War II were designed to demoralize enemy populations, officials, and armies. Since World War II, threats of violence have chased – indeed, continue to chase – civilian populations from their homes and put them at risk of attack, as well as at risk of famine, disease, and other threats to life. Such is the case in East Africa.

Terrorism was used by Serbian forces in Bosnia-Herzegovina, by Saddam Hussein's forces against Kurds and dissident Iraqis, by Taliban and al-Qaeda forces against officials in the new Afghan regime, and by indigenous insurgents and their foreign supporters, and by terrorist groups against officials in the new Iraqi regime. ISIS and its affiliated organizations represent only the newest form of terrorism. What has changed is the scale of the attacks. Terrorist violence is background noise in our world, but recent events and the potential for even more deadly attacks have elevated concerns about the violence.

Some distinctions do need to be made between terrorism, terroristic violence, and other forms of political violence. The cliché that "one man's terrorist is another man's freedom fighter" is important to remember. The term "terrorism" has tremendous political baggage and generally is only applied to one's enemies, but the use of terroristic violence is more widespread than that would suggest. Violent acts to induce terror have been used for thousands of years as a part of psychological warfare. Terroristic violence has also been used for criminal and other nonpolitical purposes. Kidnappings and extortion are common in some nations. Hacking computer systems to steal data and holding computer systems hostage for ransom are the newest tactics. Terrorism has many forms and terrorists have many tactics.

There are four common elements in most definitions of political terrorism:

1. The use or credible threat of extraordinary violence;
2. The presence of a purpose or goal;
3. The choice of targets for their symbolic value; and
4. The intent to influence a broader audience than the immediate victims (Waugh, 1980).

If violence has been used in the past, the terrorists may only have to threaten further violence in order to cause fear or terror. Terrorists may have political, economic, social, or cultural, e.g., religious, goals. The focus here is on terrorism with political purposes, but economic, religious and other purposes may also be present. Because terrorist groups are usually small, from a very few to a few thousand, they tend to focus their attacks on people, facilities, and other targets that will maximize their impact and minimize their losses. Attacks on judicial officials, elected leaders, business persons, and other high-profile individuals, including foreign tourists, can get the public's attention. Direct attacks on military and law enforcement personnel, for example, usually are too risky for groups with limited human and material resources. Nonetheless, terrorists may have the wherewithal to engage military and police forces when they have a large enough base of support. In military terms, the violence can escalate into guerrilla warfare or insurgency and even into civil war. U.S. military spokesmen, for example, distinguished early in the Iraq War between Iraqi insurgents and foreign terrorists although the distinction became somewhat blurred for officials and the media alike as the violence escalated. Defining the conflict as a civil war would acknowledge that the insurgents have sufficient popular support or at least acquiescence to wage war on the new Iraqi regime. In reality, the new regime and its supporters are fighting with remnants of the old regime (i.e., Baathists and other insurgents),

foreign groups (at least one associated with al-Qaeda), and indigenous criminal groups. Terrorist tactics appear to be common among all the groups, including those using kidnappings for financial gain.

Second, terrorism can be used by governments as well as nongovernmental groups. State terrorism is common. Governments may use violence and/or the threat of violence to silence political dissent, remove opposition, and/or enforce policies. Violence may be used or threatened to intimidate racial and ethnic and religious groups. Vigilante terrorist groups may emerge to help officials enforce laws and to punish dissenters. Terrorist organizations may be independent of government influence, loosely connected to government officials, or even directly connected to government authorities and acting as their agents. Terrorist goals may be revolutionary in terms of seeking to overthrow a government or social system or sub-revolutionary in terms, for example, of seeking change in a particular law or removal of a particular official. Terrorist organizations may have broad or limited goals, they may or may not attack human targets, and they may or may not have links to states or officials. The question is whether they intend and have the capabilities of causing mass destruction and/or mass casualties – i.e., causing catastrophic effects (see, Waugh, 1982, 1990).

Third, terrorist intent is critical. In the 1940s and 1950s, the most common motivations were independence from colonial influence or separation of ethnic groups from established nations. Popular support, including international support, was a goal. During the 1960s and 1970s, the motivations often were connected to the Cold War with the groups acting as agents of or surrogates for the U.S. and its allies and the Soviet Union and its allies. During the 1980s and 1990s and into the 21st century, the motivations often were mixtures of political and religious goals. The so-called "new terrorists" have been difficult to locate and apprehend because they have relatively small units acting with minimal or perhaps no central control. This has been the problem dealing with al-Qaeda and similar groups. Despite losing dozens of leaders, including Osama Bin-Laden, new leaders have been chosen and the conflict continues. Terrorists with religious motivation do tend to be more willing to kill large numbers of people than secular terrorists (Hoffman, 1999, p.21). The emergence of the Islamic State (ISIS) as a transnational power in the Middle East and North Africa demonstrates the strategic use of violence to both intimidate the opposition and to recruit new members. The ISIS practices of beheading and burning hostages to frighten and demoralize enemies and the abuse of female prisoners have become the symbols of that organization and certainly have aided its expansion in the region and its radicalization of others outside of the region Bombings of train and subway systems in Western Europe and, more recently, attacks on civilians using vehicles are evidence of the appeal of ISIS' political and religious agenda. The May 2017 suicide bombing at a concert in Manchester, England, was an extension of that campaign of violence. The death toll was at least twenty-two, many children, and there were over fifty injured in the blast. Possible accomplices of the bomber were arrested. The bomber was born in the U.K. of an immigrant family and a suspected ISIS sympathizer. ISIS declared responsibility for his act (Samuelson, Reilly, & Liu, 2017). A network of ISIS supporters who may have helped the bomber have been taken into police custody and police and counterterrorism units will continue the investigation for months or even years (Welle, 2017a). The U.K.'s Terrorism Analysis Centre raised the national threat level to "critical" because more attacks were considered "imminent" (Samuelson et al., 2017), although the threat level was dropped within a few days.

Within the United States, anti-government, anti-LGBTQ, anti-Semitic, anti-immigrant, and anti-minority terrorism is on the increase, as well. Not all the violence is international, in other words. And, not all of the violence is anti-establishment. The Southern Poverty Law Center that monitors extremist groups in the U.S. has identified 917 separate "hate groups," including the Ku Klux Klan, neo-Nazi, white nationalist,

racist skinhead, Christian Identity, neo-Confederate, black separatist, anti-LGBT, anti-Muslim, and general hate groups, plus hundreds of anti-government "Patriot" and other groups of varying degrees of extremism and violence (Southern Poverty Law Center, 2017). While few of the groups might be called "terrorists," the threat of violence is a common tactic. Violence is in their language. The Murrah Federal Building bombing in April 1995 demonstrated the potential for domestic terrorism in the U.S. Both men convicted of the bombing were associated with the ultra-right-wing Patriot Movement. Their bomb killed 168 people, including 19 children (CNN, 2017). Repressive violence is also increasing, sometimes in the guise of counter-terrorism programs (Amnesty International, 2017).

Fourth, some terrorist organizations have demonstrated their willingness to cause mass casualties and the available weaponry has become ever more lethal. Current focus on the threat of so-called "weapons of mass destruction" is somewhat misleading when military-style automatic weapons and explosives are readily available in many parts of the world, including the U.S. Hazardous chemical, biological, and radiological materials are available and some groups have the capabilities of building weapons with such materials. And, there is a risk that terrorist organizations or states will buy, steal, or replicate a biological or nuclear weapon developed during the Cold War. Nuclear proliferation and the security of nuclear weapons left over from the Cold War are also concerns. There are hundreds of international terrorist attacks every year and the most common weapons are explosive devices, often homemade. The number of international terrorist attacks within the United States, however, has been very low. With the exception of the 9-11 attack, the number of American fatalities has also been low (Miller, 2014). The potential for terrorists to get weapons capable of killing thousands or even millions exists, but there is much greater likelihood that they will use homemade bombs or use purchased or stolen conventional explosives (Smithson & Levy, 2000). Following the 2001 attacks by international terrorists, there was a series of attacks involving anthrax, a biological agent, which are assumed to have been committed by a domestic terrorist or terrorists. But, the scale of the attacks was relatively small. Having the capability of creating biological weapons does not necessarily mean having the capability of storing and delivering such weapons. Governments, however, may have the capacities to create and store such weapons. The use of chemical weapons, chlorine and sarin gas, by the Assad government in Syria demonstrates that such weapons can be used to demoralize opponents. Over 1400 Syrian civilians were killed in a 2013 attack and the Assad government was forced to agree to stop using chemical weapons. Nonetheless, the regime killed at least 70 people, many children, in an April 2017 gas attack (Barnard, 2017).

All of this is to say that terrorists may be states or small organizations or even individuals and their goals may be limited or very broad. They may avoid killing or injuring human beings or they may be willing to cause mass casualties and mass destruction. Clearly, some wish to cause catastrophic disasters and have the capabilities to carry out those intentions. The U.S. experience with the World Trade Center attacks in 1993 and 2001 and the Oklahoma City federal building bombing in 1995, the Japanese experience with the sarin attack in 1995, the Indonesian experience with the Bali bombing in 2002, the Russian experience with the hostage taking in the Moscow theater in 2002 and the Beslan school in 2004, the Spanish experience with the train station bombing in Madrid in 2004, the British experience with the subway attacks in 2005, and the French and Belgian experiences with bombings in 2015 and 2016 are testament to the disastrous consequences of terrorist acts. Airliners full of passengers, hotels full of guests and staff, schools full of children and teachers, corporate facilities full of workers and customers, and marketplaces full of shoppers have often been targets of terrorists.

The recent attacks in France and England involving trucks and automobiles are just the latest manifestation of terrorism. The resultant disasters have required quick action by

emergency responders, coordination of efforts by emergency managers, and long periods of recovery, not to mention recovery from the physical and psychological damage by their victims. The potential that chemical plants might be bombed, dams or bridges might be bombed, water supplies might be poisoned, critical computer infrastructure might be disabled, virulent diseases might be spread among human or animal populations, or any number of other catastrophes might be perpetrated by terrorists gives impetus to efforts to prevent, mitigate the effects of, and prepare for such events. Security measures can be effective. Individuals can also learn how to protect themselves better.

In very general terms, terrorist violence has been cyclic. The anti-colonial wars of the post-WWII era, the proxy wars of the Cold War period, and the religious and ethnic violence of more recent decades seem to have given way to non-state conflicts as epitomized by al-Qaeda and the ISIS. Skyjackings and kidnappings were common in the 1960s and early 1970s and bombings and armed attacks are most common now. The use of vehicles as weapons is the newest tactic and security precautions are being taken to prevent vehicle access to venues that might be vulnerable. While some governments continue to wage war with terroristic tactics against their own citizens and some nations, including the United States, have long histories of domestic terrorism, the focus today is on the violence committed under the cover of religion. In the long run, the bigger threat is domestic terrorists motivated by nativism and racism, however.

7.3 The Impact of Terrorist Violence (Hazard Analysis)

Terrorists, according to the old common wisdom, want an audience, but not a large number of dead (see Waugh, 1990). The reasoning was that, while attacks can demonstrate the power and commitment of the terrorists, the vulnerabilities of their targets, and the ineffectiveness of government authorities, large numbers of dead can alienate political support. Moreover, to paraphrase Stalin, one death is a tragedy and a million deaths are a statistic. Grisly pictures of car and suicide bombings cause television viewers to weigh the objectives of the terrorist organizations against those human lives. Now, the old common wisdom itself has been a casualty of evolving terrorist motivations and technologies of war. Since the 1980s, terrorists have shown increasing willingness to kill many people, often innocent bystanders, without regard for the impact on public opinion and potential political support. Bombings of aircraft, public markets, schools, stadia, and other gathering places have increased the casualty lists. The general populace, rather than representatives of the state or socioeconomic elites has become the target of choice. Such targets are "soft," unprotected or minimally protected. Such targets also provide drama. The psychological impact is magnified. As a result, the new common wisdom since the 1990s is that terrorists may well wish to kill hundreds or thousands or even millions of people and may well have the wherewithal to do so. The shift to mass casualty and mass destruction attacks by some terrorist organizations has increased the potential for disaster and fundamentally changed the nature of the hazard. Moreover, as the scale of the attacks has increased, the psychological and social impacts of terrorism have certainly changed. Individuals and communities often surprisingly adjusted to the relatively localized violence that characterized terrorism during the early decades after World War II. The potential lethality and destructiveness of terrorism today makes it a hazard that cannot be ignored.

There are a number of reasons why terrorists have been willing to kill and/or injure large numbers of people. First, they frequently have their own financial and material sources and are not dependent upon outside support. Financial support from so-called "rogue" states, criminal activities (e.g., robberies, kidnappings, extortion, and drug smuggling), and wealthy benefactors reduces the need for outside fund-raising and, thus, reduces the need to appeal for broad popular support. Second, groups motivated by religious or political extremism or very broad

international goals are less likely to draw support domestically or internationally than those seeking autonomy from central authorities or colonial powers. Many groups have little expectation of or need for broad popular support. Third, access to military weapons from assault rifles to sophisticated explosives, as well as capabilities to build such low tech weapons as homemade fertilizer and fuel oil bombs, have increased the potential lethality of such groups. Little sophistication is needed to improvise a large explosive device. Recipes for bombs can be found easily on the Internet. As a result, terrorists have created disasters on a scale that has required the same kinds of hazard management, disaster response, and long-term recovery that nations have had to provide for major earthquakes, typhoons, floods, industrial accidents, and other acts of nature and humans.

The escalation of the potential lethality of terrorist attacks was evident in the first World Trade Center bombing in 1993 and the sarin gas attack in the Tokyo subway in 1994. In both cases, the scale of the disasters could have been much greater had the terrorists' devices functioned as intended. The attacks were relatively unsophisticated in terms of the technologies involved, but either could have caused hundreds or even thousands of casualties. The escalation of terrorist capabilities was clear in the bombings of the Khobar barracks in 1996, the U.S. embassies in Kenya and Tanzania in 1998, and the USS Cole in 2000. Those attacks were directed against targets that were assumed to be secure. Since then, the 9-11 attacks in New York and Arlington and bombings in Bali (Indonesia), Riyadh (Saudi Arabia), Istanbul (Turkey), Beslan (Russia), Madrid (Spain), Taba (Egypt), London, Netanya (Israel) and Sharm el Sheik (Egypt) have provided evidence that the risk of terrorist attack is increasing and from several quarters. While none of the attacks involved chemical, biological, or radiological devices or materials (so-called "weapons of mass destruction"), they did involve large numbers of casualties and significant destruction. They also had and continue to have tremendous impact upon the nations involved and have raised questions concerning the efficacy of government officials responsible for providing security. Perhaps more importantly, the increasing consequences and frequency of terrorist attacks, the two common measures of risk, have encouraged policymakers to respond. The potential costs of such attacks are so great that preventing them, rather than apprehending terrorists after their violence, has become the focus of government efforts (Heymann, 1998). No leader wants to have a major attack on his or her "watch" because public safety and security is a fundamental responsibility of government. The political costs of failure can be very high. Unfortunately, too little attention has been paid to the need to mitigate the effects of potential attacks, to lessen their physical, economic, and psychological impacts. Terrorism cannot be prevented entirely because there are too many potential targets and too many potential weapons. A resilient population, such as the citizenry of Boston or Manchester, may be the best defense.

For the U.S., the deaths of almost three thousand people in the airliners, collapsing towers, and damaged Pentagon on September 11, 2001, have had a profound effect upon the nation's sense of security. The attacks led to the largest reorganization in the U.S. federal government since the creation of the Department of Defense in 1946 when the Department of Homeland Security was created in 2003. Massive investments in security programs have also meant major shifts in federal spending away from social and economic programs. Similarly, the attacks in Madrid in 2004 and London in 2005 have shaken public confidence in their governments' capacities to protect residents and visitors and encouraged increased investments in security technologies and programs. The political costs of failure were evident in the aftermath of the rail station bombings in Spain. Spanish officials responded poorly to the bombing, blaming a domestic group, and were voted out of office as a result. Around the world, terrorist violence has precipitated increased security measures to monitor public gathering places, to control national borders, and to protect sensitive facilities (such as airports, ports, and rail stations). The economic and sociopolitical costs of security are

growing exponentially with little evident reduction in the risk of attack, although some potential targets are much better protected.

7.4 Long-Term Effects of Terrorism (Risk Assessment)

The association of disaster with terrorism is understandable and the scale of recent attacks and the potential for future attacks have certainly focused official and public attention on the consequences of worst case scenarios. In some measure, the historical association of disaster with war may be how officials view the association between disaster and terrorism. Their major concern seems to be how people will react to external threats, rather than how people and communities might deal with such threats and how they might recover. Indeed, the disaster research community and many professional emergency managers tend to focus less on the specific nature of "weapons of mass destruction" than on developing capabilities to deal with those and similar hazards and the resilience to adapt and recover quickly. The shifting official focus from NBC (nuclear, biological, and chemical) weapons and materials to the current CBRNE (chemical, biological, radiological, nuclear, and explosive) weapons and materials has been seen as something of a policy "shell game" and the limited attention given to community preparedness and resilience has been a source of great frustration. It is encouraging, however, that the U.S. military is now interested in the importance of "civil security," the role of individuals and communities in reducing vulnerabilities to attack and developing measures to reduce their impact (Dory, 2003). Dealing with the disasters that might result from terrorist attack is an increasing concern. The focus of Homeland Security policies and programs is still on preventing such attacks, but more attention is being paid to the social and economic costs. The concern with infrastructure damage is broadening.

The change in policy focus is evident in the switch from preparing for the fifteen planning scenarios adopted in 2004, with twelve being terrorism related, to a focus on bringing more resources to bear in the event of such disasters – not just national security resources, but including the resources of the nation's emergency management system. It is still important to estimate casualties, damage to infrastructure, economic impact, and recovery time, but the assumptions about governance structures and processes under the planning scenarios had to be revised. Current estimations from the Centers for Disease Control and Prevention of fatalities from an influenza outbreak like the catastrophic 1918 outbreak are from 2 million to 150 million with 7.4 million being a "reasonable estimate" (McKenna, 2005). The potential for millions of deaths is one of the reasons why public health officials have argued that influenza is a much bigger threat than bioterrorism and, consequently, much more funding should be provided for programs to identify and respond to influenza outbreaks early.

Homeland Security policies and plans were being made to deal with worst case scenarios, rather than the most likely scenarios. While recent attacks have demonstrated that terrorists can cause mass casualties and mass destruction, not all are at equal risk of attack and, in fact, many are at very little risk. Not all potential targets are of sufficient symbolic value to attract terrorists. While "lone wolf" or solitary types of terrorists may choose "soft" or unprotected targets close-by, the biggest targets are those with high symbolic value and/or those with large numbers of people. More importantly, not all terrorists have the wherewithal or even the desire to kill many or cause catastrophic destruction. A reasoned assessment of risk might better identify potential targets, better prepare law enforcement and security officials and emergency responders, and help better target resources for the attacks that may come.

Terrorist acts do pose some unique problems for those targeted and those responsible for dealing with real and threatened attacks. Fortunately, the "unnatural" disasters resulting from terrorism are very similar to those resulting from natural phenomena, as well as human accidents and technological failures. In many respects, recent terrorist-sponsored disasters have been

very similar to natural and other human-made catastrophes. The same first responders have to deal with the consequences of terrorist acts that have had to deal with structural collapses, fires, train wrecks, vehicle crashes, aircraft crashes, pandemics, and other large-scale disasters. The same second responders have to deal with the physical and psychological trauma, restoration of lifelines, and other activities to get individuals and communities functioning again. The same support agencies need to assist with short- and long-term recovery.

But, terrorist-sponsored disasters are different from other kinds of disaster in several ways. First, disasters caused by terrorists are not accidents or "acts of God." They are caused by people and they are caused on purpose. The images of dead and injured children recovered from the daycare center in the collapsed Murrah Federal Building in Oklahoma City in 1995 were all the more disturbing because the act that brought down the building was intentional and was committed by other Americans. Similarly, the fact that British citizens were involved in the July 2005 London subway bombings was met with disbelief by many Britons and lead to a reassessment of the terrorism threat in the U.K.

Second, disasters caused by terrorists are crime scenes. Consequently, responders to terrorist disasters should avoid, as much as possible, disturbing the crime scene in order to preserve evidence that may help law enforcement officers apprehend the terrorists. Protocols have been developed in the U.S. since the Oklahoma City bombing to minimize contamination of crime scenes by rescue workers and to lessen the likelihood that law enforcement officers will interfere with lifesaving action when they are securing the sites and preserving evidence. Third, disasters caused by terrorists normally involve a mix of responders very similar to that for a natural disaster, but generally involve law enforcement and military personnel in lead, rather than support, roles. Large-scale disaster responses frequently involve large numbers of governmental and nongovernmental agencies, as well as organized and spontaneous volunteers. In that regard, responding to natural disasters and terrorist disasters are very similar in that the resources of broad networks of public, nonprofit, and private organizations and individuals may be needed (Waugh & Sylves, 2002; Waugh, 2003b). While authorities dealing with terrorist incidences may be reluctant to use nongovernmental resources, particularly volunteers, they may be essential in very large events. The response to the Oklahoma City bombing involved dozens of organizations, from the American Red Cross to the Oklahoma Restaurant Association, and hundreds of individual volunteers (City of Oklahoma City, 1996).

The response to the World Trade Center attack drew hundreds of organizations and many thousands of volunteers (Lowe & Fothergill, 2003; Sutton, 2003; McEntire, Robinson, & Weber, 2003). There is a wealth of disaster research on the 9/11 response and recovery efforts. For example, the evacuation of Lower Manhattan involved an improvised boat-lift on a scale that exceeded the historic boat-lift that evacuated thousands of Allied troops from Dunkirk, France, in 1940. James Kendra's and Tricia Wachtendorf's *American Dunkirk: The Waterborne Evacuation of Manhattan on 9/11* (2016) examines the effort to transport evacuees to New Jersey and Staten Island and other locations and to carry supplies and emergency responders to Manhattan to help with the disaster response. There were many examples of improvisation and volunteerism following the 9/11 attacks. Citizens of Gander, Newfoundland, Canada, housed and fed Americans and other passengers when U.S.-bound aircraft were forced to land in Canada when U.S. airspace was closed on 9/11 (DeFede, 2011). Similar intergovernmental, multi-organizational responses occur in other nations. For example, the responses to bombings in Istanbul in November 2003 were very similar to the response in Oklahoma City (Ural, 2005) as nongovernmental organizations assisted with the response and recovery efforts. Designing an effective response to terrorist disasters, in fact, is complicated by the lead roles of agencies unfamiliar with the networks that respond to large natural disasters and unused to communicating and collaborating closely with nongovernmental actors (Waugh, 2004a). The

biggest difference between the responses to terrorism-related disasters and other kinds of disasters is just that – the lead roles of agencies and officials responsible for capturing or killing the perpetrators rather than performing lifesaving roles and helping reduce the impact of the disaster on people and property.

7.5 Responses to Terrorist Disasters

Aircraft bombings have killed hundreds at a time, often with no survivors. For Americans, there were major terrorist attacks before the bombing of the World Trade Center in 1993 and the Murrah Federal Building in Oklahoma City in 1995 that required substantial emergency responses, but those experiences were often used as the baselines for dealing with terrorist events until the 9-11 attacks. More recent attacks have raised issues relative to hospital surge capacity. Urban locations generally mean greater access to trauma centers, but the capacities of emergency medical systems can be overwhelmed. Planning for pandemics and other medical emergencies has helped answer questions about quarantine, triage processes, decontamination, dissemination of information to the public, privacy of medical records, the availability of trauma centers, and other issues. But, systems can still be overwhelmed by a mass casualty incident. In some measure, governance issues, e.g., who is in charge and who has responsibility for what, are clearer because often decisions have been made to designate lead agencies, lead officials, incident commanders, and such. But, that is not always the case.

7.5.1 The Oklahoma City Bombing

When a 4,800-pound homemade bomb exploded at 9:02 a.m. on April 19, 1995, in a truck next to the Murrah Federal Building, the front of the structure collapsed and buildings in a ten block radius were also damaged. The police, fire, and emergency medical response was quick and the Oklahoma City Fire Department became the lead for the disaster response. Later, law enforcement agencies set up their own perimeters to secure the site and to collect evidence. The bombing of the federal building caused a disaster that elicited a national response and federal, state, and local responders converged to rescue victims and search the collapsed facility. Emergency responders from surrounding states were drawn into the effort as the days progressed. Via the media, the nation lived through the bombing and its aftermath.

Because the event involved a federal crime (terrorism), a federal facility, and the deaths of federal officers, the FBI and other federal agencies had clear jurisdiction. Nonetheless, the search and rescue operation was managed by Oklahoma City fire personnel. Federal resources, including "federalized" Urban Search and Rescue Teams and a Disaster Mortuary Team, were brought in by the Federal Emergency Management Agency (FEMA). The response and recovery operations lasted sixteen days. One hundred and sixty-eight people were killed, some in surrounding buildings or on the street. Firefighters from more than seventy-five Oklahoma municipalities and over thirty-five departments from Texas, Kansas, Arkansas, and other states were involved. Over one thousand FEMA personnel and hundreds of personnel from other federal agencies were involved. The American Red Cross and numerous other nonprofit organizations, as well as private sector organizations, were involved (City of Oklahoma City, 1996; Waugh, 2000). The scale of the disaster required considerable resources from all levels of government and from nongovernmental organizations. But, the Oklahoma disaster was very small in comparison to the disaster caused by terrorists on 9-11.

7.5.2 The 9-11 Attacks

The collapse of the World Trade Center towers was one of the largest terrorist-caused disasters in modern history. While the number of deaths and injuries were remarkably small given the numbers of people in the towers, the surrounding

streets, and the subway system below the towers that morning, the psychological impact of the disaster was tremendous. The physical and economic impacts upon the city and the surrounding metropolitan area was catastrophic. This was the costliest disaster for FEMA, the US Department of Housing and Urban Development, and the US Department of Transportation (US GAO, 2003, p.19). The search and rescue operations cost $22 million and debris removal cost $695 million. Almost two years after the collapse of the World Trade Center towers, the total federal expenditures for response totaled $1.17 billion. $2.649 billion was provided as assistance to state, city, and other organizations, to individuals and families, and to businesses (US GAO, 2003).

Over $5.5 billion was committed to rebuild the transportation system in lower Manhattan, repair utilities, and support short-term capital projects. The rebuilding of the transit system has been slow and only $54 million of the committed $5 billion were disbursed as of June 2003. Reconstruction continues in and around the old World Trade Center site. $5.5 billion in funds and tax benefits were committed for economic revitalization. By June 2003, $173 million in funds had been disbursed and presumably the tax benefits had had some impact. Two items to note are the differences in funds committed and funds spent and the provision of tax benefits. Expenditures can stretch out for years as recovery projects are implemented. In addition to the losses covered by federal programs, the uninsured and insured losses were in the billions of dollars. It took nine months to clear the debris and approximately 18,000 businesses were affected. Many businesses in lower Manhattan failed. It was a catastrophic disaster by any measure.

The total amount of money committed to the New York City recovery through FEMA, the US Department of Housing and Urban Development, and the US Department of Transportation was in excess of $18 billion during the first years after the attack. This amount does not include Small Business Administration and other disaster assistance grants. FEMA activated 20 of its 28 Urban Search and Rescue Task Forces – almost 1300 members and 80 dogs (US GAO, 2003, p. 24). Thousands of volunteers were used for search and rescue, support for emergency responders, and other critical tasks.

It should also be noted that the crash of TWA Flight 800 off Long Island in 1996 lead to the passage of the Aviation Disaster Family Assistance Act of 1996. Because the crash was initially presumed to be the result of a terrorist bomb, the lead agency was the F.B.I. rather than the National Transportation Safety Board (NTSB). Normally the NTSB would have investigated the crash and local authorities would have dealt with the victims and their families. The crash was deemed a crime scene and the F.B.I. acted to preserve evidence, including evidence associated with the victims' remains. There was little sensitivity to grieving families, a very slow process of identifying and releasing remains, and poor communication with families, airline officials, and local public officials. As a result of the public outcry, the Aviation Disaster Family Assistance Act was passed to assure that the needs of victims and their families were met in aviation disasters. The Act specifies roles for the airlines, the American Red Cross, and other agencies and the airline industry has developed procedures to deal with such disasters. Unfortunately, the procedures developed were not followed after the 9-11 crashes. Families got very little support.

7.5.3 The 2015 San Bernardino Attack

On December 2, 2015, two individuals opened fire at attendees at a holiday party for the Inland Regional Center in San Bernadino. Fourteen people were killed. The center assists people with disabilities and special needs. Both shooters were killed in a shootout with police. The shooters, husband and wife, were radicalized, but not directly associated with ISIS. The husband worked at the center. So-called "active shooter" cases, like the San Bernadino attack, are difficult

to prevent. Identifying "radicalized" individuals, particularly those who are not associated with a particular group, is the key but information is difficult to find. The important point is that it demonstrates the difficulty in preventing such acts. Automatic weapons and ammunition are relatively easy to acquire legally or illegally and there are almost an infinite number of possible targets. Similar attacks could happen almost anywhere and anytime – and have.

7.6 The Challenges of Terrorist Disasters

Many questions remain concerning how to deal effectively with natural and human-made disasters. How to provide effective alerts and warnings, how to educate the public about hazards and appropriate protective actions, how to encourage adequate emergency preparedness at the individual and community levels, and how to design and manage effective evacuation programs are a few of the many questions that have not been completely answered. Many questions have been answered, such as why people may not choose to evacuate when authorities ask them to do so. The question that arose in the months after the 9-11 attacks and as the nation's Homeland Security programs were being put into place was how much knowledge gained over a half century of dealing with natural and technological disasters is transferable to terrorist disasters. The emergency management professional community and the disaster research community have generally argued that much of what we know about dealing with natural and technological hazards and disasters is applicable to Homeland Security. Nonetheless, relatively little has been transferred. For example, the weight of social science research supports the conclusion that panic is rare in disasters, particularly when people are given sufficient information to determine what they should do. That is also true in disasters involving nuclear and biological material, in chemical accidents and spills, and in pandemics. There was no panic at Chernobyl in 1986 during the world's worst nuclear accident (see, e.g., Medvedev, 1990). Remarkably, there was no panic in the Tokyo subway in 1995 during the Aum Shinrikyo sarin attack (see, Murakami, 2000). There are also remarkable stories of heroism and calm from the World Trade Center collapses in 2001. Panic appears to be far more common in circumstances where information concerning appropriate protective action is poor or nonexistent or people are literally trapped in buildings or ships or other structures. Experience and research strongly support the need to provide as much information as possible during emergencies, rather than withhold information for fear of causing panic. Unfortunately, decision makers appear disinclined to provide information when it is needed in an emergency.

While there are still coordination problems when federal, state, and local emergency management agencies work together, some of the cultural and organizational differences have been worked out over the years. The frequency of natural and technological disasters does provide plenty of opportunity to test and correct systems and to become familiar with the capabilities and priorities of other agencies. The infrequency of terrorist incidents limits opportunities to learn how to improve capabilities, although Homeland Security programs may encourage more training and exercising. The divide between the national security or terrorism-related programs and the non-terrorism program is still substantial and has had an impact upon the administrative cultures within the Department of Homeland Security and even within the Federal Emergency Management Agency.

7.7 Conclusions and a Research Agenda

Terrorist disasters can closely resemble natural and other human-made disasters, including becoming cascading disasters. For example, the 9-11 World Trade Center disaster involved airliner crashes, high-rise fires, structural collapses, and hazardous materials events, as well as numerous lesser emergencies. The disaster occurred in multiple locations. The scale

certainly was greater than for other terrorist events, but less than that of the 1906 San Francisco earthquake or, perhaps, the next great "urban" quake in California. The organizational effort following the World Trade Center attacks required extraordinary coordination and communication (much of which was ineffective), but, in many respects, the disaster itself created familiar imperatives and it was managed by national, state, and local agencies in collaboration with other governmental and nongovernmental organizations – and individual volunteers.

There are differences between terrorist-spawned disasters and other kinds of disasters. However, the range of possibilities makes it extremely difficult to identify potential targets, let alone protect them. Richard A. Clarke and R.P. Eddy suggest in their book *Warnings: Finding Cassandras to Stop Catastrophes* (2017) that we do get warnings of terrorist developments, as well as warnings about climate change and other threats, and simply fail to heed them. Whether foreseeing new developments is enough to stop them from becoming real threats is debatable, but intriguing. Much depends on the amount of information in the crystal ball. The rise of ISIS was predictable. The 9-11 attack was predictable because there was a World Trade Center attack in 1993 and many clues that an attack involving aircraft was in the making. Theories of absolute deprivation or rising expectations or even a hot summer will cause violence in our cities may suggest actions to reduce the risk, but is that enough information to design policies and programs to address the issue? The point is that anticipating the rise of terrorist organizations and their potential targets would make it easier to prevent attacks. The increase in right-wing extremism and domestic terrorism is also predictable as well. The next attackers may be ISIS operatives or American militia members or they may be from any number of other international or domestic extremist groups. The attacker may be another lone bomber or a lone biologist with anthrax or ricin or hoof and mouth virus. The point is simply that the range of possibilities is so great that a broad approach is necessary to assure that law enforcement, military, and emergency response personnel have a range of capabilities, therefore a more generic "all-hazards" program would be more adaptable to circumstances than a simply a terrorism-focused program and will be more consistent with the national emergency management resources we have.

Recent history has taught us that the terrorist threat changes over time. The attacks on trains and subways, including the March 2004 bombings in a Madrid train station that left 191 dead and around 1500 injured and the July 2005 bombing in the London Underground that killed 56 and injured about 700, encouraged attention to security in the transportation sector. Attacks by individuals or small groups, such as the May 2014 shooting in Brussels that left four dead, the January 2015 attack on the Charlie Hebdo magazine office in Paris that left 17 dead, and the February 2015 attack in a café in Copenhagen that left one dead, are much more difficult to stop because there may not be evidence of preparation. The November 2015 attacks on the Bataclan concert hall, restaurants, and Stade de France football stadium in Paris left 130 dead and hundreds injured, the January 2016 suicide bombing near the Blue Mosque in Istanbul that killed twelve German tourists, the March 2016 attack at the crowded airport and a train station killed 32, the July 2016 attack in Nice that involved a truck claimed 86 lives, and the December 2016 attack at a Christmas market also involving a truck claimed the lives of twelve. The scale of the attacks was increasing. Security measures began to include using vehicles and bollards to keep vehicles out of more pedestrian areas. Attacks on police officers in Paris followed in early 2017 with one officer being killed on the Champs Elysees. Another vehicle attack was carried out in London in March with four people killed and yet another vehicle attack was carried out in Stockholm in April 2017 with five killed. The suicide bombing at the Ariana Grande concert in the Manchester Arena in May killed 22. Clearly, there are patterns in the attacks, particularly those involving vehicles. Some attacks were larger scale and well organized, many were not. Not all of these attacks were connected to ISIS. Most

were carried out by individuals with only tenuous links to ISIS. Security measures kept bombers out of the crowded Stade de France stadium during the 2015 Paris attack and out of the Manchester Arena the May 2017 attack during Ariana Grande's concert. The bombs exploded outside of those venues.

The listing of recent terrorist attacks in Europe would suggest that it is dangerous to live or travel there, but life goes on. Journalists and officials noted the resilience of Manchester within a day or two of the attack at the Ariana Grande concert. Manchester had experienced violent attacks during "The Troubles" in the mid-1990s. A truck bombing by the IRA injured 212 people and no one was killed. The newest bombing has had its effect, but the city is "calm" and people are back to work (Bevanger & Schumaker, 2017; Welle, 2017b). It may simply be that no one thinks that terrorists will target them, just as no one thinks that an earthquake or hurricane will cause them harm. People do learn to live in war zones and other hazardous areas.

7.8 Future Research Agenda

The literature on terrorism, terrorists, terrorist weapons, anti-terrorism measures, and counter-terrorism policies and programs is large and growing. Much is known about terrorist motivations, organizations, weaponry, and tactics and much is known about anti- and counter-terrorism measures. The persistent issues have been related to the relationship between terrorists' political objectives and their choice of targets and to the effectiveness of anti- and counter-terrorism policies and programs. It has also been common to focus on the instruments of terrorist violence, rather than on the human targets. Military studies have tended to focus on the lethality of weapons and measures to preempt or prevent attacks through improved intelligence gathering. Nuclear proliferation and the potential for nuclear, chemical, and biological agents to be lost, stolen, or sold to terrorists are major concerns. Security studies typically focus on risk and vulnerability assessments and the "hardening" of facilities, including security "layering" and how to maintain vigilance over time without becoming careless; and Law enforcement studies tend to focus on prevention and the apprehension of the terrorists. Active shooter exercises are the new focus because there have been numerous armed attacks recently, although not all have been perpetrated by terrorists. The problem of terrorism is, in fact, many problems, but there is a need to find a broader perspective that will facilitate the development of a comprehensive strategy to deal with the hazard of terrorism.

The study of anti- and counter-terrorism policies and programs in the U.S. has been seriously hampered by the secretiveness of DHS and the Federal Bureau of Investigation. Access to officials and offices had particularly been limited during the George W. Bush Administration. Academic researchers generally found it difficult to access people, offices, programs, and data within the Department. The creation of DHS was the largest federal reorganization in almost sixty years and academic researchers were anxious to see how the constituent programs and personnel were being integrated. The creation of the Department also consolidated many, but not all, of the federal programs that deal with the internal and external threats from terrorism. Access to DHS was much easier for scholars during the Obama Administration, but overcoming barriers associated with the national security apparatus were still challenging. Access to the Federal Emergency Management Agency (FEMA) was much easier, but still complicated when dealing with the national security programs within the agency. How accessible the Trump Administration's DHS and FEMA will be is uncertain at this stage. Policies and personnel are expected to change.

Future research efforts should focus on at least the following general topics:

1. A better understanding of terrorism and why individuals and groups choose to use violence to achieve political ends is critical, if the risks of violence are to be addressed in the long term. Authorities and scholars need to address the precipitants of terrorism,

including poverty and religious intolerance, and to provide options for opposition groups to consider before they choose terrorism. Much was done in this area during the 1970s and 1980s, but, as noted in the previous discussion, terrorist organizations and political goals have changed.

2. More effective organization of anti- and counter-terrorism programs is a fundamental need. Intergovernmental and international coordination to deal with terrorism and other potential disasters has been problematic. Intra-organizational coordination was a problem prior to the 9/11 attacks and during the national anti-terrorism (TOPOFF) exercises that followed. Coordination is awkward in a federal system like the US because of the division of powers and developing strong working relationships can be difficult. National authorities generally have greater resources, but cannot always bring them to bear during terrorist incidences. Local authorities may well have more experience dealing with bombings, hostage cases, and other terrorist-type events than their federal counterparts, but too often lack resources to deal with threats and attacks effectively. Local authorities typically have much more experience dealing with disasters and can bring essential skills in hazard mitigation, preparedness, response and recovery to counter-terrorism programs, but support from national authorities is needed.
3. Better coordination of multi-organizational tactical operations is a critical need. This is also a governance issue. Incident command systems (ICS) were developed to coordinate large fire responses. That type of hierarchical command structure seems to work in those kinds of environments, but have serious limitations in other kinds of disasters and with other kinds of organizations (Jensen & Waugh, 2014). Unity of command may not be practicable in many complex emergencies, such as pandemics or even large-scale terrorist incidences. Unified command with a more consensus-based decision process may be much more effective. Similarly, the National Incident Management System (NIMS), which is supposed to use ICS principles to structure a national response to large-scale disasters and terrorist incidences may be seriously flawed because it may run counter to the system of shared governance in the US and may interfere with local first response (Waugh, 2009). Certainly newly centralized decision processes delayed deployment of National Guard troops and first responder volunteers during the Hurricane Katrina disaster. Reliance upon officials in Washington to make critical decisions that could have been made at the local or state level or by federal officials close to the scene is a serious flaw in the system. The disconnection between local needs and the national response is a reflection of the centralization problem as well.
4. The integration of law enforcement and military personnel into disaster response has also been problematic. Law enforcement officers have interfered with life-saving activities in major disasters, including terrorism-related disasters, in the past because of their priority of preserving evidence. In domestic terrorist incidents, law enforcement agencies are the designated lead agencies and they need to be able to work with those governmental and non-governmental organizations that also will be involved in the response and recovery efforts (Waugh, 2002a). The Katrina experience demonstrated the value of military participation in catastrophic disaster responses, particularly in security and in search and rescue operations, but military personnel are not trained to deal with victims more broadly. Research is needed on how to prepare law enforcement and military personnel better for disaster relief operations, how to integrate them into local operations and how to prepare local officials to communicate effectively with those personnel. Cultural interoperability is an important issue (Waugh, 2002b).

5. The development of inter-sector collaboration has been very slow. Most of the nation's infrastructure is in the private sector and there has been limited success in encouraging preparedness efforts by businesses. Incentives need to be developed to encourage more private investment in emergency planning, business continuity planning, and other preparedness activities. Research is needed on issues such as how to create a market for emergency preparedness. It is a positive sign that some large corporations are seeking Emergency Management Accreditation Program (EMAP) accreditation. Their interest in adopting the EMAP Standard for a comprehensive emergency management program likely reflects growing concern about hazards, including terrorism and climate change. The interest in business continuity planning also reflects concern about disasters that could negatively affect business operations.
6. The exercise of federal jurisdiction in events involving terrorism raises issues that have been dealt with in other kinds of large-scale disasters. In emergency management, the solution has been to build local and regional capacities to deal with disasters until state and federal resources are available. Investments in training and equipment for local first responders have been a priority. Pre-positioning critical resources, like medical supplies and pharmaceuticals, has also been a priority. The National Guard Civil Support Teams to deal with radiological events is one of the measures that has been implemented since 9/11. More research, including policy and program evaluations, would help target resources where they are needed to build local first responder capabilities and where the risk of attack is greatest. A question that needs to be addressed is how to link FEMA's Whole Community Approach to Homeland Security programs. As the Trump Administration addresses the issues related to terrorism and other hazards, there will be questions about the roles of DHS and FEMA, building local capacities to deal with hazards, and funding levels for a wide variety of programs. Will the Emergency Management Performance Grant program continue, for example? Will Community Development Block Grants still be available to help communities rebuild following disaster? The relationship between DHS and state and local governments will be an important subject of study.
7. The human dimensions of terrorism-related disasters have been far from adequately explored. Research on how people perceive the hazards posed by terrorism, how they interpret the risks, what they know about potential terrorist acts, how they make decisions concerning protective action, and how authorities can influence the public to take appropriate action, including preparation for potential attacks, are some of the questions that need to be answered. The presumption on the part of officials and the media that the public is likely to panic needs to be dispelled to assure that accurate and timely information is provided to encourage people to take appropriate protective action. The disaster literature answers many of these questions in relation to natural and technological disasters, but, evidently, validation may be necessary for the research to be accepted by public officials and the media.
8. Effective risk communication is also a serious issue that needs more study. What kind of information does the public need in order to make decisions concerning evacuation, sheltering in place, and other protective action? How much can be delivered via public education programs and how much can be delivered via alert and warning messages? How much information is needed by the public – certainly large segments of the public want to access such information via the web and social media. Disaster research shows that information needs differ, but that adequate, accurate information is essential if authorities wish the public to

respond appropriately. The public has to trust those providing the information in order for it to be accepted.

9. Psychological impact is the raison d'être for terrorism. Terrorism is violence for effect, but what influences that effect? What variables affect how people perceive and respond to terrorism? How can the psycho-social effects of terrorism be mitigated? Are there differences in how people perceive threats and attacks and are the psychological impacts of biological and nuclear threats and attacks greater than the impacts of other kinds of terrorism? Communities have bounced back from terrorist attacks with a "business as usual" attitude to demonstrate that the terrorists have not achieved their goal of interrupting normal life. Such is the case with the March 2017 terrorist attack near the British Parliament.
10. To the extent that terrorist acts may cause catastrophic disasters, much more research needs to be done on long-term recovery issues. The Homeland Security Council's scenarios included the explosion of nuclear and chemical devices which could cause long-term contamination in major cities, displacing thousands of residents. How can large numbers of evacuees be resettled if their communities cannot be quickly cleaned up? Homeland Security and emergency management officials have struggled with issues like mass decontamination and mass burials, but issues related to long-term housing and employment of evacuees have certainly become major concerns since Hurricanes Katrina and Sandy.
11. Surge capacity issues have also been major concerns in natural and man-made disasters. The capacities of hospitals and the medical system as a whole to deal with large numbers of casualties are important, but much more research needs to be done on the capacities of local emergency response and emergency management agencies, the National Guard, and the multitude of nongovernmental disaster relief organizations during major disasters. Nongovernmental organizations, from local community groups to national faith-based organizations, represent that nation's capacity to deal with large scale disasters and more research needs to be done on how to integrate them into disaster operations better.
12. If terrorism is different from other kinds of disasters, how is it different and what do the differences mean for mitigation, preparedness, response, and recovery? How can societies assure that individuals, families, and communities recover quickly from terrorist-related disasters? How can communities be made more resilient and less vulnerable to terrorist violence?

There are many other questions that need to be answered and research that needs to be conducted to inform policies to deal with the threat and the actuality of terrorist attacks. Fortunately, much is known about managing hazards and dealing with large-scale disasters that is applicable to terrorist events. Open communication among Homeland Security officials, emergency management officials, terrorism and counter-terrorism researchers, and disaster researchers would help better identify research needs and improve policies and programs to deal with the risk posed by terrorism.

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Climate Change and Disasters

8

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Contents

8.1 Introduction

Contemporary climate change induced in part by human activity has come to head the international development agenda (Kelman, Gaillard, Lewis, & Mercer, 2016). Attempts to address climate change tend to occur, often deliberately, in isolation from other development endeavors, thereby often overshadowing other long-term environmental issues (Mercer, 2010). Further, the development of climate change science and policy has to a large extent overlooked the large set of ideas and approaches to adapting to change within development and disaster risk reduction (DRR) literature, policy, and on-the-ground practice. Consequently, efforts are often duplicated, adopted approaches bypass or exacerbate other issues and needs, and a valuable opportunity is missed to learn from past experiences from work in development and DRR (Kelman & Gaillard, 2010).

The artificial demarcations between climate change, DRR, and development are deeply entrenched in many ways. These demarcations reflect high-level global processes with long histories. Significantly, 2015 saw the establishment of three separate international agreements. First, in March in Sendai, Japan, the Sendai Framework for DRR 2015–2030 (SFDRR & UNISDR, 2015) laid out a voluntary pathway for the next 15 years of DRR, following on from the 10 years of the Hyogo Framework for Action 2005–2015 (HFA & UNISDR, 2005). Second in New York City, USA, the United Nations Sustainable Development Summit on 25 September

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2015 adopted the 2030 Agenda for Sustainable Development, the successor to the Millennium Development Goals (UN, 2000), which ran from 2000 to 2015. The Agenda includes a set of 17 Sustainable Development Goals (SDGs) with 169 targets leading to indicators which are still being developed (UN, 2015). Third, in Paris, France in December 2015, the UN Framework Convention on Climate Change negotiated an international treaty for dealing with climate change (UNFCCC, 2015). Separations have thus been engrained for the next 15 years, with climate change largely at the top of the international development agenda.

Nonetheless, a need exists for more integrative development to avoid the pitfalls associated with addressing climate change, disaster risk, disasters, and broader development issues in isolation. Addressing climate change and its impacts shares numerous common themes with DRR, employs common approaches, and, while with often significantly different interpretations, uses common terms (Kelman, Gaillard, & Mercer, 2015). It is therefore logical that DRR and climate change adaptation (CCA) are joined in a way in which they can learn from past experiences and move forward synergistically with each other and other development processes (Kelman et al., 2015).

As this chapter will explore, the frameworks and principles that underpin DRR contribute many benefits for CCA. This chapter will therefore provide a theoretical rationale for embedding CCA as a subset of DRR, which in turn should sit within wider development processes. It will begin by discussing key terms in DRR and defining climate change. The intersections between climate change and hazards, vulnerability, and risk are then examined. The chapter will move on to discuss implications of the current approach to vulnerability employed in climate change, and how climate change has come to operate as a scapegoat for other environmental and hazard-independent issues. Finally, a case will be presented for CCA to be reconceptualised in theory, policy, and practice as a subset of DRR, while climate change mitigation (CCM)—as distinct from disaster mitigation—should operate as a component of pollution prevention. All these concepts and processes should sit within wider development theory and practice.

8.2 Disasters, Hazards, Vulnerability, and Risk

As Chap. 1 and others in this Handbook detail, a range of definitions for disasters are provided across different disciplines, applications, and timeframes (e.g. Perry & Quarantelli, 2005). This chapter will use the term disaster to refer to any "situation involving a natural hazard which has consequences in terms of damage, livelihoods/economic disruption and/or casualties" (Wisner, Gaillard, & Kelman, 2012: 30), so disasters occur due to a combination of hazard and vulnerability. A hazard is an environmental phenomenon, albeit often influenced by human activity such as land use and resource consumption (Wisner, Blaikie, Cannon, & Davis, 2004), such as climatic trends, volcanic activity, precipitation, landslides, space weather, bacteria, and viruses.

Vulnerability encompasses the ongoing conditions of society that stop people from being able to deal with environmental phenomena without adverse consequences (Baird, O'Keefe, Westgate, & Wisner, 1975; Cannon, 1994; Hewitt, 1983; Lewis, 1999; O'Keefe, Westgate, & Wisner, 1976; Wisner et al., 1977, 2004). Human decisions, values, attitudes, behavior, and governance structures create societies and allocate resources in ways that create and maintain vulnerability (Hewitt, 1983; Lewis, 1999; O'Keefe et al., 1976; Waddell, 1977; Wisner et al., 2004). They create and perpetuate hazard-independent structural constraints, which encompass social, economic, cultural, and political factors and result in people having different levels of exposure to and impacts from hazards according to their social status (Watts & Bohle, 1993; Wisner et al., 2004).

The processes of vulnerability are perpetrated in the actions and activities of people who are usually remote from and beyond the influence or control of those most affected. When factors determining vulnerability are more endogenous,

in other words when people and communities impact their own vulnerability processes such as through livelihood choices, it is usually a result of a lack of awareness, lack of choices, or inappropriate decision-making—but these are typically influenced or exacerbated by exogenous factors as well.

Vulnerability is therefore both subjective and contextual (Bankoff, Frerks, & Hilhorst, 2004; Hewitt, 1983; Lewis, 1999; Wisner et al., 2004). It is not a static condition, but one that varies over time and space, accruing over long periods from social processes such as politics, resource distribution, and inequity, thus encompassing processes through which a society's current state was reached as well as likely future trajectories (Hewitt, 1983; Lewis, 1999; Oliver-Smith, 1986; Wisner et al., 2004).Through the lens of vulnerability, disasters are not 'natural', neither in the sense of being from nature nor in the sense of being normal and acceptable (Hewitt, 1997; Lewis, 1999; Mileti, 1999; Oliver-Smith, 1986; Steinberg, 2000; Wisner et al., 2004).

With disaster risk as a combination of hazard and vulnerability, DRR strategies and policies have long been operating within the international development community (Mercer, 2010). DRR usually gains prominence after a major disaster, with it remaining difficult to garner significant support for DRR in the absence of a disaster. Given that disasters result from ongoing societal conditions, namely vulnerability, it is impossible to separate DRR from wider human development. Through adopting this lens of vulnerability, DRR becomes fundamentally a development process, putting into practice the long-standing suggestions of a wide range of literature from around the world and across the decades including, but definitely not limited to, Copans (1975), Enarson and Morrow (1998), Garcia-Acosta (2004). Glantz (1994a, b), Hoffman and Oliver-Smith (2002), Lavell (2000), Lewis (1979, 1988, 1999, 2003), Maskrey (1989), Oliver-Smith (1979, 1986), Torry (1979b), and Waddell (1977). Accordingly, UNISDR (2009, online) defines DRR as 'The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters' with examples being improved land use and environmental management and amongst a host of other activities.

8.3 Climate Change

Contemporary climate change, with a significant component related to the emission of greenhouse gases and the destruction of sources of these gases' uptake, has emerged as a significant global topic over the past few decades (IPCC, 2013–2014). Climate change, which is epitomized by an increase in mean global temperature, has two principal definitions. The first is provided by the Intergovernmental Panel on Climate Change (IPCC), the main body responsible for synthesizing climate change science for member government approval. The IPCC (2013–2014, p. 5) defines climate change as 'a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use'.

The other principal definition is provided by the United Nations Framework Convention on Climate Change (UNFCCC), the main international treaty for addressing climate change, defining it as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC, 1992, Article 1, Paragraph 2, p. 3). The pertinent difference between the two definitions is that the IPCC considers all climate

changes, regardless of the change's driver, whereas the UNFCCC considers only anthropogenic climate change.

8.4 Climate Change's Implications for Disasters

Contemporary human-induced climate change is likely to impact disaster risk through complex interactions with disaster's constituent components of hazard and vulnerability. The effect of climate change on hazards varies by hazard, by location, and by scale. Climate involves complex, often unpredictable feedback loops that make projections challenging. Uncertainty increases further when climate change simulations are applied to greater time scales and as the focus shifts to smaller spatial scales (Shaw, Pulhin, & Pereira, 2010a). Nonetheless, numerous individual studies provide insights into potential impacts of climate change on some hazards and potential hazards, indicating that climate change can exacerbate some hazards, diminish others, and have no effect on others.

Interest in attributing extreme climatic events to climate change has substantially increased (for a more detailed summary see National Academies of Sciences, Engineering, and Medicine, 2016). Changes have been observed in the frequency, intensity, and duration of some extremes, as well as more sophisticated simulations of changes through climate models. In some instances, a strong understanding of the causes of such changes has been developed. For example, climate change will certainly impact hydrometeorological trends and hazards. A hotter climate could lead to increased intensity of precipitation, since a warmer atmosphere holds more water vapor. On the other hand, many arid areas are likely to become increasingly dry (Dore, 2005). Projections suggest that increases in global temperatures associated with climate change will lead to an increase in the average intensity of tropical cyclones, yet a decrease in the number of storms (Knutson et al., 2010). In the Norwegian Sea, storms called 'polar lows' are expected to decrease in frequency as the ocean water is projected to warm more slowly then the air above, which is not favorable to the formation of these storms (Zahn & von Storch, 2010).

Changes in hydrometeorological trends and hazards are likely to have impacts on other hazards. With an increase in precipitation, it would be expected that there will be a consequent increase of precipitation-induced flooding. With more precipitation, more landslides may occur. Again, such interactions are complex, and are likely to be spatially and temporally variable. For example, in order for a landslide to occur, there needs to be an adequate amount of material to slide. After initial frequent occurrences of landslides associated with climate change, larger landslides could possibly be less frequent as less material can build up before a landslide occurs (Kelman, 2015).

While increased levels of precipitation may contribute to avalanches through increased snow accumulation, increased air temperature may increase the amount that falls as rain instead of snow (Kelman, 2015). Increased temperatures are expected to decrease winter flood frequency in central Europe's Elbe and Oder rivers, as they are often linked to ice jams which are less likely to occur under higher temperatures (Mudelsee, Börngen, Tetzlaff, & Grünewald, 2003). Consequently, interactions between climate change and different hazards in specific locations are complex, also intertwined with continual human modification of the landscape, meaning that attribution of hazard changes solely to climate change is difficult.

Microbiological hazards are also likely to be discernably impacted by climate change. Costello et al. (2009) summarize the likely impacts by examining rodent-borne and vector-borne diseases. Increases in temperatures tend to cause vectors and parasites to breed and mature at faster rates. Within a given timeframe, more life cycles are possible, and the rate of biting consequently increases, supporting the spread of vector-borne disease. A parallel increase in the density of vectors is likely to occur alongside increasing temperatures expanding the range that species can inhabit. This is also likely to expose populations to vector-borne diseases that they have not encountered before, meaning that they

may have lower immunity and less knowledge of countermeasures.

This is again not likely to be a simple or homogenous impact. Costello et al. (2009) also suggest that climate change may foster some conditions preventing the spread of both vector-borne and rodent-borne diseases, such as in areas where hydrometeorological patterns and hazards are altered in such a way that vectors or larvae are harmed. Examples are salination resulting from sea-level rise and coastal inundation that could prevent vectors which rely on freshwater (or could drive them inland) while intense precipitation could wash away eggs and larvae.

Much debate and speculation centers on climate change's possible interactions with geological hazards. McGuire (2013) discusses how climate change has the potential to augment volcanic eruptions, tsunamis, and earthquakes. It is plausible that a shifting weight on the earth's crust driven by melting glaciers and sea-level rise could impact seismic and volcanic activity and hence subsequent tsunamis. Uncertainties are high and the conclusions are contested.

Climate change can therefore be seen as less of a hazard itself and more as an example of a major environmental hazard driver and diminisher, with complex and intricate overlaps, connections, and interactions with natural hazards. Other examples of worldwide and continental environmental hazard influencers include cycles such as El Niño-Southern Oscillation, the Indian Ocean Dipole, and the North Atlantic Oscillation. Further complexities and intricacies are added by the fact that climate change is likely to impact these cycles (Kelman, 2015).

Climate change also has the potential for influencing vulnerabilities. Communities, both indigenous and non-indigenous, have long been adapting to climatic trends, variabilities, and extremes (Hewitt, 1983; Torry, 1978; 1979a; Waddell, 1975). Human-induced climate change will likely drive the planet into a climate regime not yet experienced by humans, so people will be faced with new patterns and processes (IPCC, 2013–2014). Further, changes are projected to be at a rate that exceeds the ability of local knowledge and current governance mechanisms to keep pace, potentially affecting vulnerabilities through complex pattern of interactions (e.g. Bankoff, 2004; Gaillard, 2010; Hewitt, 1983). Conversely, if people respond to changing hazards to avoid harm, then reactions to climate change might lead to long-term vulnerability reduction.

8.5 Dealing with Climate Change

The already evident widespread changes and the future projected consequences of climate change have prompted significant attention within policy, practice, and research. Focus has been placed on the ability of society to deal with large-scale environmental change in planned and strategic ways, under the banner of CCA. The UNFCCC describes CCA as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (UNFCCC, 2014), while the IPCC (2013–2014) refers to:

> Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, e.g. anticipatory and reactive private and public and autonomous and planned. Examples are raising river or coastal dikes, the substitution of more temperature-shock resistant plants for sensitive ones, etc. (IPCC, 2013–2014).

Meanwhile, to try to prevent anthropogenic contributions to climate change, CCM refers to human interventions aiming to reduce the sources of greenhouse gases and to increase sinks that remove the gases from the atmosphere (IPCC, 2013–2014; UNFCCC, 2014). Examples include reduced use of fossil fuels such as through hybrid vehicles and cycling, use of wind and solar means of electricity generation, improved building insulation, and expanding forests (UNFCCC, 2014). The definition provided by IPCC (2013–2014) also emphasizes interventions that reduce the sources and increase the uptake of other substances which may have direct or indirect contributions to climate change, such as

emissions that alter tropospheric ozone concentrations, which indirectly affects climate.

Whilst IPCC and UNFCCC have largely separated CCA and CCM, there are connections and overlaps between both processes. For example, dealing with increased air temperatures in buildings could involve indoor climate control through passive and natural ventilation measures, in which design measures augment air flow and cool indoor temperatures without using electricity. Consequently, CCA and CCM are achieved simultaneously. Large-scale dams are another example, detailed in the next section.

Exploring these connections is part of avoiding dealing with human-induced climate change being isolated from other processes. While there is no doubt of the importance of responding to large-scale environmental changes, CCA and CCM should not be isolated endeavors, separate from other processes aimed at addressing global challenges and development predicaments such as DRR and sustainable development. All processes employ similar approaches, involve similar themes, and employ common terms. The following section will discuss these connections, exploring the importance and mechanisms of joining forces amongst the processes rather than forging separation. Advantages of the interpretations of vulnerability within DRR literature and practice will be discussed, suggesting how CCA and CCM would benefit from adopting a similar interpretation and subsequent approaches to addressing vulnerability.

8.6 CCA, CCM, and Disaster Risk

As noted in the previous section, disaster risk is a function of hazard and vulnerability. Climate change influences some hazards, so there is no doubt that climate change has a strong potential to change disaster risk. Further, CCA and CCM strategies themselves can exacerbate disaster risk (Kelman, 2015).

For example, large hydroelectric dams can help to mitigate the effects of climate change by reducing dependence on fossil fuels, and can contribute to CCA by providing a long-term water supply in the face of uncertain precipitation levels. Large dams, though, tend to increase flood risk (Etkin, 1999). Most structural defenses have the potential to fail, often due to hazard parameters not accounted for in design and construction, or due to inadequate maintenance. Dams prevent smaller floods, creating a false sense of security that permits people to inhabit floodplains with few flood risk reduction measures, which increases their vulnerability to floods (Fordham, 1999). This process is termed 'risk transference': risk is transferred into the future (Etkin, 1999). Any flood is far more damaging than floods occurring prior to the establishment of the structural measure. Risk transference can also occur between places, sub-populations, and different development or environmental concerns (see Graham & Weiner, 1995). In such instances, attempts to address climate change might be successful in the short-term, or from the isolated perspective of CCA, yet inadvertently increase disaster risk and adverse impacts from subsequent disasters.

8.7 Vulnerability in CCA

Climate change, climate change research, and its definitions and approaches to vulnerability permeate and dominate many development policy agendas. The definitions and subsequent interventions and actions employed by key actors such as the IPCC can, in fact create, perpetuate, and exacerbate vulnerability. IPCC (2013–2014, p. 28) defines vulnerability to be "the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt". At first glance, this definition appears more encompassing than the definition previously provided by the previous IPCC report as "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive

capacity" (IPCC, 2007: p. 883). This earlier definition explicitly focused on only climate-related and extreme events, and frames vulnerability as being dependent on climatic features, particularly on the magnitude of change. Yet further terms require clarification to interpret the newer definition: 'sensitivity', 'cope', and 'adapt'. IPCC (2013–2014) provides definitions of these terms, always within the climate change context only. 'Sensitivity', for example, is defined as "The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to sea-level rise)" (IPCC, 2013–2014, p. 24).

The focus thus is still placed on climate and on vulnerability as depending on climatic features. The IPCC definition therefore fails to connect climate change to other environmental contexts even when those contexts apply similar concepts (e.g. Papathoma-Koehle, Kappes, Keiler, & Glade, 2011). Climate change influenced hazards are just one set of the many creeping environmental changes posing threats and opportunities to society (e.g. desertification; see Glantz, 1994a, b). The influence of climate change on hazards is complex, place-specific, and often unpredictable, so focusing solely on climate change and related phenomena overlooks complexities that constitute hazards and risk, especially with respect to vulnerability (Kelman, 2015).

Likewise, there are numerous sources from which vulnerability is created and supported. Revisiting earlier definitions, vulnerability is a complex manifestation and result of development issues such as limited livelihood options and restricted land use; external exploitation of people, places, and resources; and oppression and lack of political voice (e.g. Bankoff, 2004; Gaillard, 2010; Hewitt, 1983; Lewis, 1999; Wisner et al., 2004). The IPCC definition adopts a restricted and narrow view of the concept that fails to acknowledge, identify, and redress these fundamental root causes (see also Global Network of Civil Society Organisations for Disaster Reduction, 2009, 2011). It overlooks crucial, long-standing observations and analyses in DRR and development, such as the contextual and long-term process of vulnerability (Kelman et al., 2015; Lewis & Kelman, 2010). While it could not be expected for any definition or literature review to encompass all literature and experiences from on-the-ground practice, climate change's failure to acknowledge the substantial body of work on vulnerability from DRR, and its well-documented and empirically supported definitions and understandings of vulnerability, results in conceptual limitations, leading to failure to address the root causes of vulnerability.

The IPCC's approach is reminiscent of the period in disaster studies often referred to as the 'hazard paradigm'. Initiated by White's (1945) dissertation on human adjustment to flooding in the United States, this paradigm placed emphasis on people's and society's ability to adjust to perceived threats from nature, emphasizing the extreme dimensions of natural hazards that are beyond human control (e.g. Burton & Kates, 1964; Chapman, 1994; Frampton, McNaught, Chaffey, & Hardwick, 2000). Nature is explained as the source of danger, to which people must adapt. Policy makers, scientists, governments, and the media framed disasters as uncontrollable, unpredictable, and unanticipated (see Hewitt, 1983 for a full critique). Consequently, there was a preoccupation with structural and technical solutions aimed at understanding, monitoring, predicting, and preventing hazards. Non-structural approaches that were employed were still largely hazard-focused; for example, delineating land use or awareness campaigns based on hazard characteristics (Bankoff, 2001; Hewitt, 1983).

The mid-1970s and 1980s, in particular, saw the intersection of disaster studies literature and ongoing international development work, to examine the concept of vulnerability as the root

cause of disaster. The 'hazard paradigm' gave way to the recognition that development decisions driving and maintaining vulnerability constitute the fundamental causes of disasters, representing a critical shift in the manner in which disasters are framed and how DRR is approached (Torry, 1979b; Waddell, 1977). This view has come to be embedded within disaster-related development literature (e.g. Baird et el., 1975; Hewitt, 1983, 1997, 2007; Lewis, 1999; Maskrey, 1989; Oliver-Smith, 1986; Wisner et al., 2004, 2012) and is widely accepted by development practitioners and policy makers (e.g. Global Network of Civil Society Organisations for Disaster Reduction, 2009, 2011; Turcios, 2001; UNISDR, 2002).

The hazard paradigm appears to be resurfacing through political and scientific discourses, particularly those in climate change, eliciting mainly techno-centric responses (O'Brien et al., 2006). Emphasis is placed on structural and technical solutions dedicated to preventing climatic hazards without duly and fully considering vulnerability (Gaillard, 2010) or even a wider hazard range. While technical solutions to vulnerability are often effective and important, for example indoor climate control to avoid freezing or overheating during temperature extremes, addressing vulnerability predominantly requires social and political solutions (Kelman et al., 2015). Many technical solutions not only avoid addressing the root causes of vulnerability, but can exacerbate vulnerability such as through the process of 'risk transference' discussed earlier.

Despite the critiques of it, the IPCC approach and those with similar interpretations of vulnerability, continue to permeate policy. Resulting efforts to address climate change are often incomplete and ineffective in addressing the root causes of vulnerability (Kelman, 2015). Climate change thus operates in a manner that is a step backwards rather than forwards, repeating approaches and paradigms that have long been abandoned by literature, policies, and on-the-ground practices in DRR and development (Kelman et al., 2015).

8.8 Climate Change as a Scapegoat

As it has come to dominate political and policy agendas, climate change has sometimes become a scapegoat for issues or events, not fully accounting for their complex, multifaceted causes and constraints (Kelman & Gaillard, 2010). Climate change presents national governments and international communities with an ideal scapegoat for DRR and development shortcomings (Gaillard, 2010). By placing the blame on global-scale processes, governments and other institutions can avoid acknowledging and acting upon responsibilities for addressing the factors creating and supporting vulnerabilities (e.g., Gaillard, 2010; Kelman & Gaillard, 2010).

For example, Southwest Bangladesh comprises over 50 large islands which were formerly intertidal and forested. Earthen embankments established to increase arable land for rice cultivation disrupt sediment depositions that sustain such intertidal landscapes. This results in elevation loss, among other problems, making storm surge one of the biggest threats facing the region, but due to the local, human changes rather than due to storm surges worsening or sea-level rise per se (Auerbach et al., 2015). Increased intensity of flooding, particularly following Cyclone Aila in 2009, has been blamed on climate change, whereas it is attributed to this increased use of structural defenses (Auerbach et al., 2015). In some instances, it can be a more insidious use of climate change as a scapegoat. The prominence and breadth of climate change has allowed some powers to use it as an excuse to carry out actions and policies they have long aimed to achieve. For example, the government of Maldives, which has long been attempting to consolidate more centrally the population from outer islands, has been using climate change as an excuse to push a policy of forced resettlement (Kothari, 2014).

Climate change influenced hazards are just one of the many changes posing challenges and opportunities. With climate change operating as a convenient scapegoat, whether intentional or not, one result is many fundamental issues of vulnerability being downplayed and other

environmental issues being overlooked. There needs to be more effort in policy and practice to disaggregate disaster risk into hazard and vulnerability in order to understand better what climate change influences and what it does not influence. The role of climate change should never be ignored, but it should be thoroughly addressed without overshadowing or obscuring the wide and multifaceted range of other existing and intersecting development challenges, such as livelihood opportunities, external exploitation of people and resources, poverty, social deprivation, and poor education.

8.9 Rationale for Embedding CCA Within DRR

Dealing with CCA and DRR as two isolated issues produces duplication of efforts and approaches; a focus on single and narrow topics; and the exclusion of other needed ideas and subjects (Kelman & Gaillard, 2010). Addressing one issue without the other can be counterproductive. For example, building a new school with natural ventilation that saves energy and copes with higher average temperatures will have little benefit if that school will collapse in the next moderate, shallow earthquake. Better integration of the various topics would achieve more comprehensive and effective development and sustainability processes that address the complex, interrelated issues in development. Given the factors discussed above, the most effective approach for achieving integration is depicted in Fig. 1: Placing CCA within the context of DRR (Shaw et al., 2010a, b) and CCM within existing pollution prevention frameworks, while noting the overlaps between (i) CCM and CCA and (ii) DRR and pollution prevention. Both pollution prevention and DRR then sit within wider sustainability and development work.

The theoretical rationale for embedding CCA within DRR can be elaborated through four main points. First, climate change is one contributor to disaster risk amongst many, and should therefore not be the sole or dominant focus when examining vulnerability reduction and dealing with hazards and hazard drivers. Other contributors include non-climate related hazards, and factors encompassed by the concept of vulnerability, including inequities, injustices, poverty, and prioritizing short-term benefits of exploiting environmental resources over the long-term consequences (Wisner et al., 2004). Whether the social oppression that forms and maintains vulnerabilities is more significant than the impacts of climate change depends on the

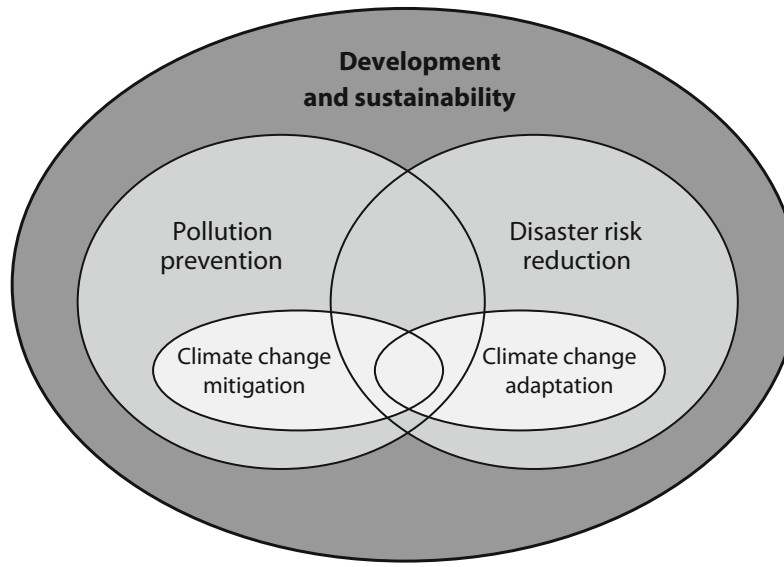

Fig. 1 CCA as a subset of DRR and CCM as a subset of pollution prevention, noting the overlaps. Both DRR and pollution prevention themselves sit within broader sustainability and development processes

specific context. It is therefore important that climate change is addressed but does not dominate and overshadow other contributors. Placing CCA within DRR allows climate change to be addressed as one factor amongst many.

Second, interpretations of vulnerability in climate change are theoretically limited, and do not acknowledge the insights provided in DRR literature and work. Researchers and practitioners in DRR have long published on vulnerability at all time and space scales, based on many forms of change (Aysan & Davis 1992; Bankoff, 2001; Etkin, 1999; Glantz, 1977; Hewitt, 1983; Lewis, 1979, 1999; Wisner et al., 2004). From a process of learning from both the past and present, DRR efforts provide more comprehensive views of vulnerability (Kelman et al., 2016). Many good practice examples demonstrate what can be achieved when broader concepts of vulnerability are accepted and applied (Global Network of Civil Society Organisations for Disaster Reduction, 2009, 2011). CCA would thus benefit from adopting DRR's more encompassing approaches to vulnerability.

Third, climate change is one of many factors influencing parameters of future disasters (Mercer, 2010). Interactions between climate change and specific hazards in specific locations are extremely complex, meaning attribution of disasters to climate change is difficult (Herring, Hoerling, Peterson, & Stott, 2014, 2015). Moreover, climate change is just one of many creeping environmental changes. DRR by definition deals with climate-related changes at all time and space scales and from multiple causes, encompassing an 'all hazards approach' (Garcia-Acosta, 2004; Glantz, 1977; Hewitt, 1983; Lewis, 1999; Wisner et al., 2004). Rather than keeping climate change as a separate or dominating topic, the proposal from a development perspective is to enact a 'multiple exposure' perspective by viewing climate change as one challenge amongst many (Gaillard, 2010; Kelman et al., 2015, 2016; Mercer, 2010).

Last, the reality is that climate change has become politically important, both within and outside of development. This should be viewed as an opportunity to raise the issues discussed in this chapter, and to engage interest in more comprehensive, integrative development processes (Kelman et al., 2015, 2016). Embedding CCA within DRR will capitalize on the current dominance of climate change in both development and environmental management agendas, and allow for broader agendas and more long-term perspectives to be promoted and achieved, thereby leading to positive policy and practice outcomes (Kelman & Gaillard, 2010). Without this approach, climate change may be addressed, but possibly at the expense of other pressing issues and potentially increasing disaster risk in the process—or disaster risk may be successfully addressed while harming longer term development endeavors.

DRR itself cannot be isolated from other processes that must be implemented to improve development and sustainability. Achieving DRR goals depends upon addressing wider development and sustainability issues, and vice versa. Indeed, in many locations, the most pressing and fundamental development challenge is neither climate change nor disaster risk—nor is DRR the ultimate endeavor. Failure to adequately consider this reality can lead to the more pressing and fundamental development issues, which constitute vulnerability, remaining unaddressed. A school constructed to withstand multiple hazards may fail to contribute to development and sustainability goals if, for example, girls are not permitted to attend. Likewise, if a hospital is constructed to factor in all DRR considerations including CCA, but its services are accessible only by more affluent people due to a pay-per-use system, then there is not only a failure to address issues of inequality, but also inequality is exacerbated so that development becomes set back. Disasters are the outcomes and manifestations of complex issues, not really of larger environmental changes, but more to the point due to economic, political, and social values, attitudes, and behavior (Hewitt, 2007). DRR thus sits as one subset within development work as has long been known and articulated in different forms (Baird et al., 1975; Hewitt, 1983; Lewis, 1999; O'Keefe et al., 1976; Wisner et al., 2004).

Meanwhile, CCM is aligned with existing development work by placing it within pollution prevention where it focuses on a particular pollutant: greenhouse gases (Kelman et al., 2016). The reduction of greenhouse gas emissions draws upon existing principles and practices for pollution prevention that pre-date contemporary climate change concerns, practices that have been proven to be environmentally, socially, and economically effective (Royston, 1980). This is not denying that CCM has developed new ideas and innovations specific to greenhouse gases which could inform other pollution prevention work; however, the principles and ethos from earlier remain the same. Furthermore, long-standing land use practices and ecosystem conservation methods operating under the general label of environmental management overlap with the principles, ethos, and actions behind increasing greenhouse gas sinks (Kelman, 2015). CCM therefore becomes an important element within ongoing pollution prevention and environmental management principles and practices.

8.10 Conclusions and Ways Forward

The narrow theoretical basis of climate change, and its role as a scapegoat or distraction from fundamental drivers of vulnerability, in no way diminishes climate change as a considerable concern. Dealing with climate change should be neither discouraged nor sidelined. Rather, climate change should be addressed as part of wider development contexts and in ways that are not detrimental to those contexts. An ongoing process is thus framing climate change in research, policy, and practice to try to avoid the difficulties resulting from narrow views of vulnerability alongside the technocratic, hazard-focused approaches (Kelman et al., 2015).

This overview of climate change and disasters suggests a future research agenda based on three points. First, to understand why and how climate change has become so separated from wider discourses in order to learn from past experiences, to avoid repeating similar mistakes in the future, and to ensure that the topics are brought together. This research point covers science, policy, and practice, as well as exploring reasons for the separation of CCM and CCA. One sub-theme would be examining the climate change vocabulary adopted, to determine why climate change developed its own set of vocabulary and how to bring together constructively the terminology of various topics. Another sub-theme would be interrogating the institutional culture around climate change related science and policy to analyze the apparent need of climate change focused personnel for separation from other topics.

Second, a research agenda should examine in more detail the structures, organizational cultures, contributions, and areas of improvement of the international institutes related to climate change and disasters. The IPCC, UNFCCC, and UNISDR seem to continue without a thoughtful, constant evaluation of their advantages and limitations. How much of their existence is inertial self-perpetuation? What are the benefits and opportunity costs of continuing the processes which each institute embodies? What are areas of current overlap and separation, especially examining how further connections could be made?

The final principal question for a research agenda is the effectiveness and sustainability of existing approaches and structures. In addition to the institutions, organizational cultures and processes have developed around all dimensions of climate change and disasters. Are these approaches and structures achieving the desired and expected goals? How could improvements be achieved without undermining core elements—or is the latter needed for the most effective and sustainable results regarding climate change and disasters, especially joining forces to be stronger together?

Concluding with this research agenda, this chapter has presented a case for CCA to be reconceptualized in theory, policy, and practice as a subset of DRR whilst CCM sits within pollution prevention. Since climate change influences some hazards, and since DRR efforts provide more comprehensive approaches to understanding and addressing vulnerability, an appropriate place for CCA is to sit as one of the

many processes within DRR. There, it will gain from the broad and in-depth body of work and lessons from on-the-ground practice within DRR's long history in dealing with not just environmental changes, but also economic, political, and social changes (Shaw et al., 2010a, b). To avoid actions and processes that establish development trajectories in which disasters are normalized means employing the best knowledge and practice from the past and the present to create the future in which DRR including CCA succeeds as part of development.

DRR itself must thus be embedded within wider development and sustainability processes. This will ensure that society breaks away from the conditions that lead to disasters, whether or not they involve hazards influenced by climate change. This approach could contribute to creating a development future in which tribalism and separation of development issues and concerns has ended, so that institutions work together to achieve common goals on common, rather than parallel, pathways. The current emphasis and political focus on climate change should be capitalized upon to draw attention and interest into more comprehensive development that focuses not just on climate change but also on integrating CCA, DRR, and CCM into sustainable development.

Despite the insight, logic, science, and experience provided from a wide swathe of fields seeking connections, the artificial demarcations between climate change, DRR, and development remain deeply entrenched in many ways. As described at the beginning of this chapter, 2015 saw three separate global sustainable development processes instilled via long-term international agreements. This segregation, as well as wider academic territorialism and political and policy factors, means these processes are never likely to come together fully. Academic silos continue to operate, with sets of literature (IPCC, 2012; Solecki et al., 2011; Thomalla et al., 2006) suggesting ways forward that continue the division between climate change and other topics, without questioning why they are assumed to be separate or without fully exploring the difficulties which could ensue due to the separation.

Nonetheless, practitioners, administrators, and academics should not be deterred from attempting to bring the three areas together to build the future we seek. These processes are already taking steps to improve connections, even if that involves explicitly demarcating territories. For example, in the 2030 Agenda for Sustainable Development (UN, 2015), Goal 13 "Take urgent action to combat climate change and its impacts" has an asterisk that states "Acknowledging that the UNFCCC is the primary international, intergovernmental forum for negotiating the global response to climate change." This document therefore fully acknowledges the UN's legal process to address climate change but clearly separates it from the UN's voluntary process to address sustainable development.

Moreover, when analyses are undertaken on whether these processes should, in fact, be separate, possible solutions emerge, such as provided by this chapter and related previous publications (AUEDM, 2010; Kelman & Gaillard, 2010; Kelman et al., 2015, 2016; Shaw et al., 2010a, b). Understandings generated can be translated meaningfully into other levels in governance, education, and voluntary action, as well more local scale planning and development (Shaw et al., 2010a). Disciplines need to work together by linking topics and by finding connections that end disagreements and that ensure that work in each institutional path is not counterproductive to other sectors, instead coming together to collaborate. This is crucial if we are to create something new, beyond the unfortunately normal situation of poor development, poverty, vulnerability, and disaster. There needs to be new 'normal' situations in which hazards are not so hazardous, and in which addressing them does not occur in isolation from other decisions, but is instead integrated into wider development processes.

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9 On Bridging Research and Practice in Disaster Science and Management: Unified System or Impossible Mission?

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9.1 Introduction

This chapter explores the relationship between research and practice in disaster science and management. For reasons to be discussed further below, though not more so than other areas, this nexus is more complex than one might expect. While some have a vision of a scholarly community in disaster science engaged with practitioners of emergency management and producing research that can inform and improve practical efforts (Comfort, Waugh, & Cigler, 2012), others are skeptical of the possibility or advisability of aspiring to these kinds of impacts and partnerships. Some might even believe that science is best when practiced in its purest theoretical form, though they might not say it in public. Some think that applied work is by definition "lesser" work. Such views are, of course, not unique to disaster science and management (c.f. George, 1993; Zelikow, 1994). Parallel arguments take place across the social sciences as well as in public policy and administration research. From a theoretical perspective, those that consider the academy and practice as distinct and divided, see the field from a perspective that reflects Luhmann's (1995) "systems theory." This perspective argues that scientifically rigorous and more 'hands on' or practical knowledge arise from separate and essentially incompatible self-referential social

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systems, each with their own very different logics, "ways of defining and tackling problems", languages, incentive structures, and plausibility criteria (Kieser & Leiner, 2009, pp. 516–517). In extending this way of thinking to *Disaster Science and Emergency Management*, some see scientific research on hazards and disasters as grounded in "the academy" while emergency management practice as "administrative/applied work." In essence, from this perspective, these two "systems" are distinct and separate and one could draw metaphorical "circles in the sand" around each. Doing so, one would find no place where the two intersect. The aspiration to bridge the gap between research and practice in disaster science and management would stand out as a difficult if not impossible mission. Taking on this task would mean facing decades and maybe even centuries of tradition within these institutions. However, despite the sometimes daunting divisions and obstacles to improving communication and developing partnership between researchers and practitioners in our field, this chapter provides a counter point to such pessimistic arguments. Rather, and recognizing the difficulty of the task, it presents an alternative possibility where the community imagines drawing "a different circle" around the shared substance of disaster science and management work. This view would require a shift regarding how the community thinks about the various roles we engage in as part of the new system. Simply stated, we argue that it is possible to see attempts to scientifically understand and to manage disasters as parts of a greater whole.

In the sections that follow we have three goals. First, we join prior voices that challenge the notion that disaster research and emergency management practice are and must remain widely separated domains. Instead, we argue that much can be accomplished by thinking about these activities as different foci of the emerging and rapidly evolving profession of *Disaster Science and Management*. Further, we identify some characteristics of academics and practitioners that are well suited to creating the new system. As evidence of the potential, we also provide a preliminary list of critical roles that individuals in this profession are already engaging in or might engage in. These bridging activities serve as proof of concept about the potential for deeper collaboration. Second, we draw on existing research and perspective papers to recognize some of the real barriers to a more-connected and cross-fertilized community, and highlight several historical and ongoing efforts to improve the connection between research and application. Finally, we conclude with a discussion of the future of research and practice in disaster science and management. That final section provides our vision for how researchers and practitioners might support each other into the future; how they might work together; and how such work might improve both real world conditions and theoretical constructs. We also provide a potential future research agenda.

9.2 Rethinking the "Divided Systems" Mindset

Most scholarly writing on the relationship between academics and practitioners in the field of disasters, as well as in neighboring fields of foreign and public policy, is focused on a perceived "divide" and the functional barriers to research/practice integration (c.f. George, 1993; Nye, 2008). In a later section, this chapter will review the content of these findings as critical barriers to be addressed, but here we begin by addressing what may be the most important barrier to a disaster science and management system, namely a narrow mindset or mental model about the nature of the academic/practical work in emergency management - a mindset that reinforces and provides justification for people to continue as is rather than challenge the status quo.

Prior scholars have often discussed the "seemingly battling values" (Cwiack, unpublished manuscript) and "Daunting Challenges" (Oyola-Yemaiel & Wilson, 2004)" that separate those who have learned about emergency

management through research and/or formal education programs (academics) and those who have learned through on-the-job experience (practitioners). Others have devoted significant effort to describing the different functions, audiences, and distinctly different worldviews. Some have even suggested that research and practice were so divided that intermediaries or "translators" were needed (Fothergill, 2000; Quarantelli, 1993). Others discuss two groups with different "cultures or subcultures" based on differences in beliefs, behaviors, goals, language, and priorities (Fothergill, 2000). Even in a prior work by two of this chapter's authors (Trainor & Subbio, 2014), we began with the assumption that a great divide existed between researchers and practitioners that needed to be bridged. This mindset, while prevalent, is also limiting in that it facilitates an "us vs. them" mentality that inhibits constructive communication and collaboration. Kendra (2007) illustrates this well in his extended essay "Are you active in the field… or do you just teach?" where he dissects the assumption of many that teaching and research are secondary occupations to the more legitimate vocation of serving in an emergency management organization—a not entirely uncommon view among some communities of professionals. The article captures the view that academic research and formal emergency management education tend to be too disconnected from practice to provide real value. Academics often make similar assumptions about practitioners. While extoling the value of practical knowledge and experience - and often requesting that individual practitioners provide interviews and information for research – in other settings academics all too often discount those same lived experiences if they have not been processed and refined through the rigorous methods they have spent decades learning to master. Instead of seeing the unique perspectives as an opportunity to learn about how practitioner views evolve, how they learn, and what novel contexts or factors might be influencing their views and/or their lived experiences, all too often their ideas, informal hypotheses, and theories-in-use are regarded as suspect, narrow minded, or misinformed. Further, despite learning from the work of these individuals, academics often present a vision for a future where practitioners are replaced by those solely trained through traditional programs, an implicit, although not-always-intentional, slight against those who have gained their knowledge through experience - particularly in the case of programs where practitioner knowledge and experiential learning does not appear anywhere in the curricula developed for students. Based on our experience with that prior work, however, this chapter approaches the relationships between research and practice from a different perspective.

While acknowledging that not every person is equally suited to this type of work nor interpersonally able to do it, this chapter adopts the view that it is possible and maybe even necessary to develop systems, structures, and traditions around the notion of a *Disaster Science and Management System* that includes both those focused on research and application of knowledge related to vulnerability, resilience, hazards, disaster, catastrophes, prevention, preparedness, mitigation, response, and recovery. Individuals that saw themselves as part of this circle would hold that traditional divides are not immutable facts but artifacts of how we choose to organize the enterprise.

Further, the chapter resonates with prior assertions that these groups should be seen as two domains or divisions of a common enterprise (Kendra, 2007). In other words, the research/practice divide is as much a product of choice as a social fact. Accepting the status quo and asserting that the distinction is inherent to the enterprise, underemphasizes the agency of individuals to choose their actions. The historical systems, policies, practices, and traditions do set the context for behavior and provide a powerful inertia, but these are nonetheless human made and as such can be remade by those willing to assert their agency (Giddens, 1984; Sewell, 1992). This chapter operates from the assumption

that the distinction between academic and applied concerns is only as important as the community believes it is and to the degree we put in place or challenge systems, policies, rules, practices, and organizational structures that create and sustain that reality.

Building on the argument, if at least some proportion of the research and practice community made the mental shift described above, it could open the field to new and exciting partnerships that draw on the strengths of all members. Such as system could have significant comparative advantages in that it would likely facilitate new thinking about complex and dynamic processes and contexts. It would facilitate relationships that could open new modes of inquiry and practice as well as greater access thus furthering the pursuit of more useful and more usable knowledge (c.f. Lindblom, 1990).

9.3 Building the Shared System

In what follows, we illustrate the ideal characteristics of individuals who would be poised to lead the shift in thinking articulated above. For convenience, we have dubbed these individuals r*eflective practitioners* and *engaged academics.* Below, we describe the characteristics of these two groups and for each we provide a set of roles they might engage in with examples that illustrate how these are already being or could be enacted in the future.

9.3.1 The Reflective Practitioner

Reflective Practitioners, whether formally or informally trained in their fields and professions, closely observe their work place in many cases for years or decades with a critical eye and an open mind. These individuals can be invaluable sources of information and inspiration (Schon, 1983). Unlike others who are rash and reactive, these reflective practitioners take in the world around them in order to understand it and make it better. They do the best they can with the information at hand when dealing with today's problems, but they crave a deeper understanding of what happened and how to do better next time. They consider not only how they have done things in the past, but why and to what end. They are lifelong learners and display the highest commitment to their craft. Some of these practitioners put their observations in writing in the form of notebooks, diaries, or presentations/speeches to colleagues which may or may not be publically available. Some even publish popular or policy-oriented articles or books that can be valuable sources of inspiration for researchers. All actively work to influence their peers in order to improve the profession.[1] Others focus their ideas on improving their own job, organization, or jurisdiction. Reflective practitioners can change the field in many ways and are excellent partners and contributors to research and educational activities because their experiences give unique perspectives into the day-to-day work of emergency management and risk reduction. Below we provide several examples of the roles these reflective practitioners play and illustrate the application of those roles in the academic research and education.

- **Educator and Student**: As educators, reflective practitioners deliver knowledge of how their work is done to peers and the next generation of emergency managers. They understand the intent and the letter of policy, but are able to think beyond policies and protocols as well. As a result, they can link research ideas and concepts to specific cases to make them come alive as narratives. They can discuss the history and evolution of specific programs and policies and are keepers of institutional knowledge. There are numerous examples of practitioners serving in this role within the enterprise. For example, many degree programs offer practicum courses where practitioners talk to students about

[1]See for example, Lucien Canton (2007) *Emergency Management: Concepts and Strategies for Effective Programs*, which provides insights on the field of emergency management derived from a lifetime of service in senior roles such as the Director of Emergency Services for the City of San Francisco.

their work. Some individuals host visits to their offices and may even take on interns for credit. Others serve as clients for capstone projects where students mock up solutions to their real world problems and receive feedback. Further, many practitioners actively train and educate their peers. Some even have formal roles as professors or adjuncts. Those that are willing to engage in such activities serve as a vital link. As students interacting with engaged academics, practitioners can learn a great deal and be forced to think in novel ways. Whether it be through formal briefings, presentations, classes, interviews, and/or direct conversations. Academic thinking can inspire new views and can help transfer learning from non-disaster contexts and can improve disaster practice.

- **Knowledge Refiner**: Many research-based theories and concepts are abstract representations of the real world. As such, they represent but never fully replicate reality. As a result, scientific knowledge advances based on improvements in those representations. As a reality check, practitioners can help identify where general academic ideas and assertions might break down or inadequately capture the nuances of the real world. In others words, they can find the holes and inconsistencies in the application of broad findings to specific circumstances that might serve as opportunities for improved knowledge. One example of this is related to the widespread looting myth in disasters (Dynes & Quarantelli, 1968). Academics have long maintained that massive looting in the aftermath of disasters is not a critical issue as pop culture and the media might suggest (Fischer, 1998). The finding was so consistent that in some circles within the research community it became common to refer to looting as a "disaster myth." The assertion of "looting as a myth" was in many ways an over extension of the initial assertion that "widespread looting is a myth." Further, it relies on accepting another conceptual argument that during disasters, property rights change around resources necessary for survival (Quarantellli & Dynes, 1970). The combination of prior work and ideas drawn from conversations with practitioners about what did and did not constitute looting during Hurricane Katrina helped inspire the creation of the concept "appropriating behavior" to distinguish between criminal self-serving behaviors and similar activities that are necessary for survival (Barsky, Trainor, & Torres, 2006) The example illustrates that when taken seriously, practical questions about the world when combined with research efforts can improve research, conceptualization, and theory.
- **Concept creator**: Building on the prior role, reflective practitioners can also seed new research ideas. As practitioners organize their thinking, they develop proto-concepts, typologies, and semi-formalized frameworks; posit relationships among factors; create situational diagnoses; and make other evaluations of the work emerge. Such concepts, constructs, or theories in use can be made more explicit, fleshed out, and translated into more precise and scientific language. The concept of "prevention" is one example of practitioners engaging in this role. DHS and FEMA have, through greater integration with anti-terrorist and public health domains, added the concept of prevention to the traditional disaster cycle (FEMA, 2013). This "new" concept, often placed prior to mitigation, is intended to capture activities that keep an imminent terror event from happening. While academics on the whole have to date not adopted this new "phase," the practice driven identification of this part of emergency management as a distinct phase has led to conversations about the disaster cycle and whether the ideas should lead to the reconsideration of the longstanding four phases of the emergency management (i.e., mitigation, preparedness, response, and recovery) or, at a minimum, lead to the refinement of the existing definitions to clarify where related activities fit in the broader typology.
- **Informant**: As informants, practitioners actively work with academics to capture, document, and analyze their work,

experiences, and perceptions in a way that allows them to be used to inform others and to improve basic knowledge. They are willing to work with the academy and facilitate thinking about disaster risk and emergency management. Those in practice "know" a great deal. Implicit to the design of many research efforts is the recognition of this knowledge. Even so, many do not have the time to go about conducting systematic research themselves. Those that are willing to engage with the research enterprise, provide input, serve as a gateway to the community of practice, and/or even advocate for the importance of research work are vital to improving both practice and science. Many of the case studies on which disaster science as a broad research area have been built required a practitioner who was willing to work with researchers and/or serve as a key informant. Those that are willing to facilitate research work are an important part of the scientific enterprise.

9.3.2 The Engaged Academic

The parallel to a reflective practitioner is an engaged academic. Engaged academics are not simply the opposite of the ivory tower academic who say it is not their responsibility to write or communicate in an accessible or practically useful way (see Fothergill, 2000 for a discussion of this group). To the contrary, the engaged academic feels it is important, and actively works to create useful knowledge. Rather than separating from the complications of the world and the topics they study, the engaged academic connects with real communities and organizations involved in disasters and emergency management. He or she truly respects those communities, their world views, and perspectives. The engaged academic, at the same time, knows that he or she brings a view or perspective that is valuable as well. The broader perspective in the academy can often mean a knowledge of procedures and process in other places, training in logic and analysis, and access to a body of knowledge built over decades by countless researchers. The engaged academic carefully considers prior research, accepted methods, and the complexities of moving from abstract and/or general ideas to specific real world problems. They see data around them, they recognize the limitations of past work, and embrace the possibility of new findings or views that may improve knowledge or add depth to understanding. Engaged Academics too can play multiple roles, as illustrated below.

- **Educator and Student**: It is unsurprising that one of the roles of an engaged academic is that of educator. Teaching is one of the core activities of the academy. As Professors and instructors, academics play a critical role in building the Emergency Management workforce. They encourage and empower students to develop and share knowledge and skills. This can take place in a variety of contexts and on very different time scales. Researchers can help to "mold the minds" (Eriksson & Sundelius, 2005) of undergraduates and graduate students, thus influencing future generations of practitioners. Some of these students may even rise to very influential policymaking roles. In addition, it is increasingly common for mid-career professionals to seek higher education and there are a number of Masters' Programs in which researchers have direct access to a wide range of professionals.[2] Further, academics in some places provide continuing education and/or present findings in emergency management conferences. As was suggested about practitioners above, when interacting with knowledgeable, experienced, and reflective practitioners engaged academics can learn much from practitioners via formal briefings, presentations, interviews, and when access is forthcoming, direct observation. In fact, as a researcher takes on a new research domain or

[2]See https://training.fema.gov/hiedu/collegelist/embadegree/ for a list of current Emergency Management degree options. Last accessed June 14, 2017.

begins developing a new course that involves generating or imparting detailed knowledge of practical matters, much time can be saved and understanding deepened by learning from those in practice as well.

- **Mythbuster**: As mythbusters, academics sometimes identify shortcomings in conventional wisdom. In some instances, commonly held understandings of the world are incorrect and systematic research can provide compelling evidence that challenges these falsehoods. Perhaps the best example of this is the so called "panic myth" in which many public officials traditionally are inclined to withhold information about threats and acute hazards from the public for fear that provision of such information would trigger irrational individual and collective behavior. However, a substantial body of empirical social science research has convincingly demonstrated that "panic" is a relatively rare and only happens in very specific situations (Auf der Heide, 2004; Quarantelli, 1954). Further, research has also shown that human risk perception and reaction to hazards and warnings is a complicated process that takes time and requires reinforcement from multiple sources (Lindell & Perry, 2011; Miletti & Sorenson, 1990).
- **Consultant**: In this role, academics work in close partnership with "clients" from the world of practice. Often this takes place in a formalized contract or cooperative agreement, but sometimes takes place on a more informal and voluntary basis. When working with practice in this manner, the "client" brings a practical problem or task to the consultant and has a privileged role in formulating the research topic and research questions, although these often emerge through dialogue between the researcher and the "client". The researcher or research organization (hopefully) brings a number of virtues and assets to the collaboration - open-mindedness, integrity, access to the knowledge base documented in the literature, systematic methods, etc. For example, researchers at the Swedish National Center for Crisis Management Research and Training (CRISMART) have played this role in partnership with many EU and Swedish government agencies including the cabinet offices and ministries, national agencies, and regional and local governments. This work has not only resulted in many applied educational products (such as trainings and exercises) and research reports, but also inspired and contributed to a large number of journal articles, dissertations, research proposals and other scientific products. Similarly, the Department of Homeland Security Centers of Excellence are also built on this model with an expectation that research efforts be explicitly tied to practitioner needs. Numerous additional examples of this arrangement exist.
- **Critic**: Another important mode of social science engagement with practice is in the role of critic. Researchers may subject organizations, programs, coordination mechanisms, and other practices and priorities to critical scrutiny. By critical, we mean thoughtful and analytical assessments of both good and bad dimensions of a program or approach. In this role, researchers may call attention to inefficiency, incompetence, inequality and bias or other negative patterns or conditions (c.f. Ragin and Amoroso, 2010). Obviously, this role tends to place researchers at odds with many practitioners and can, under certain circumstances, create distrust and other toxic forms of relationships between the two communities. But in other circumstances, good willed criticism can lead to improvements in practical knowledge particularly when that criticism is "constructive." One example of this role is discussed in a report by Trainor and Barsky (2011) entitled "Reporting for Duty." This effort, funded by the Department of Homeland Security, was initiated because one of the collaborators critiqued state planning assumptions regarding the likelihood that healthcare workers would come to work during a pandemic. The prior assumptions were based on the results of a single study developed by a Master's degree student. The critique was followed by

conversations on the strengths and weaknesses of different types of data and the use of research findings that resulted in a review of research on this topic for the purposes of better understanding the science and its implications for practice.

In the preceding section, we made the case for a disaster science and management system; we provided a vision of the ideal academic and practical partners for such a system; and identified some critical roles those individuals might engage in. Where possible, we provided examples of contemporary efforts that illustrate those roles in action. Those seeking to create such a system however will face important obstacles. In the next section, we provide greater insight into the barriers these individuals might face as they work to create such a system.

9.4 Barriers to an Integrated Disaster Science and Management System

In prior sections, it was argued that a new system of knowledge creation and practice in Disaster Science and Management is possible. That argument was followed by a discussion of the types of individuals that might lead the effort as well as descriptions of the activities they might engage in. If individuals are to work to bridge and redefine the system, it will be critical for them to understand the social and organizational difficulties that have been documented in the extant literature. Understanding these issues is important given that the more integrated system envisioned in the introduction to this chapter will require concerted efforts to develop solutions to these problems.

In reviewing the literature, it is important to begin by noting that very little actual research has been conducted on the transfer of information between researchers and practitioners in disaster science and management. With the notable exceptions of Fothergill (2000) and Lee (2016), most works in this area rely on the authors' views and perspectives rather than systematic analyses of empirical data. Further, despite the growth of Emergency Management and Academic programs focused on hazards, disasters, and crises, there is not a great volume of work in this area. Even so, embedded within the commentaries and research that does exist are several important themes that will be described below.

9.4.1 Limited Engagement and Interaction

One of the most often cited barriers to greater connection between research and practice is a lack of meaningful opportunities for engagement and sustained interaction (Gori, 1993; Johnson & Durham, 1995; Rubin & Webb, 1987) and the difficulties of building trust and/or making progress when the interaction that do occur are few and far between. While one could argue that these insights are less relevant today, there is no contemporary empirical evidence that addresses this issue. While some attribute the tendency to not interact to feelings of intimidation (Meyers, 1993) others suggest that it has more to do with a lack of forums where those charged with emergency management agencies and those focused on research can find mutual interests (Trainor and Subbio, 2014). Many argued that this lack of engagement especially early in projects often led to results that were not connected to the real problems people faced on a daily basis (Cowan & Beavers, 1994; Johnson & Durham, 1995; Rubin & Webb, 1987). Similarly, some projects fail because they do not address issues or complexities that researchers know about. Many who have been asked to work on a large grant after the ideas were 90% developed should understand the problems with this approach to building teams. It is much harder to figure out how you fit into someone else's vision of the world or a project than it is to develop a shared vision from the outset.

9.4.2 Misunderstandings About the Nature of "Research" or "Practice"

Building on the last barrier, lack of real relationships means that many researchers do not know what practitioners really do on a daily basis, and many practitioners do not understand the responsibilities of an academic (Fothergill, 2000). Instead, much of what is known comes from stereotypical views or a few interactions that significantly color perceptions, for good or bad.

For example, take the very idea of "research." The lay notion of research is often linked to any search for information from external sources (Malone, 1993). For an academic, however, research is something very different. For scholars, "Disaster research is a real-world activity that includes grant applications, staffing, budgets, regulation, policy, travel, deadlines, and work in the field (Kendra, 2007; Trainor & Subbio, 2014). The work itself is a highly complicated technical process that demands review of prior findings, data collection, rigorous analysis, and cautious conclusions that consider how the new work compares to prior work. Further, every element of the process must be transparent and must conform to a complicated and not always transparent set of rules and standards that stretch across hundreds and even thousands of books and articles. The work is done knowing that at some point every choice will be scrutinized by other scientists who have been trained to identify, sometimes with glee, mistakes or misinterpretations that might have been made.

To a large extent, an academic's value is judged based on the quality of his or her published work. What results is a form of hyper-vigilance and a strong need to check, re-check, and review one's work until it is as strong as possible. Anything below an academic's own standards of quality is seen as unacceptable, so many miss deadlines in order to tweak their work, to make it just a little bit better than it was. Academics have this freedom, because they can, more often than not, choose when to submit their work for publication and in what venue, a freedom not afforded to all.

Similarly, researchers often misunderstand and under-appreciate the complexities and demands of working in/or for an agency. While it may be very clear that some factors influence an outcome based on research, it is far more complicated to decide what to do about that. Knowing is only the beginning of a complicated set of activities that includes navigating policy, negotiating with stakeholders that have different views, recognizing legal and jurisdictional limits, establishing facts, battling false information, managing limited staff resources, etc. (see Lee, 2016 for a discussion of some related issues).

Further, the amount of time to complete any project or task tends to be shorter than in research. In contrast to the academic described above, the practitioner community is accustomed to firm deadlines. During emergency operations and even in day-to-day life, a given issue may require a decision and action far sooner and with greater uncertainty than they may be comfortable with, yet the decision must be made anyway. Similarly, law may dictate when certain plans are developed and/or the schedule upon which they must be updated. Grants that fund much of a practitioner's emergency management program have deadlines as to when the related work is completed, and when all of the supporting documentation is then due to the funding authority. While academic work has similar structures, the nature of research work means that, in practice, the expectations are looser and processes to relax them (i.e., routine no-cost extensions, deadline extension, etc.) are abundant.

The need to have their work products completed by a given deadline results in a trade-off between timeliness and quality. For some, a timely decision or product that they could live with, even if they knew it could have been better, is acceptable over a better decision or product that is made or produced too late. Whatever problem is being addressed now must be dealt with quickly in order to meet political and/or statutory demands. At a minimum, the next problem that must be solved is already building,

and a pressure to finish the task at hand and move to the next is constant. Meyers (1993) provided an important insight into the consequences of not really knowing each other when she suggests that, despite doing important work, practitioners often ignore academics because they are not comfortable with the way academia ignores important elements of their daily life.

These differences in the daily life of academics and practitioners can lead to significant tensions when not directly addressed. These routines often lead to expectations that may or may not be met when working across the profession.

9.4.3 Expectations for Knowledge

As identified by Trainor and Subbio (2014), it is important to note that academics and practitioners sometimes have different expectations for knowledge and/or information that would need to be better understood. Academic work most often focuses on developing or testing concepts about the nature of a phenomenon or explores how one of those concepts relates to others. They use disasters, events, or organizations as the laboratory in which they explore general ideas about how broader social, physical, or engineered systems and processes work. There is a tendency to rely on logic and the scientific process to connect specific findings to broader and/or more abstract ideas linked together over a long history of research. The context and specifics of the place where data is collected are discussed in methodological terms most often describing the uniqueness of that place (i.e., in qualitative work) or the generalizability of the findings (i.e., quantitative work) by relating findings from one's research with findings from research on other disasters, and identifying the similarities and differences.

Practitioner's expectations are often different. They are not trying to completely understand how the world works. In general, practitioners want knowledge that helps address their problems. Though some look for broader, more complex patterns, a premium is placed on work that directly links to the specific problems they are addressing. Generally, practitioners want to be able to use a bit of information on its own to improve their programs. There is also a premium placed on prior experiences, programs, policies, or practices that have already been developed. This information may come from a trusted colleague, after-action reports, meetings, collaborative organizations, best practice recommendations, or other sources. The benefit of a programmatic solution or an approach developed by someone who works in a similar position over broad ideas about factors that should be considered are important particularly given the pressures discussed above. Given this, practitioners rely more on personal experience and network contacts that they can directly access, such as peers, even if it directly conflicts with evidence gathered from years of research on a topic.

These different expectations for knowledge are important because they can lead to conflict about the value of any piece of information. These conflicts relate to the need for evidence, how supporting information is presented, the degree to which insights gained from one event can be applied to another, and for how long insights are considered valid.

For example, academics and practitioners tend to have different ways of presenting supporting information. Researchers will refer to previous studies to support an idea, but assume that the readers are familiar with those previous studies or will have the ability and drive to review those studies. Practitioners expect to see the specific supporting details in the text.

The next conflict relates to how generalizable information is from one situation to another. Practitioners learn so that they can apply information to their own situation. They read about the response to incident X in jurisdiction Y to see how they can be better prepared for when incident X happens in their own jurisdictions based on their own judgement of the content. Academics, on the other hand, employ a complicated set of standards related to the purpose of the study, the methodology used, and the sampling method utilized to decide if findings apply

broadly across several jurisdictions or situations. But, what if no evidence exists for a particular context? In research, that circumstance would just be a gap in knowledge, but in practice decisions need to be made and it is not always feasible to conduct new research prior to making each decision.

Further, while academics use research and findings that are many years old in order to link contemporary and historical work along shared hypotheses, theories, and methods as part of the replication required by science, practitioners are critical of information that they think is too old under the expectation that it is likely obsolete. Given these differences, practitioners, in their desire to apply information to their own programs, sometimes give the most recent information the most weight, sometimes completely discounting the older information even when on some elements or dimensions they might be better. Academics sometimes focus on the broader ideas and process and fail to see the important differences between different contexts.

9.4.4 Different Communication Styles and Outlets

Another often repeated concern in the literature is that research is not accessible to the practitioner community in two ways and that the lack of access hampers integration. The first access issue is related to the ability to locate or obtain research materials. The second access issue is related to the degree to which non-researchers can read and make sense of research content and/or identify the practical lesson or solution the research might support.

In addressing the first, several authors have raised the concern that academics typically read and send their work to peer-reviewed journals, scholarly presses, and academic conferences (Cowan & Beavers, 1994; Johnson & Durham, 1995; Rubin & Webb, 1987). It must be understood that many of these options are costly and difficult to access if you are outside a well-funded university library system. Books, journal subscriptions, and even single copies of relevant articles can be cost prohibitive. Meanwhile, the places where practitioners are more likely to frequent, such as government publications, trade magazines, newspapers, blogs, social media sites, professional and technical conferences, etc. are places academics rarely choose to send their work (Fothergill, 2000). This is often the case because, for the most part, these outlets are not viewed as good academic sources to publish rigorous/scientific work and are generally not peer-reviewed, one of the basic foundations of disciplinary work. In short, common practices regarding the dissemination of research and knowledge and where it should take place do not often prioritize impact.

Even if one is able to physically acquire the materials, it is an altogether different task to make sense of it. A number of academics have noted that jargon offers a unique barrier to the collaboration between practice and research. For example, several scholars have noted that generally, scientists communicate mainly with peer technical communities using complex language (Buika, Comfort, Shapiro, & Wenger, 2004; Fothergill, 2000; Trainor & Subbio, 2014). As noted by one of the reviewers for this chapter:

> "Scientists communicate with scientists"…and to some extent this is a fundamental part of how we educate or train PhDs…we are replicating ourselves…we hire people similar to ourselves…and publish in areas where like-minded folks will "congregate"…this is a major issue/flaw."

It is important to remember that fully interpreting research results requires specialized knowledge, whether that be an understanding of a theoretical concept, or sampling approaches, knowing accepted data analysis procedures, or even understanding the logical limits of conclusions drawn from any work. Given the need to know these things to make sense of a study, much of the work is not in a user-friendly form (Cowan & Beavers, 1994; Neal, 1993) particularly for practitioners who are often trying to get the big picture or decide between policy/program Option A or policy/program Option B. It is important to more seriously recognize the merits

of alternative methods of distributing and delivering the key results of science. In the practical world, the luxury of time and extended deliberation are not always afforded. This problem is complicated even more when we recognize that the best science available may be quite limited and/or that any single study must be critically assessed relative to other studies on the same topic that use different methods, concepts, or even disciplinary perspectives. It is not reasonable to expect that most practitioners will have the skill set to place each study into multiple scientific contexts, to understand the conflicting perspectives, and know how to take these and forward a solution. This reality makes it difficult for researchers and practitioners alike to make definitive statements on what should be done given particular scientific findings.

9.4.5 Priorities and Incentives

Finally, it is important to note that in terms of what type of activities a person should be working on there are also very different opinions. For example, while many agencies are interested in tools and decision systems, it is common for research universities to push back on academics that do "applied work" (Buika et al., 2004). These forms of push back range from subtle jokes and innuendo to the adoption of explicit metrics that weigh theoretical and academic work over more applied efforts in terms of rankings, tenure and promotion, and general status in the vast majority of university settings. Similarly, in applied settings, more theoretical or complex ideas are not always received well.

9.5 Ongoing Efforts

Despite the call for improved collaboration in this chapter, it is also important to note the many ongoing efforts by members of the *Disaster Science and Management* community to realize the type of system described here. There are a number of longstanding and important institutions and activities within the community that have focused on the types of activities we have described above. Importantly, these efforts have also served important convening functions in that they are the most common forums to exchange and integrate work. While it is not possible to chronicle all of these efforts, those below represent some of the most essential activities to date.

9.5.1 Natural Hazards Center[3]

Started in the 1970s, perhaps one of the longest-running sustained efforts directed at integrating research and practice is the work of the Natural Hazards Research and Applications Center in Boulder Colorado (see Meyers, 1993 for a more comprehensive overview of the Center's work). The center, founded by Gilbert White, and since directed by a preeminent group of scholars has, since its inception, been focused on putting research into practice. The center is advised by a diverse committee of academic, public, and private stakeholders. In its role as a network builder, it engages in a number of activities that have been critical. In particular, its publication of the "Natural Hazards Observer," its library, and the annual Workshop, are critical efforts in translating and disseminating research knowledge for both researchers and practitioners.

9.5.2 FEMA Higher Education Program[4]

Another critical effort associated with bridging research and practice is the FEMA in Higher Education Program. Started in the early 1990s under the leadership of Wayne Blanchard, this program has long facilitated the interaction between those involved in the development of higher education curriculum and standards for

[3] https://hazards.colorado.edu/. ***Last accessed June 15, 2017.***

[4] https://training.fema.gov/hiedu/. ***Last accessed June 15, 2017.***

disaster science and emergency management across the US. Built on collaborations between practitioners, researchers, and educators, the program has funded literature reviews, curriculum development, course development, standards, accreditation conversations, annual surveys, and a number of other important conversations about how practical concerns, research, and education converge. It has done a great deal to consider how lessons from the field and from research are integrated into classroom experiences for the next generation of emergency managers.

9.5.3 National Academy of Science Disaster Roundtables

While some may not fully appreciate their impact, it is important to also note the work of the National Academies of Science, Engineering, and Medicine. The academies play an important and vital role in bridging research and practice around critical issues to their (often governmental) clients. In particular, the special attention the organization pays to the balance and composition of teams leads to the meshing and negotiation between people with different perspectives that would not otherwise have a reason for sustained interactions. In looking at past and present leadership of this group,[5] one can note an important mix of academics and practitioners. Similarly, examination of results from past workshops show critical input from a range of individuals that span research and practice.

9.5.4 International Association of Emergency Managers (IAEM)[6]

The International Association of Emergency Managers is another critical contributor to the integration of research and practice. The association has increasingly served as an important bridge between academics and practitioners in a number of ways. For example, IAEM has recognized and facilitated student chapters and a student council within the organization and encouraged campuses to participate. It has recognized formal education as an important element of the Associate Emergency Manager (AEM) and Certified Emergency Manager (CEM) credentials. Further, the association provides forums at annual conferences for research presentations. Finally, it holds student competitions and awards. As it has grown over time, IAEM has become a major point of interface for Disaster Science and Management work across the profession.

9.5.5 Individual and Center Efforts

In addition to the specific efforts mentioned here, there are many more examples of individuals and organizations taking steps in their daily activities to integrate the academy and practice. While impossible to catalogue, review of hazards, disaster, and emergency management centers across the nation[7] would show that the vast majority already do direct work for agencies and governments at the local, state, federal and/or international levels. While the scale, scope, and consistency of such work varies from place to place, it is important to note that this kind of collaborative work is happening. Similarly, many emergency managers open up their workplaces to student and faculty visitors, give presentations and lectures, and in some cases even serve as instructors or professors. While there is no database or formal record of these one-off efforts, they can easily be found by reviewing the annual reports and press releases from these organizations.

[5] http://dels.nas.edu/global/dr/Board-Members. Last accessed June 15, 2017.

[6] https://www.iaem.com/. Last accessed June 15, 2017.

[7] See: https://www.ndsu.edu/emgt/graduate/current_students/research_resources/ for a useful list of centers. Last accessed June 15, 2017.

9.6 Conclusions and Future Directions

In keeping with other chapters in this Handbook, in this section, we provide a set of possible future directions for research and practice that follow from the discussion above. As a pre-amble to these assertions, one should note that many additional possibilities exist. In a space with limited foundation, each study has the potential to have a great impact. Given the focus of the chapter, we also provide some practical next steps that might help advance a more integrated Disaster Science and Management Community.

9.6.1 Research Opportunities

Very few rigorous theoretically informed efforts to study the profession exist. With the notable exceptions of Knowles' (2011) extant work on the evolution of Emergency Management and Fothergill's (2000) work on knowledge diffusion, most other efforts explore this knowledge system as "perspective pieces" and as such provide their views rather than scientific analysis. Significant work could be done based on institutional theories, theories of knowledge creation, organizational theories, or even studies of the professionalization process. There are many opportunities to apply existing social science ideas and better understand how we organize this enterprise. Work at this nexus is significantly underdeveloped conceptually and empirically. Future scholars interested in this topic could very quickly provide information that would be of value. Here we identify a few promising topics for future research including: Analysis of Professional Identities and Perceptions, Analysis of Knowledge Diffusion, Network Analysis of Disaster Science and Management Systems at Various Units of Analysis, Cognitive Task Analyses, and Systematic Analysis and Critical Review of Practices in Academic/Practitioner Engagement.

Professional identify and perception. On the basis of previous publications and our own somewhat impressionistic observations of interactions among professional groups in our field, we have pieced together a tentative depiction of how practitioners and researchers have tended to view themselves and each other in recent decades and years. Yet we are very much aware that such perceptions and identities may change over time and that the empirical knowledge base remains underdeveloped. Systematic empirical work would be helpful. Methods such as cognitive mapping, survey research, content/discourse analysis, and ethnographic observation could be fruitfully deployed in an effort to create a more differentiated and integrated understanding of the relevant professional identities and perceptions among the diverse members of the emergency management and disaster science community (Schraagen, Chipman, & Shalin, 2014).

Knowledge Diffusion: A second topic for future research focuses on knowledge diffusion. Theoretical models of knowledge flow exist and could be used to examine how researchers and practitioners in the field of emergency management and disaster science share and do not share information.[8] Such research might ask questions such as: How and to what extent does research contribute to policy-making, operations (doctrine, tactics, techniques, and procedures etc.) and practical education? How and to what extent do practitioner's needs, experience, and knowledge contribute to developing and implementing research projects?

Social Network and/or Social Capital Analysis: A third option would be to utilize Social Science concepts and tools designed to conduct analysis of relationships on our own community. In this chapter, we suggested that relationships and meaningful interactions are important cornerstones of a more unified Disaster Science and Management profession. This suggestion could be the basis for a number of research efforts that utilize social science concepts and methods focused on relationships. For example, social network analysis tools could be used to map and mathematically analyze the structure

[8]See Green, Ottoson, Garcia, Hiatt, and Roditis, (2014) for an example of this type of work in Public Health.

and patterns in relationships between academics and practitioners. Further, using regression or GIS-based techniques, it is possible to explore the spatial distribution of those relationships or the consequences of different patterns of relationships on outcomes. Similarly, using a social capital perspective (as discussed in the chapter on social capital by Meyer in this book), one could examine if and how relationships are leveraged to improve the enterprise as a whole. Such research might ask questions, such as: How often do practitioners and researchers interact? What types of interactions are common? What consequences positive or negative do these interactions have? What are the key points of contact and mechanisms, which enable the flow of knowledge and information between the spheres of research and practice?

Comparative Cognitive Task Analysis: Next, we could explore the notion that researchers and practitioners lack understanding of each other's roles, tasks, and incentive structures. One way to approach this area of focus would be to document and analyze the ways that researchers and practitioners engage with particular issues. This could be regarded as a natural extension of the approach taken in Trainor and Subbio's (2014) study that facilitated systematic comparisons of practitioner and scientific views on several topics in emergency management and disaster science. Such research could explore: What tasks, work processes, and practices are used by researchers and practitioners working with particular problem sets. What problems do these groups prioritize? What criteria are the most important benchmarks of success? One could compare and contrast practical and academic approaches to conducting (or developing methodologies for) risk and vulnerability analysis. Another approach might be to conduct studies focusing on what elements of particular initiatives (e.g., the FEMA Whole Community Initiative) these actors focus on and exploring the underlying motivators for the foci.

Systematic Analysis and Critical Review of Practices in Academic/Practitioner Engagement. Finally, as suggested above there are many types of initiatives and varied programs that have been put in place in various locations across the globe. From a policy analysis perspective, systematic review and specific case studies of policies and programs aimed at facilitating the expansion of the Disaster Science and Management Profession could be conducted. Such analysis might look at the effort required, types of stakeholders, costs, and impacts on education, research, and/or practice. Through this type of work, we might identify a series of best practices that could be applied. Further, it would be possible to identify critical factors that facilitate the success or failure of such initiatives.

In summary, a critical assessment of the content on which this chapter was built provides a sense of the significant research opportunities that exist in this area. While this chapter articulates a plausible vision for the future, it is important to note that very little empirical work has been conducted on the nature, conditions, and outcomes associated with the interaction of academics and practitioners in Disaster Science and Management. As a result, there are a large number of important and unanswered questions.

9.6.2 Practical Opportunities

If one wanted to go about the work of facilitating greater collaboration between academics and practitioners, there are also a number of important practical steps that could be taken. The first and arguably most important way to expand this system is to facilitate the creation of long-term relationships. The process of knowledge transfer should not be linear (straight from researcher to practitioner), but interactive and fluid. More quality interactions (Fothergill, 2000) and greater practitioner participation in research will provide unique views and approaches (Buika et al., 2004). Even short-term or "light touch" interactions, if approached from the proper mindset, can also have a significant impact. Things like agencies adding an academic advisor or consultant, or universities naming a local professor of practice, can help bring important perspectives and can facilitate greater understanding of how these activities are related. The use of professors

in practice is a good approach to bring practitioners and researchers together in a teaching/research environment. Doing so would be of great benefit and value to the students and the field itself. Practitioners could also invite academics into the emergency operation's center to observe operations and provide insight during an event, or academics could invite practitioners to classes in order to discuss their experiences, or could ask them to serve on an advisory board for a degree program or research project.

Second, it is possible to explore different kinds of publications and information-sharing opportunities. Academics can share their findings with practitioners by publishing brief summaries in practitioners' newsletters, magazines, etc. This would be especially useful because most practitioners know of few, if any, of the publications in which academics typically share their findings. Given the limits of their budgets, practitioners may not be able to access the publications they *do* know about because these publications are just too expensive. Research briefs developed by academics for practitioners would help ensure the exchange of information between the two groups. Likewise, practitioners could solicit input from the academic community for practitioner-based publications. Going further, printed publications are not the only opportunity for formal information sharing. Reinforcing a point that Malone (1993) made, we should consider a broad range of sources to deliver and receive this information. For example, conferences and workshops are used to bring different professionals together. However, practitioners' conferences focus on emergency management practice, and academic conferences focus on emergency management research. At the local level, relatively few practitioners attend academic conferences, and relatively few academics attend practitioners' conferences. There are national and international conferences that may be attended well by both practitioners and academics, but the travel and registration costs to attend these conferences are a deterrent to both groups. States and emergency management associations that conduct conferences, workshops, or other meetings could invite participation by the academic community. Similar events for the academic community could be expanded to include content for practitioners.

Expanding how we deliver live content is another option. Meyers (1993), focusing on solutions to the lack of information transfer, long ago called for more straightforward presentation of research findings and also suggested the use of executive summaries. In the modern digital environment, there are many additional options available to share information. For example, PowerPoint, Prezi, simple videos, art, social media, and many more are all available for use if we came to see them as legitimate ways to communicate. Traditional academics that would like to engage more fully with the practice community need to embrace a broader range of medium to communicate results. Similarly, those in practice that want to consume research should consider some formalized training on research methods in order to become more sophisticated consumers of these findings. Emergency Managers could also be expected to have a minimal level of research knowledge in order to be able to process research findings.

9.6.3 Final Thoughts

It is unclear what the future of the Disaster Science and Management community might be. This chapter has presented one possible future that builds on current day efforts in the social and other sciences to improve knowledge while also contributing to practice. Drawing on social and systems theory, it provides a theoretically informed and practical grounded vision of an integrated Disaster Science and Management system where academic and practical efforts are seen as part of a unified whole. It provides two ideal type participants in such an enterprise, the reflective practitioner and the engaged academic. For each of these actors, we provided a description of critical roles and examples of those roles being enacted today. The chapter went on to discuss barriers and highlighted a few ongoing efforts to create a more unified enterprise. It ended with future directions and practical next

steps. A science bereft of the insights and requirements of practice, is a more sterile, self-referential, less dynamic, and less relevant science. A practice deprived of constructive and critical interaction with science is a practice in which counterproductive habits of thought and action, myths, and spurious or superficial knowledge and bias can long persist - contributing to less effective, less equitable, less sustainable, and less legitimate outcomes. From the view point of this chapter's authors, researchers and practitioners are stronger - and smarter - together.

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Part III

Inequality, Social Stratification, and Disasters

Race, Class, Ethnicity, and Disaster Vulnerability

10

Bob Bolin and Liza C. Kurtz

Contents

10.1 Introduction

On August 29, 2005 Hurricane Katrina made landfall along the United States Gulf Coast and rolled over New Orleans, a city poorly protected by levees and ill equipped to handle a storm the size and intensity of Katrina. The disaster that unfolded in its wake provided a stark example of the pervasiveness of racism and class inequalities in the US as well as the indifference to African American victims by those responsible for public health, safety, and well-being in the region (Bullard & Wright, 2009; Dyson, 2006). In some areas of the city, armed white militias attacked displaced African American. Thompson (2008), for example, carefully documents numerous cases of vigilante violence directed against black survivors in the immediate aftermath of the storm, actions unprecedented in US disasters. The widely broadcast media images constructed an unambiguous story: tens of thousands of mostly low-income African Americans were left to fend for themselves as the city of New Orleans flooded from breached levees on Lake Pontchartrain. Their only refuge was a large sports arena unequipped to serve as an 'evacuee center' and devoid of any resources to support the thousands of people who gathered, many arriving only after wading through toxic, sewage-contaminated flood waters. In a city with a 2005 poverty rate of more than thirty percent, where one in three persons did not own a car, no significant effort was made by government at any level to assist the most vulnerable people to escape the disaster (Alterman, 2005). Even a decade after the event there is substantial

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variability in estimates of the number dead although evidence makes it clear that African Americans had up to four times the mortality rate of whites.[1] While Hurricane Katrina momentarily and unavoidably called attention to issues of race and class inequalities and their relationship to peoples' vulnerabilities, disaster research has clearly shown that social inequalities are foundational conditions that shape both disasters and environmental risks on a global scale. For disaster researchers, Katrina also marks a significant convergence between disaster studies and environmental justice research in the US (Bullard & Wright, 2009). Notably, Bullard (Bullard & Wright, 2009), one of the founders of US EJ research provides extensive justice-focused commentary and analysis on Katrina and its aftermath.

In the discussion that follows, our primary interest is on how recent hazards, disaster and environmental justice research have analyzed the relationship between race and class inequalities and social vulnerability in disasters. In the US and many other countries, the imbrication of race and class is deeply entrenched, a product of a long history of racist and exclusionary practices which have marginalized and spatially segregated groups of people deemed intrinsically inferior by those holding political and economic power (Goldberg, 2002). The state is a major agent in the production, transformation, and enactment of constructions of race, part of what Goldberg refers to as the 'racial state'. Through law, policy, and a complex suite of institutional arrangements, racial discrimination in myriad forms is shaped by state sanctioned practices in civil society (Haney, 1994). In spite of civil rights legislation, the chronic and corrosive effects of racism have produced deep and lasting social, political, spatial, and economic disadvantages for people in targeted racial categories (HoSang, LaBennett, & Pulido, 2012; Winant, 2001). Those disadvantages have historically expressed themselves in class position, primarily through their pervasive negative effects on employment, educational, residential opportunities, and health statuses for those in marked racial categories. Given that racial/ethnic minorities will form the majority of the US population by 2042[2] and already do so in California, this is an area, as we will argue, which should be of major concern for all those involved in hazards and disaster research and emergency management (e.g. Wilson, 2005). While people's vulnerability to environmental threats is shaped by a concatenation of sociospatial and biophysical factors, race/ethnicity and class have proven central in understanding social processes during hazard events (e.g., Bullard & Wright, 2009; Wisner, Blaikie, Cannon, & Davis, 2004).

In this chapter, we review some key theoretical and methodological issues in research on race and class in hazard vulnerability and disaster. While we will review recent research literature pertinent to the topic, this chapter is not intended to be a detailed review of the disaster literature, as those are available elsewhere (e.g., Fothergill & Peek, 2004; Tierney, 2007; Williams, 2008; Wisner et al., 2004). Nor will we be discussing human acts of collective violence, including war, genocide, humanitarian crises, or terrorism, as these raise complex and contested political issues beyond the scope of this chapter.

There are three main sections in the discussion that follows. We begin with a critical review of recent theoretically informed treatments of four key concepts covered here: social vulnerability, race and ethnicity, and class. This review is used to illustrate and problematize some of the conceptual issues invoked by these terms in academic research and includes a short discussion of relevant early US disaster studies. The second section presents a review of more recent studies that illustrate approaches to understanding the intertwining of race and class in disasters. We concentrate our discussion on studies that focus on people's vulnerabilities and the central role of ongoing social, economic, political, and sociospatial conditions that turn hazard events into disasters (see Cutter, 2003; Eakin & Luer,

[1] http://fivethirtyeight.com/features/we-still-dont-know-how-many-people-died-because-of-katrina/.

[2] http://www.nytimes.com/2008/08/14/world/americas/14iht-census.1.15284537.html.

2006; Wisner et al., 2004). Many of these studies use a vulnerability approach developed through critiques of the ahistorical and technocratic orientation of early hazards research. Vulnerability analysis grounded in political ecology, an interdisciplinary critical approach developed in geography, anthropology and development studies (Robbins, 2012). As part of our literature review, we highlight some representative examples from the Indian Ocean Tsunami (2004), Hurricane Katrina (2005), and other recent disasters that explore how race and class shape vulnerability and influence disaster processes.

In the concluding section, we discuss environmental justice research (EJ) which we argue is a rich source of observations on race, class, and environmental hazards across a range of spatio-temporal scales (e.g., Walker, 2012). The EJ literature examines the disproportionate allocation of environmental burdens and risks and how those risks too often fall on those least able to cope with them. EJ research also provides examples of studies which unpack the complex historical processes which racially structure space and differentially place vulnerable people in harm's way through a variety of overt and covert mechanisms (Boone, Buckley, Grove, & Sister, 2009; Collins, 2009; Cutter, Mitchell, & Scott, 2000; Mustafa, 2005). As part of our EJ discussion we review persistent radiation hazards and the experiences of those living on the Navajo Nation in the US Southwest to illustrate how race, class, indigeneity, and environmental risk intersect at multiple scales (Johnston, 2007; Kyne & Bolin, 2016).

10.2 Theorizing Inequalities

In what follows we review key theoretical treatments of class, race and ethnicity with a particular focus on how these factors can shape people's vulnerability to hazards of all types. In the hazards and disaster literature, vulnerability analysis is a broad theoretical approach for investigating hazards at the intersection of social and environmental inequalities and uneven geographic development (Cutter, 2003; Peet & Watts, 2004; Robbins, 2012). A 'vulnerability approach' works to identify an ensemble of sociospatial and political economic conditions and historical as well as current processes which can explain how specific hazard events become disasters. Beginning with the publication of Hewitt's foundational edited volume, *Interpretations of Calamity from the Perspective of Human Ecology* in 1983, vulnerability studies have shifted the analysis of disasters away from a focus on the physical hazard agent and a temporally limited view of disasters as 'unique' events separate from the ongoing social order (Hewitt, 1983a,b). Vulnerability researchers argue that environmental calamities are shaped by the already existing social, political, environmental, and economic conditions and thus should not be considered as 'natural' occurrences (e.g., Cannon, 1994; Collins, 2009; O'Keefe, Westgate, & Wisner 1976). Indeed, as Quarantelli noted (1992, p. 2) in this vein, "…there can never be a natural disaster; at most there is a conjuncture of certain physical happenings and certain social happenings."

Wisner et al. (2004, p. 11), in one of the most comprehensive statements on hazard vulnerability research in the last decade, define vulnerability as "*…the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard*" (Italics in original). They go on to note that vulnerability is determined by a variety of factors, variable across space and time, that differentially put people and places at risk of loss from environmental hazards. Other scholars have similarly defined vulnerability as the combined effects of exposure to a hazard agent, susceptibility to harm from that exposure, and the ability to cope with or adjust to the effects (e.g. Polsky, Neff, & Yarnal, 2007; Turner et al., 2003). Thus, key components of people's vulnerabilities include a biophysical dimension (exposure to hazard agents) and a social dimension (their

ability to avoid or manage the effects of the hazard) (see Cutter, 1995).

People's vulnerabilities can be shaped by a number of factors, both social and biophysical (Cutter, 1995; Gentile, 2016). Among commonly noted social factors are class, race, caste, ethnicity, gender, age, poverty, disability, and immigration status, as well as a variety of community and regional scale factors (Cutter, Boruff, & Shirley, 2003; Wisner et al., 2004). In the last decade there have been various efforts to develop quantitative vulnerability indexes, the best known of which is Cutter et al.'s (2003) Social Vulnerability Index (SoVI). Quantitative indexes to measure vulnerabilities across scales using demographic data are useful planning tools to characterize regions at risk of major disaster events. The limitation of such quantitate approaches is that they tend to reify and essentialize vulnerability as a fixed condition inherent in a certain fraction of the population. In contrast, more qualitative approaches see vulnerability as shifting, contingent, and spatiotemporally variable rather than fixed (Hutanuwatr, Bolin, & Pijawka, 2012; Mustafa, 2005). Qualitative vulnerability case studies are, however, limited in scope and scale in contrast to quantitative studies, and may not fit the existing paradigms of disaster management institutions (Gentile, 2016; Tierney, 2007). It is well recognized in the literature that vulnerabilities, however they are measured, are variable by hazard type, contingent on a variety of multi-scale situational conditions, unevenly distributed across individuals, households, communities, and regions, and change over time (Bankoff, Frerks, & Hilhorst, 2003; Cutter, et al., 2000). Race and racial disparities figure prominently in many vulnerability studies and it is to that topic we now turn.

10.2.1 Race and Racism

To discuss race and racism, we draw off recent work influenced by critical race theory, an approach stemming from legal studies which dates back several decades (Kurtz, 2009). Critical race theory scholars have promoted a view that racism, rather than being individual acts of intentional discrimination, are in fact "…an endemic part of American life, deeply ingrained through historical consciousness and ideological choices about race, which in turn has directly shaped the US legal system, and the ways people think about the law, racial categories and privilege" (Parker & Lynn, 2002, p. 9). Omi and Winant's (1994) sociohistorical analysis of racism and racial formation remains one of the most influential critical works on race in the social sciences (HoSong, et al., 2012). They contend that postwar US sociology's treatment of race was deeply flawed by its attempt to equate race and ethnicity by applying a white ethnic immigrant framework to *racialized* minorities; that is groups who are essentialized as biologically and characterologically different than white Europeans. Racialized minorities in the US thus include African Americans, Latinos, American Indians, and Asians, each with its own distinct history of oppression and discrimination. Equating race and ethnicity led to the assumption that over time 'cultural assimilation' would erase so-called ethnic differences. Omi and Winant argue that this framework shifted attention away from the deeply structured ways such groups have been "racially constructed" in the US and obscured the complex class and cultural differences among people marked by these racial categories (Omi & Winant, 1994, p. 23; see also Omi & Winant, 2012).

As Young (1991, p. 126) notes, when a dominant group deploys a racist ideology which "defines some groups as different, as the Other, the members of these groups are imprisoned in their bodies. Dominant discourse defines them in terms of bodily characteristics and constructs their bodies as ugly, dirty, defiled, impure, contaminated, or sick." A white European immigrant can stop being 'ethnic' in ways that a person of color cannot stop being labeled black or Arab or Latino, however much the latter are assimilated into putative dominant cultural forms. Race (and racism) exists at the level of hegemonic ideology in the sense that one cannot escape the

marginalizing effects of racial categories and their historical constructions.

The way racial and ethnic categories in the US Census have changed over time is an example of this shifting and discursive terrain of racial constructions. For example 'Hispanics', a term dating to the 1980 census, may be 'white' (or another race), and all are ostensibly ethnically different from 'non-Hispanic whites' in unspecified ways. The unstable and changing census categories and attached cultural representations which 'move' people in or out of racial and/or ethnic categories over the decades hints at the ambiguities and fluxes of such identity markers and the ways that they reflect the racial state (Goldberg, 2002). Regardless, these categorical shifts should not obscure the fact that American Indians and people of Asian, African and Latin American ancestry have faced intense discrimination, marginalization, and dispossession as racially categorized minorities at various times and places in US history (e.g., Feagin, 2015; Feagin & Cobas, 2014).

Hazard studies that rely solely on census classifications leave unexplored the meaningfulness of racial labels for affected people in particular localities and the social diversity these static terms elide. They also support a static, ahistorical and essentialized understanding of race as a fixed social category rather than a complex social, historical, and geographic *process*. Indeed, as has been argued by critical race scholars, rather than being a neutral source of information on demographics "the Census is a tool of the racial state's effort to organize and discipline racial categories for human beings" (Kurtz, 2009, p. 691). How populations are categorized racially, by the census or by other means, can become deeply inscribed in lived experiences of people these categories (see Bolin, Hegmon, Meierotto, York, & Declet, 2005; Pulido, 2000). However, it is also important to recognize that, in spite of its limitations, census data have served a central role in both EJ and disaster studies, in identifying and mapping sociodemographic impacts and inequalities in exposure to and recovery from environmental hazards (Collins, 2010; Cutter et al., 2003; Gentile, 2016)

Further obscuring conceptual clarity is the frequent conflation of race and ethnicity in the sociological literature, although ethnicity too is an unstable concept that escapes easy definition (Omi & Winant, 1994). As with race, relying on shifting census categories omits any consideration of the instability of labels or the political struggles over the cultural identities they incorporate. Anthropology, beginning at least with Barth's classical statement on ethnic groups (Barth, 1969), has produced an extensive literature on ethnicity and ethnic groups, centering ethnicity as *the* key subject of contemporary cultural anthropology. At its (deceptively) simplest ethnicity implies an ensemble of cultural characteristics and social relations that distinguish one group from another (cf. Shanklin, 1999). Ethnicity shapes individual identities and group characteristics while at the same time drawing boundaries with others who ostensibly do not share a set of cultural characteristics. However, the cultural features and practices that either unify or divide groups are frequently difficult to identify, particularly in complex postcolonial and multicultural social formations (Gupta & Ferguson, 1997).

Two more key concepts are introduced by Omi and Winant (1994, 2012) which, in the context of this chapter, are useful in understanding the ways that racial categories and racism shape environmental inequalities and disaster vulnerability: racial formation and racial project. Racial formation, as alluded to above, refers to the historical process "by which racial categories are created, inhabited, transformed, and destroyed" (Omi & Winant, 1994, p. 55). Such formations incorporate specific 'racial projects' which represent and organize human bodies and social practices across space and time, privileging certain categories of people and the places they occupy over others (Pulido, 2000). Thus, racial formations are historically produced, hierarchical, and hegemonic, and are expressed materially, spatially and in discourse (Goldberg, 2002; Kurtz, 2009; Omi & Winant, 1994). For

hazards research, understanding racialized social processes requires a historically informed investigation into the particularities of racial formations in specific places and times and how those shape the environmental risks people face (e.g., Bolin, et al., 2005; Pellow, 2000). It also avoids the essentialist treatment of race found in quantitative studies, wherein racial/ethnic categories are treated as concrete attributes with ensembles of assumed but undocumented social characteristics.

In using race to explain observed individual differences in social research, Omi and Winant (1994, p. 54) claim that scholars too often treat "race as an *essence*, as something fixed, concrete, and objective." Against such essentialism, they contend that race should be understood as "an unstable and 'decentered' complex of social meanings constantly being transformed by political struggle… : *race is a concept which signifies and symbolizes social conflicts and interests by referring to different types of human bodies*" (Omi & Winant, 1994, p. 55 Italics in original). What types of bodies are included in what racial category reflect place-specific historical and political economic processes that produce distinct patterns of advantage and disadvantage based on such classifications (e.g., Bolin, et al., 2005; Boone et al., 2009; Hoeschler, 2003). Racialized groups, for example, may be spatially segregated, denied social services, excluded from work opportunities, and forced to occupy unsafe and hazard prone spaces that privileged groups can avoid (Maskrey, 1994; Wisner et al., 2004). Such racially and spatially marginalized groups can also be denied access to necessary resources to cope with disaster losses, deepening their vulnerability to future hazard events (Collins, 2010; Mustafa, 2005).

10.2.2 Class and Political Economic Crises

While an in-depth understanding of ethnicity may be more the domain of social anthropologists than sociologists (Oliver-Smith, 1996), the opposite holds for studies of social class. To be sure, social class cuts across and is inextricably bound up with race, as one is always class situated, whatever other determinants of social positionality may be simultaneously at work. Class theory, particularly in its Marxist and poststructuralist forms, is both complex and at the center of a variety of theoretical developments (Gibson-Graham, Resnick, & Wolff, 2001; Glassman, 2003; Harvey, 2014). While there are a number of approaches to class and economic positionality, here we use class as a trope for aspects of an agent's dynamic position in processes of economic and social production and reproduction. In Marxist terms, classes are elements of the social relations of production, which include not only people's primary productive activities, but also patterns of ownership, the appropriation and distribution of surplus value, and the legal and cultural systems and practices which justify and reinforce existing class inequalities (Harvey, 2010a, b). In this sense, classes are processes that extend beyond the 'economic' in any narrow and essentialist reading. As Glassman (2003, p. 685) writes, "… classes are always already constituted as economic, political, cultural, and ideological entities – including being gendered and racialized in specific ways…"

It is common in the social sciences for people to be assigned class position based on a variety of quantified indicators, including income, occupation and education. Other scholars focus on relational factors such as position in the extraction of surplus value, ownership patterns, and labor market position (Glassman, 2003). Class processes are connected to a complex range of issues, from political and economic power and job security to modes of consumption, identity formation, subjectivities, legal rights, and sociospatial processes (Bourdieu, 1984; Harvey, 2014). The latter include a range of issues from labor and housing segregation to land use patterns and the distribution of hazards.

As with the other concepts discussed here, class processes and class composition should be understood as historically constructed, overdetermined, contingent, and dynamic (Glassman, 2003). With class, change can be pronounced as

dominant regimes of accumulation shift with political economic crises and as localized class struggles crystallize over specific issues (Harvey, 1996; Smith, 2008). In the US and many other multi-racial societies, class and race are bound up together, a historical effect of racially exclusionary practices in education, housing, access to resources, sectoral employment, and the formation of industrial working classes in the US. The pervasive effects of these practices remain today as evidenced by income, poverty, and unemployment data and segregated urban landscapes (e.g. Boone et al., 2009).

The structural instability of class position in the context of a crisis-prone capitalist system is perhaps most visible with the economic restructuring in the US beginning in the 1970s and the ascendency of a hegemonic neoliberalism. This restructuring produced the 'de-proletarianization' of significant fractions of the US industrial working class as jobs and factories were moved toward non-union, low wage regions of the US and to the global South (Harvey, 2005; Soja, 1989, 2000), accompanied by the growth of insecure, low-wage, part-time, and service sector employment. It also produced geographic shifts in employment opportunities, weakened trade unions, reshaped industrial and residential landscapes, and reduced real incomes for significant fractions of the working class (Castree, 2009; Davis, 1992; Yates, 2005). It has also engendered a historically unprecedented job and wage squeeze on the middle and working classes over the last two decades (e.g., Harvey, 2005; Piketty, 2014; Soja, 2000). And these pressures are disproportionately impacting people of color, where by 2005 in the US more than 30 percent of black workers and 39 percent of Latino workers earned poverty wages or below (Yates, 2005). According to the Bureau of Labor Statistics, as of 2013, twice as many black and Latino workers were in poverty compared to whites,[3] and the net wealth of white US households was approximately 20 times that of black households and 18 times that of Latino households.[4] The upshot of these kinds of statistics is that the nature of economic vulnerability, which can shape hazard vulnerability, is changing and assumptions about the security of the middle class in disaster planning and recovery can no longer be taken for granted (see Bolin, Hegmon, Meierotto, York, & Declet, 2013). With neoliberalism being imposed on indebted Third World countries through the World Bank and the World Trade Organization, social inequalities and processes of marginalization are being intensified in the global South as well (Peet & Watts, 2004; Smith, 2008). The imposition of 'free market discipline' through structural adjustment programs has produced growing income inequalities, declining wages, reduced social protections and services, privatization of common property resources, the dispossession of peasants, and increased ecological disruptions (Davis, 2006; Harvey, 2010b; Robbins, 2012). These transformations lead to increased vulnerability to hazards through environmental degradation from resource exploitation, land grabs, displacement of the poor onto marginal lands, and a decline in social protections offered by the state (Bankoff et al., 2003; Collins, 2009; Hutanuwatr et al., 2012). Class, and the larger political economic relations which shape class processes are a key, if neglected, part of understanding disaster. Class positionality connects closely with the types of resources people have available for use in crises, the types of public resources available, and has a strong spatial dimension often linked to occupation of hazardous areas (Collins, 2009; Wisner & Walker, 2005).

To sum up to this point, race and class, are theoretically complex signifiers of social processes that involve struggles over legal and political rights, access to resources, livelihoods, and safe environments as well as the constitution of social identities (e.g., Peluso & Watts, 2001). The combined effects of these factors are linked to sociospatial processes in disasters as shown in the research literature (Mustafa, 2005; Wisner et al., 2004). In the following sections we will

[3] http://www.bls.gov/opub/reports/working-poor/archive/a-profile-of-the-working-poor-2013.pdf.

[4] http://inequality.org/99to1/facts-figures/.

discuss selected research on how these concepts have been utilized in disaster and vulnerability research.

10.3 A Brief History of US Disaster Research on Race and Class

The US disaster research tradition arose from the same postwar milieu that encouraged white immigrant-driven theories of racial assimilation noted above. Some of the earliest disaster studies were the Strategic Bombing Surveys of World War II, conducted to understand the 'morale' of civilian populations subjected to sustained bombing attacks (Mitchell, 1990). This general interest carried over into the Cold War, where research, funded by the military, was conducted on civilian disasters. A 'sociological perspective' on disaster emerged in a series of studies funded by the Army Chemical Center and conducted by the National Opinion Research Center (NORC) at the University of Chicago (Drabek, 1986). Disaster research in the US became institutionalized with the establishment of the Disaster Research Center (DRC) at Ohio State University in 1963 by sociologists Quarantelli and Dynes (Dynes & Drabek, 1994).

During this period, US-based researchers produced a series of monographs and other case studies on various disaster 'events' (see Bolin, 2006, for a review). The newfound sociological interest in racial/ethnic assimilation, however, did not extend to this civil defense oriented research, which largely ignored differential responses to disaster across diverse populations in favor of strategically-oriented estimates of universal behavior (Tierney, 2007). Some studies, however, (e.g. in Bates, Fogelman, Parenton, Pittman, & Tracy, 1963; Clifford, 1956; Moore, 1958), did report some differential disaster impacts, such as Moore's *Tornadoes over Texas* (1958). Moore reported findings on a limited number of blacks and Mexican Americans who turned up in his sample. Moore, for example, found that blacks had disproportionate losses from a tornado and consequently had greater need for external assistance to recover (as did the elderly in his sample). He also found that blacks had a higher injury rate than whites, a finding echoed in Bates, et al. (1963) which found that blacks had significantly higher mortality than whites after Hurricane Audrey. These are among the earliest findings suggesting that to be black and poor in the US was associated with disproportionate environmental risk, although such conclusions were not highlighted in the studies. These studies demonstrate the strong interest in warning, emergency response, and evacuation behavior in early disaster research (see Drabek, 1986 for a review), as well as the impulse to generalize and systematize findings irrespective of their fragmentary nature and simplistic understanding of complex social constructs.

It was not until the 1970s that the first studies on reconstruction and recovery were conducted, driven by new interest in demographic differences in disaster response. The expansion and theoretical elaboration of disaster research were abetted by the publication of the first major assessment of hazards and disaster research in the US in the early 1970s, a work that brought together much of the sociological and geographical research available to that time (White and Haas, 1975). This work, under the leadership of the hazards geographer Gilbert White, helped establish an agenda for new hazards and disaster research that would appear over the next two decades (Mileti, 1999; White & Haas, 1975). Part of this new agenda for hazards research of the 1970s included studies focusing on racial, ethnic, and socioeconomic differences in disaster response.

Some of the first explicit discussions of class issues (mostly concerned with poverty) and race come in discussions of a catastrophic flood in South Dakota as part of the Haas et al. reconstruction study. Class (as socioeconomic status) and racial differences in access to assistance, victim experiences in temporary housing, and general recovery processes were discussed (Haas, Kates, & Bowden, 1977). A historical analysis of the 1906 San Francisco disaster, as part of the reconstruction research, highlighted the changing pattern of ethnic and racial segregation in the city as it was rebuilt, marking an important early

example of historical geographical disaster research concerned with race and ethnicity. Other reconstruction research in this era compared household recovery in Nicaragua and the US. That study emphasized important class/socioeconomic and cultural/ethnic dimensions in accounting for different household recovery strategies (Bolin & Trainer, 1978). The primary limitation of cross-sectional survey research of this sort is that while race, class, and ethnic differences can be measured and their independent statistical effects can be controlled for, why those differentials exist, how they came about, and how they manifest themselves over time cannot be addressed. As discussed extensively in environmental justice studies, the focus on the relative statistical effects of race versus class obscures any understanding of the concrete ways that race and class are bound together and embodied in human subjects, structuring people's everyday lives, including where and how they live, and their particular ensembles of capacities and vulnerabilities (Holifield, 2001; Pulido, 1996).

US disaster research in the late 1980s and 1990s began to engage with more critical approaches to race and class. The 1989 Loma Prieta earthquake in Northern California provided opportunities for researchers to examine specific race, class, and ethnic issues. Several Loma Prieta studies approached their research ethnographically, providing detailed descriptions of how vulnerable and marginalized groups coped with the aftermath of a destructive earthquake (Bolin & Stanford, 1991; Laird, 1991; Phillips, 1993; Schulte, 1991). Each of these studies investigated processes of political, social, and cultural marginalization that systematically disadvantaged African Americans and Mexican Americans in a variety of ways, from housing assistance to political representation. These studies documented how federal assistance programs consistently failed to meet the needs of the homeless, Latino farmworkers, and low income African Americans. Their results illustrated the specific ways that class, race, and ethnicity articulate ways in actual disaster processes, something that conventional quantitative surveys could not.

A series of studies of Hurricane Andrew (1992) in Florida, although not using the explicit language of racial formations and racial projects, stands as an early example of US disaster studies that examined racial projects in the context of vulnerability and disaster, providing both quantitative scope and ethnographic depth (Peacock, Morrow, & Gladwin, 1997). This research offered theoretically informed discussion of race, class, gender, and poverty dynamics, explored in a series of case studies (Peacock et al., 1997). Grenier and Morrow (1997) offered a historical overview of the development of the Miami urban region to show how processes of political and economic marginalization were creating at-risk people and communities, especially for Caribbean immigrant groups and African Americans. Throughout the Hurricane Andrew case studies, the authors highlight how race, ethnicity and class inequalities shaped people's experiences, from impact related losses to access to assistance, inequities in insurance settlements, the effects of pre- and postdisaster racial segregation, and the calamitous effects of disaster on an already marginalized and impoverished black community (Dash, Peacock, & Morrow, 1997; Girard & Peacock, 1997; Peacock & Girard, 1997; Yelvington, 1997).

Each of these studies documents how already existing social conditions in greater Miami shaped the contours of disaster and the ways that marginalized populations variously endured continuing or increased disadvantages in the recovery process (see Dash et al., 1997). However, the research also demonstrates that race or ethnicity by itself is not an adequate explanatory element: what matters is how these factors (and immigration status, gender, and age) intersect in spatially specific ways to shape a person's class locations and their access to social and economic resources (e.g., Yelvington, 1997). That is, race, ethnicity and other 'identity' factors are intertwined with class processes and the privileges or disadvantages that flow from these converge to shape a person's vulnerability to hazard events.

Both the Hurricane Andrew work (Peacock et al., 1997) and research on the Northridge earthquake (Bolin & Stanford, 1998a, b, 1999) situate their respective disasters in the context of historical, spatial, and political economic processes in urban space, and focus on the particular ways social inequalities develop and shape people's vulnerabilities to disaster. This marks a convergence with vulnerability research approaches discussed below (e.g. Hewitt, 1983a, b, 1997),[5] but these studies are only examples and point to the need for greater attention to historical context and lived experience in the field as a whole. Ultimately, the challenge for disaster researchers is to approach race (and ethnicity) as complex and contested social constructs that form the axes of a variety of historical and contemporary social struggles across a range of scales (Feagin, 2015; Feagin & Cobas, 2014).

Given the often technocratic, expert-knowledge driven, policy focus of disaster research, it is not surprising that many 20th Century researchers were not engaged in extended theoretical discussions and qualitative unpacking of their key terms. However, to provide a richer, more contextualized understanding of racial and class disparities requires more attention to theorization and historical geographic processes that have produced racialized and class segregated landscapes (Harvey, 1996; Smith, 2008; Walker, 2012). Moreover, the complex mechanisms by which certain racial and ethnic categories of people are disadvantaged in relation to hazardous environments will remain invisible as long as researchers are concerned with statistical **differences** between groups rather than the pervasive social **inequalities** that produce measured difference to begin with (Holifield, 2001). That is, while identifying statistical differences may illustrate current racial inequalities, quantitative approaches too often fail to explore the mechanisms whereby spatial inequalities in hazard exposure are produced over time. Attention to the historical and geographical mechanisms that create segregated and unequal spaces, and disadvantage some groups over others in disasters, has distinct policy implications. Specifically it helps identify the root causes of vulnerability by race and class which hazard policy can then begin to address (see Wisner, et al., 2004).

10.4 Race, Class, and Vulnerability in Disasters

This review features disaster research characterized by a consideration of people's social vulnerability in relation to hazard agents. In particular, we focus on several notable disasters, including the Indian Ocean tsunami and Hurricane Katrina as key points in the treatment of race/ethnicity, class, and vulnerability in disaster studies.

10.4.1 Inequalities, Vulnerability and Disaster

Vulnerability analysis, beginning with its classic statement by Hewitt et al. in 1983, distanced itself from the dominant, technocratic approach to disaster by engaging in an extended critique of the conventional disaster management and research (e.g., Hewitt, 1997; Susman, O'Keefe, & Wisner, 1983; Watts, 1983). Vulnerability theories posited that the dominant view of disaster in the 1980s over-focused on the physical aspects of the hazard and sought technocratic and engineering solutions to disaster rather than social and political economic changes. The emphasis on physical hazards and management solutions "…directs attention away from the social factors implicated in disaster, including poverty, gender inequality, the lack of entitlements, economic underdevelopment, and ethnic marginalization. Such conditions are endemic

[5]We note that there are important theoretical and methodological convergences *and* differences between vulnerability studies and the recently emerged resilience approach to research on hazards and disasters, but a discussion of resilience is beyond the scope of this chapter (see Eakin & Luer (2006) for a review of both). Both types of studies use the term 'vulnerability' frequently, although not interchangeably, and some studies blend the two approaches (e.g. Hutanuwatr et al., 2012).

problems of everyday life for a large segment of the world's population…" (Bolin & Stanford, 1998a, p. 6). The original critique of Hewitt et al., and a series of critical exchanges since, have produced a lively, if not always productive, debate among disaster researchers of different theoretical and disciplinary positions (e.g., Eakin & Luer, 2006; Hewitt, 1995; Quarantelli, 1995; Wisner et al., 2004).

In general terms, vulnerability research examines political, economic, and sociospatial processes of marginalization that not only produce or intensify poverty, but that also may constrain certain portions of a given population (often marked by class, race, or ethnicity) to occupy hazardous areas and structures through segregation mechanisms. Prime examples can be seen as in the proliferation of unsafe, unplanned, and impoverished squatter settlements in many of the world's major urban centers and the lack of concern and consideration shown to such populations by planners and developers (Davis, 2006; Mustafa, 2005).

Wisner et al. (2004) provide a detailed discussion of vulnerabilities across a range of hazards under a variety of specific spatiotemporal conditions. At the core of their analysis is a processual model of vulnerability accumulation and the production of differential environmental risks, termed the Pressure and Release model (PAR). In their model, hazard vulnerability is understood as a historical geographical process comprising three linked elements: root causes, dynamic pressures, and unsafe conditions. The underlying causes refer to the general historical, political, economic, environmental, and demographic factors that produce unequal distributions of resources among people by a variety of positional factors, including race and class. These processes generate social vulnerability through such things as rapid urbanization, environmental degradation, economic crises, structural adjustment programs, political conflict, and poorly planned and executed development programs (Peet & Watts, 2004). As a result, unsafe conditions are created including both spatial location and characteristics of the built environment. These unsafe conditions also include fragile livelihoods, inadequate incomes, legal and political inequities and a lack of social protections offered by the state (Hutanuwatr et al., 2012; Mustafa, 2005).

10.4.2 The 2004 Indian Ocean Tsunami

Research on the massive and highly destructive Indian Ocean tsunami of 2004 has highlighted uneven development and social vulnerability in disaster. The scope and scale of the tsunami was unprecedented, with the sea waves generated by the magnitude 8.9 Sumatra earthquake heavily damaging coastal areas in 14 countries, killing more than 230,000 people and displacing millions more as many coastal communities were literally washed away (The World Bank, 2006; UNDAC, 2005; UNEP, 2005). Many of those who died or were displaced were among the most vulnerable, living in insecure structures with marginal livelihoods, mired in deep poverty in states that provided few if any social protections (Birkmann & Fernando, 2007; Telford & Cosgrave, 2006). Given the large cultural, political, and geographical diversity of the impact zones and highly uneven patterns of development, generalizations about the tsunami and its aftermath are difficult to make. We focus our remarks on a case study of disaster recovery in Thailand to illustrate class and ethnic factors in vulnerability and recovery.

The most heavily damaged area in Thailand was along the west coast, an area that includes major tourism destinations. Of the 8200 tsunami deaths in Thailand, some 2400 were foreign nationals, mostly tourists (Telford & Cosgrave, 2006). The tsunami also heavily impacted the Thai fishing fleet, putting more than 30,000 subsistence, small scale, and commercial fishers out of work for extended periods of time and

complicating recovery (UN Thailand, 2008). Much of the recovery effort in Thailand was led by a top down, inflexible, state-centered program that prioritized the tourism industry over local small scale economies and failed to deal adequately with an ethnically and economically diverse impact region (Hutanuwatr et al., 2012).

Using Wisner et al.'s Pressure and Release model (PAR), the Hutanuwatr et al (2012) study traced the historical geographical development of their case study community, a village that went through considerable ethnic and development changes in the decades preceding the disaster. One area of the village had historically been occupied by an indigenous ethnic group known colloquially as 'Sea Gypsies' or Moken: semi-nomadic subsistence fishers who are ethnically distinct from Thais and subject to substantial discrimination, including denial of citizenship and denial of official disaster assistance (Stechkley & Doberstein, 2011). Although the Moken had occupied the area long before ethnic Thais moved in, they lacked any official land tenure, a significant factor in their marginalization. The village of 6000 had approximately 1500 deaths in the tsunami and approximately 80 percent of built structures and fishing facilities were destroyed.

To condense a very detailed vulnerability study, we note some key findings in Hutanuwatr et al. (2012). A primary tension in recovery programs across Thailand was between the government's interest in restoring and expanding tourist industry (and foreign investment under free trade agreements), and local communities' interests in restoring fishing and subsistence livelihoods and reducing risks through a variety of mechanisms. In the case study community, the technocratic, top-down programs promoted by most NGOs and the government failed to consider the ethnically and class diverse population and likewise failed to address the underlying political economic conditions that shaped local vulnerability (Chalermpak & Sriyai, 2006). That is, inflexible government programs failed to restore appropriate housing in appropriate locations, did nothing to enable a return to fishing livelihoods, and similarly denied all assistance to the hard hit Moken. Given these programmatic recovery failures, a grass roots organization, the Community Coastal Center, stepped in, using a collaborative, participatory, democratic approach. The Center developed recovery programs that accounted for the economic and cultural diversity in the community and began to address underlying conditions that created marginal livelihoods and exposure to environmental hazards (The Network of Tsunami-Impacted People, 2005). The Center incorporated ethnic diversity into its program, improved housing conditions and land use, and engaged in political action at multiple scales. This included pushing for new rights for the indigenous Moken by pushing back against the Thai Nationality Law which denied them citizenship (Network of Tsunami-impacted People, 2005; Hutanuwatr et al., 2012). Thus, their collaborative approach engaged in a vulnerability reduction process by enhancing local livelihood opportunities through occupational training, gaining access to resources for the economically marginalized, enhancing local political cooperation, encouraging cultural diversity and tolerance for indigenous people, and developing disaster preparedness programs. While the case study focuses on a single village it illustrates a suite of recovery issues that typifies many coastal communities in Thailand.

10.4.3 The 2006 El Paso/Ciudad Juarez Floods

In US disaster literature, Collins offers a recent example of theoretically informed research on processes of marginalization and the production of vulnerability in the El Paso/Ciudad Juarez floods of 2006 (2009, 2010). His work is notable because it is grounded in Marxist urban political ecology, vulnerability theory, and environmental justice, and has a focus on a large cross-border urban area. It illustrates the ways social power can marginalize low income groups while producing social benefits and enhanced environmental security for privileged classes. The flood disaster in this case was instantiated by a 10 day period of unprecedented rains (twice normal

annual rainfall) which had widespread cross-border effects particularly on low income Latinos and Mexican citizens in both cities. On both sides of the border, those living in informal housing settlements suffered extensive losses and had access to few if any recovery resources.

Collins' work offers a critical assessment of the marginalization literature in vulnerability studies by arguing that it is not always only the poor and racialized minorities who occupy high hazard zones in an urban hazardscape. While El Paso, in aggregate, lacks the abject poverty of the poorest neighborhoods of Ciudad Juarez, it nevertheless hosts some 150 very low income *colonias.* These are quasi-informal settlements in unincorporated areas lacking any infrastructure and housing approximately 70,000 of the most socially vulnerable people in the area, virtually all of whom are of Mexican ancestry or Mexican nationals without US documentation (Collins, 2010, p. 269). While the *colonias* on the Texas side were inundated in the floods and experienced severe housing losses, they did not occupy the highest hazard zones. Rather, as Collins shows, the rugged, steep, hazard-prone hillsides and *arroyos* of the Westside area of El Paso were occupied by the wealthiest classes, people who voluntarily live in hazardous terrain in exchange for the environmental amenities such terrain offers: panoramic views, clean air, low density neighborhoods, and easy access to mountain recreation. As Collins (2009) observes, the terrain occupied by the wealthiest on the Texas side is directly analogous to the terrain occupied by the poorest across the border. That the wealthy in the global North sometimes seek out hazardous terrain for housing due to compensatory environmental amenities also has been noted in studies of wildland-urban interface fires (Collins & Bolin, 2009; Davis, 1998).

Collins argues that in both fire and flood cases, voluntary exposure to hazards is facilitated by class privilege which is used to extract social and infrastructural protections from the state to reduce risks associated with voluntary exposure. Collins (2009, 2010) develops the notion of *facilitation* to describe the inverse of marginalization and show how the wealthy can mobilize publicly funded protections (flood channeling, dams, levees, emergency management services, flood insurance) to minimize their potential losses in high risk zones while shifting negative externalities and the financial burdens of protections onto lower income groups who do not benefit from equal expenditures.

In the El Paso floods, the privileged classes living in the hazardous landscapes of the west side of the city, were well protected by (federal) flood insurance as well as extensive infrastructural developments made at public expense to channel and control floodwaters. In the aftermath of the floods, special programs were initiated, at public expense, to facilitate restoration and remediation of flood damage in Westside neighborhoods. However, in the *colonias*, few residents could or would take advantage of FEMA programs (Collins, 2010). Those in the country without documentation were not eligible, and others were fearful of applying or could not qualify due to the informal nature of their housing. Inexplicably, FEMA initially offered flood assistance information only in English (Collins, 2010, p. 279) denying non-English speaking residents information on their federal assistance entitlements. Furthermore, rather than enhancing infrastructural protections against floods as was done in wealthy Westside neighborhoods, lower income neighborhoods went through 'buy-out' programs, displacing and relocating residents on the premise that buying up low value property was more economically efficient than increasing flood mitigation. The asymmetries of such class and race based public expenditures on hazard mitigation and recovery assistance raises significant justice issues, given the disproportionate flow of resources to the wealthiest residents and away from the most vulnerable with their unmet recovery needs.

10.4.4 Hurricane Katrina

Hurricane Katrina in 2005 was another major turning point in the development and use of vulnerability approaches to disaster research in the US. The failure of structural engineering

safeguards such as flood levees in combination with a category 3 hurricane killed approximately 1800 people (estimates vary), displaced an additional 1.5 million residents, and did $108 billion worth of 'property damage' (Knabb, Rhome, & Brown, 2006; Weber & Messias, 2012) – a clinical and distant term for the often near-total destruction of homes and businesses. As briefly outlined in the introduction to this chapter, the aftermath of Katrina in New Orleans and across the Gulf Coast in Mississippi, Georgia, and Alabama prominently displayed the effects of historic systems of inequality based on race and class through the lens of a disaster. Access to evacuation, pre-disaster preparedness, the distribution of post-disaster recovery resources, and even the grimmest of outcomes such as mortality rates and physical and mental trauma were fractured along racial and class lines (Cutter et al., 2006; Elder et al., 2007; Elliott & Pais, 2006; Laska & Morrow, 2006; Sastry and VanLandingham, 2009).

Faced with media depictions of residents, the majority of whom were African American, stranded in their homes by historic flooding or sheltering *en masse* in the Superdome and entirely without the resources to meet basic needs, disaster researchers as well as the public were confronted with the realities of inequality within the United States: visible, insistent, and unambiguous vulnerability in a city with a long and troubling history of racial divisions and exclusionary practices and politics (Dyson, 2006). Even the earliest research on the aftermath of the storm strongly highlighted differences in Katrina's effects that reflect the racial and class history and realities of New Orleans as a city. Elliott and Pais (2006) used an environmental justice and vulnerability-based framework to situate their research, beginning with a historical review tracing the declining importance of New Orleans and other Gulf cities as economic booms brought other regions of the South to prominence. The relative unimportance of Gulf cities to industries and economies other than oil prevented the kind of economic prosperity and migration to these cities that might have transformed deeply rooted systems of racism and classism; systems that were reflected in post-disaster recovery outcomes in the wake of Katrina (Elliott & Pais, 2006). For many people in New Orleans, life before the storm was already an emergency—a struggle for survival and prosperity against constant marginalization (Cutter et al., 2006).

Racial and class disparities during and after Hurricane Katrina are well-documented in the disaster literature. Evacuation orders were less likely to reach, less likely to be trusted by, and less likely to be followed by persons of color and lower-income residents in New Orleans than more affluent and white residents (Brodie, Weltzien, Altman, Blendon, & Benson, 2006; Elder, et al., 2007; Lachlan, Burke, Spence, & Griffin, 2009; Messias, Barrington, & Lacy, 2012). Evacuation decisions were also a matter of resources. In addition to being less likely to have access to reliable transportation like a personal vehicle, lower-income and non-white residents stayed in the city due to reliance on the local public hospital system, because they needed to care for someone who was unable to leave, or because they were concerned that police would not protect their property and communities if they evacuated (Brodie, et al., 2006; Elder et al., 2007). Studies of recovery after the storm have found that rates of post-Katrina mental illness are higher (Rhodes et al., 2010; Sastry and VanLandingham, 2009), and employment and resettlement rates are significantly lower, for low-income and African American residents (Elliott, Hite, & Devine, 2009; Elliott & Pais, 2006; Fussell, Sastry, & VanLandingham, 2010; Kates, Colten, Laska, & Leatherman, 2006, Sastry, 2009; Zottarelli, 2008). The slower rates of return migration for non-white and low-income residents in part reflects greater housing and property damage from flood waters and delays in rebuilding flood protection structures in low-income areas (Elliott et al., 2009; Fussell, et al., 2010; Green, Bates, & Smyth, 2007; Sastry, 2009), highlighting the intersection of social processes, particularly racism and classism, which shape exposure to biophysical hazards like flooding (Kates et al., 2006). These intersections of social inequality and hazard

exposure are "the products of an enduring system of southern apartheid, involving racial segregation and consequent established patterns of community settlement of people of color into less desirable, low-lying, flood prone environments" (Adeola & Picou, 2016, p. 2).

The repeated message of study results—that race and class were highly consequential before, during, and after the hurricane—demonstrate that Katrina only provided a stage on which existing vulnerabilities played out. From the timing of the evacuation (two days before first-of-the-month paychecks arrived) to which residents returned to their damaged or destroyed homes after the floodwaters receded (lower-income homeowners, bound by mortgages and without other options), everything about the storm showcased the racialized and discriminatory processes that generate inequality (Cutter et al., 2006; Dyson, 2006; Elliott & Pais, 2006). These findings "refute the apparent randomness of natural disasters as social events" (Elliott & Pais, 2006, p. 317).

The race and class inequalities that formed the initial focus of Hurricane Katrina studies were often, although not always, explicitly situated in the tradition of vulnerability analysis developed by Hewitt et al. and stemming from political ecology's critical Marxist approach (see Cutter et al., 2006; Elliott & Pais, 2006; Laska & Morrow, 2006). In the years following, however, additional research on the political, economic, social, and physical effects of the hurricane has contributed not only to our general knowledge on disaster recovery, but further revealed processes and patterns of social inequality that are visible only in the long term. These studies have further developed our understanding of vulnerability to disaster, drawing greater attention to the unevenly distributed effects of post-disaster recovery efforts and the unintended consequences of resettlement and regrowth.

Despite personal and community hopes that the recovery process would provide an opportunity for positive social change (Weber & Messias, 2012), research on recovery from Katrina indicates that, instead of reducing inequalities and increasing access to resources and power for vulnerable peoples, the recovery process itself has for many constituted a second-order disaster (Adams, 2013; Elliott, et al., 2009). Facing budget cuts and other forms of economic deprivation from strongly neoliberal government institutions, disaster relief charities and other non-profits reify the vulnerability of communities based on racial and class categories in order to justify their expenditures and resource requests – a self-referential system that is both driven by and reinforces social inequality (Adams, 2013). This interstitial system of disaster relief was made necessary in part by the delayed and uneven distribution of federal recovery funds by state and local governments, which prioritized economic expansionist projects over socially-oriented interventions like the reconstruction of low-income housing (Weber & Messias, 2012). In New Orleans, a lack of comprehensive and unified post-Katrina planning exacerbated the problems of recovery still more, as residential neighborhoods in less flood-prone areas were haphazardly prioritized for reconstruction, de facto privileging whiter and more affluent areas of the city during recovery efforts (Kates et al., 2006). Even when neighborhoods were rebuilt relatively quickly after the storm, as in the case of the historically racially diverse Uptown district, the average higher incomes of white residents allowed for faster return migration (Elliott, et al., 2009). The quick pace of return by high-income white community members prompted an influx of displaced friends and relatives into recovered areas, further restricting opportunities for return migration by lower-income residents (largely African-American), as those without financial means to rebuild immediately were often forced to wait for external aid from organizations like the Red Cross or FEMA (Elliott et al., 2009).

External aid from non-profit or charitable organizations after Katrina has been another mechanism by which racial and class-based divisions are manifested. Adam's ethnography of post-Katrina New Orleans (2013) finds that normal social and economic structures were replaced by what she terms an 'affect economy', wherein recovery services relied on unpaid compassionate labor to fulfill needs that

profit-driven capitalist markets had no incentive to meet. This affect economy fragmented along lines of perceived morality: only the deserving receive help, while only the virtuous provide it (Adams, 2013). Weber and Messias (2012) examine the experiences of disaster recovery workers—those whom Adams might call 'the virtuous'– using an intersectional feminist framing that emphasizes the overlapping identities of race, class, gender, and illuminates the processes by which neoliberal power was consolidated via political and economic means during recovery. Their results show the personal consequences for recovery volunteers of working within the already over-stretched social safety nets in low-income communities in Mississippi. Overwhelmed by continuous requests for basic assistance, without the resources to meet these needs, and often asked to perform services well beyond the scope of their organization, recovery workers, who were themselves already disproportionately drawn from vulnerable populations, paid the cost of recovery in their own mental and physical health and well-being (Weber & Messias, 2012). These workers, particularly women and persons of color, were frequently trapped in powerless 'middle' positions, unable to meet the needs of their communities but also excluded and silenced when attempting to advocate on behalf of those suffering to more powerful state and corporate actors (Weber & Messias, 2012). Weber and Messias' work is an excellent reminder that the type of biophysical and social vulnerability created and reinforced by race- and class-based power structures is pervasive in all aspects of disaster and not limited to those most affected by the storm.

Race, class, and vulnerability form the theoretical touchstones of the literature on Hurricane Katrina. Although not all of the studies on Katrina undertake the fully historical, process-oriented analytical approach of vulnerability in its most critical form, the nearly universal attention to race and class marks a major turning point in the adoption of vulnerability concepts into mainstream US disaster literature. Whether using highly contextual qualitative methods to understand mechanisms by which disaster relief services were accessed by non-English speaking residents (e.g., Messias, et al., 2012), compiling quantitative indices of recovery in New Orleans (e.g., Finch, Emrich, & Cutter, 2010), or investigating the rise of neoliberalism after the floodwaters receded (e.g., Adams, 2013), race and class disparities are not only centered in the Katrina literature, they are integral pieces of a normative call for greater equity and justice in disaster policy and beyond.

In sum, vulnerability research emphasizes political economic inequalities and processes of racial, class, and spatial marginalization in relation to risks from environmental hazards. It also stresses the importance of historical political economic factors in the production of inequalities and their links to land use patterns (Gentile, 2016). The evidence from vulnerability studies is that disasters are produced and shaped by everyday expressions of the political economy and social relations in a given place, and should be understood as an extension and exaggeration of normal conditions. The central focus of vulnerability studies on the historical dynamics of social inequalities and their expressions in sociospatial patterns has an affinity with approaches used in the environmental justice literature, and it is to that topic we turn in the conclusion.

10.5 Race, Class, and Environmental Justice

Prior to Katrina, environmental justice (EJ) literature directed its attention primarily to technological hazards and disasters and to the unequal burdens that marginalized groups bear, placing it outside of more traditional disaster research and its focus on acute 'events' (e.g. Bullard & Wright, 2009). In this concluding section, we highlight a few themes of the EJ literature and briefly examine some suggestive examples from the literature, including a discussion of radiation hazards on the Navajo Nation.

Environmental justice literature examines inequalities by race and class in the exposure to and health impacts of environmental hazards across a range of spatial and temporal scales. The EJ literature, places the subjects of this chapter– race and class inequalities– at the center of its theoretical and empirical concerns (e.g. Walker, 2012). While much of the literature examines routine and chronic exposure to hazardous agents, technological crises like the Bhopal India chemical disaster, the Chernobyl nuclear reactor explosion, and the recent Fukushima Daiichi nuclear disaster all raise important environmental justice issues (Kyne & Bolin, 2016).

While much disaster research, almost by definition, has used a temporally bracketed 'extreme event' focus (e.g. Quarantelli, 1994), environmental justice research examines the chronic and routine environmental hazards that people live with in their daily lives at a variety of spatiotemporal scales (e.g. Grineski, Bolin, & Boone, 2007). At the core of EJ is a concern with distributional justice– how environmental risks are distributed in space, and how marginalization based on race and class produces differences in exposure. It also examines procedural justice concerns: the historical, geographic, and institutional processes that have promoted inequalities in people's exposure to these negative externalities (e.g. Collins, 2009). While there are exceptions such as in the case of Katrina and the El Paso floods (Bullard & Wright, 2009; Collins, 2010), EJ studies, in contrast to disaster research, typically deal with risks that are difficult to detect and with contested health impacts: toxic chemicals in the air and water, ambient air pollution, contaminated foods, radiation exposure, urban heat, resource depletion, climate change effects, and so forth. For those enduring chronic involuntary exposure to chemical toxins, hazardous waste sites, or depleted aquifers, however, the experience of daily life may feel an ongoing disaster even without overt physical losses (e.g. Fradkin, 2004; Gibbs, 2012). Contemporary urban disasters can involve a complex mix of the effects of a physical agent (earthquake, flood) and technological hazards, producing what Pritchard (2012) calls an 'envirotechnical disaster' or a 'cascade' of disasters, one hazard triggering another (Kumasaki, King, Arai, & Yang, 2016). For example, as Katrina studies have shown (e.g. Bullard & Wright, 2009) flood waters from breached levees were heavily contaminated by inundated hazardous waste sites and sewage, increasing risks of environmental illnesses.

Nuclear disasters provide an example of the complicated mix of technological disaster, unclear temporal scale, and often subtle but consequential health effects that environmental justice framings are well-suited to explore. While nuclear disasters like Fukushima Daiichi debacle in 2011 (still ongoing) may attract substantial media interest and raise significant EJ concerns, other nuclear contamination 'events' unfold over time and lack any signal event like a nuclear meltdown or large scale evacuation (Funabashi & Kitazawa, 2012; Kyne & Bolin, 2016). For example, the accumulation of now more than 80,000 tons of plutonium contaminated spent fuel rods at US civilian nuclear reactors constitutes and environmental health threat that is measured in tens of thousands of years. This risk is magnified since there is as yet no safe permanent storage of this extremely hazardous waste, most of it currently being stored on site at poorly secured reactor sites (Kyne & Bolin, 2016). Yet such chronic nuclear risks receive little if any media attention, in the absence of an acute release of radiation.

10.5.1 Radiation Hazards and Justice on the Navajo Nation

The Navajo Nation in the US Southwest has had to deal with the legacies of radiation contamination and its health effects for decades and only recently has it received assistance from the US Environmental Protection Agency (EPA) for hazard mitigation (Pasternak, 2014). Initial radiation exposure on the reservation began in the 1940s with extensive uranium mining operations

to support the US nuclear weapons program. In the course of 40 years more than 4 million tons of ore was extracted from Indian lands by Navajo miners. In the process miners were exposed to radon gas and other radioactive substances while communities across the reservation were exposed to dust and water contamination from large piles of mine waste and the tailings from uranium ore milling operations (Arnold, 2014). In addition, the Navajo Nation also received direct radioactive fall-out from the US nuclear surface testing program in Nevada (1950-1962), producing additional negative health effects from downwind radiation exposure (Kuletz, 1998). The legacy of this 'nuclear colonialism' is that today the 27,000 sq. mi. reservation has more than 500 unremediated mine and mill tailing sites. All emit varying levels of ionizing radiation and leach radioactive substances into groundwater with a variety of probable health effects including lung cancer (unheard of among the Navajo prior to the 1940s), kidney disease and a variety of other health complications (Arnold, 2014). Although uranium mining ceased on the reservation in the 1980s and was banned in 2005, the health effects persist across generations exposed to these radioactive releases. Nor are these issues limited to just the Navajo Nation but rather affect tribes across the US West.[6]

From an EJ perspective, the casual disregard of Indian miners and their families' health by corporations, the decades of delay in federal compensation for radiation exposure victims and in EPA clean-up and hazard mitigation all speak to the marginality of American Indians in these matters (Kyne & Bolin, 2016; Masco, 2006). While not a disaster in the sense of being a single hazard event, it nevertheless represents a protracted radiation exposure process, one whose effects persist and are felt most directly by at the bodily level, contaminated homes, communities, and critical groundwater resources (e.g. Johnston, 2007).,

[6]http://www.environmentalhealthnews.org/ehs/news/2016/tribal-series/crow-series/years-after-mining-stops-uraniums-legacy-lingers-on-native-land.

We have highlighted aspects of vulnerability analysis and environmental justice research in this chapter to suggest areas where more interchange and cross-fertilization with other approaches to disaster studies could be mutually beneficial enhancing theoretical diversity and encouraging increasingly interdisciplinary research efforts. With persistent racial and class discrimination in the US and elsewhere, growing income inequalities, and rapidly changing environmental conditions due to climate change across scales, disasters must be understood as part of a complex suite of socioenvironmental and political economic facts that pre-exist and shape a given disaster.

10.6 Looking Forward

To enrich future disaster research, a better grounding in the historical geographic development of class and race relations in particular places is necessary. This grounding must include more attention to the theoretical issues implicit in the categorization of peoples by race and class, the processes by which these categories are engendered, and the spatial patterns of segregation. Environmental justice research and vulnerability studies both provide models for such analyses that could be incorporated into the ensemble of methodologies already deployed by disaster sociologists (e.g., Morrow, 1999). The regional catastrophe that emerged in the aftermath of 2005s Hurricane Katrina provides researchers with a mandate to attend to the complex historical and political ecological factors that have shaped race and class relations and produced the landscapes of risk so clearly and tragically revealed in the disaster.

With disasters growing in number and severity, and often coupled with long-term environmental degradation, technological failures, anthropogenic climate change, racial and ethnic conflicts, and growing class inequalities, the shared interests of disaster research, vulnerability studies, and environmental justice research appear clear (Oliver-Smith & Hoffman, 1999; Robbins, 2012). The increased use of political

ecology theory, spatial analysis, and studies of racial formation and class inequalities would strengthen disaster research by providing a spatially and historically informed understanding of the conditions which shape the severity and consequences of disaster. It would also help connect disaster research with a larger intellectual community in environmental sociology, environmental justice studies, and political ecology, allowing researchers to connect the historically separate concept of a disaster event with its antecedent conditions. In-depth, interdisciplinary case studies spanning disaster sociology, political ecology and environmental justice research would provide the necessary theoretical and methodological tools to investigate the intersections of social inequalities, hazards, and the production of space, as well as how these intersections affect the lived experiences of disaster-affected communities. In particular, environmental justice research provides important examples of how the chronic disasters of toxic chemical and radiation exposure can make people's daily lives ones of risks and health uncertainties that span decades, low grade disasters that lack beginnings or ends (Kyne & Bolin, 2016; Walker, 2012). Lastly, new research will require a willingness to critically investigate social inequalities and the social and environmental policies that put people and places at risk.

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Gender and Disaster: Foundations and New Directions for Research and Practice

11

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Contents

Gender is a key element of human experience which shapes identity, intimate relationships, household routines, legal standing, access to resources, cultural norms, institutional practices, and all other aspects of social life. It follows that gender also bears on capacities, decisions, and outcomes throughout the disaster lifecycle. Importantly, while research shows that gender inequalities and differences contribute substantially to disaster vulnerabilities, gender also shapes how agency and resilience are realized in crises. Gender further influences how disaster risk is created and the practice of disaster management itself.

Since the publication of our earlier review in the *Handbook of Disaster Research*, gender and disaster research has grown substantially in scope and influence. In this update, we again concentrate on peer-reviewed materials available in the English language,[1] and on natural, technological, and intentional hazards and disasters. After offering a brief overview of diverse theoretical strands of analysis and research, we synthesize key findings about mortality, health, and well-being; gender-based violence; family and work; and grassroots change. We then highlight three critical new lines of inquiry regarding sexual minorities, masculinities, and climate change. We conclude with observations about future research and how the field might better utilize the expanding knowledge base on gender and disaster to reduce hazards risk.

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[1]Space limitations precluded inclusion of reports and studies from non-governmental organizations; with few exceptions, we omitted these as well as completed academic theses and dissertations. Readers are advised to visit the Gender and Disaster Network website for access to many of these influential publications and resources. We also recommend recent overviews of the field, including Laska, Morrow, Willinger, & Mock, (2008); Enarson (2012); Tobin-Gurley & Enarson (2013); and Seager (2014).

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11.1 Expanding Theoretical Foundations

A notably broader theoretical landscape now guides research in disaster studies. Current scholars write from (and across) multiple disciplines, yet gender and disaster scholarship is still unified by the foundation of a social ecology approach, which examines how social actors are embedded in complex, multi-level social systems shaped by dynamic and historical processes that result in differential access to resources (Peacock, Gladwin, & Morrow 1997). In more affluent countries, liberal feminist thought emphasizing the gendered division of labor and equal opportunity complements this (for instance, see the U. S. studies reviewed by Enarson, 2012). In contrast, studies in lower- and middle-income countries are grounded in the nexus of development and gender equality, inviting more attention to a global political economy shaped by gender, race, and class, and the implications for people's agency and rights (e.g., Bradshaw, 2013). The decade also brought increased focus on the cross-currents of race, class, sexuality, and gender, specifically including more feminist theorizing highlighting cross-cutting racial and sexual orientation privilege as social forces in disasters (e.g., Luft, 2016).

Feminists grounded in philosophy and environmental studies, in turn, challenged embedded assumptions about gender, power, and the natural world (Arora-Jonsson, 2011; Banford & Froude, 2015; Cuomo, 2011). Feminist political ecologists introduced a focus on the nexus of gender, disaster, and climate change (e.g., Alston & Whittenbury, 2012; Buechler & Hanson, 2015). A gendered lens on human security was also used to illuminate gendered risk factors in disasters (Dankelman, 2010; Enarson, 2014; Ray-Bennett, 2016). As in disaster studies generally, the dominant social vulnerability lens of the past was questioned, often replaced by a gender justice lens (e.g. Enarson, 2009; Fordham, 2011). This work was complimented by an emerging resilience framework highlighting the agency and capacities of people in disasters. Recent examples include findings from the Christchurch, New Zealand earthquakes (MacManus, 2015); comparative studies of women's long-term recovery (Drolet et al., 2015); strength-based analysis of tsunami widows in India (Jude & Miriam, 2013); and research on early warning systems reflecting women's social networks in Indonesia (Mulyasari & Shaw, 2013).

Taken as a whole, these theoretical and analytical shifts imply a continuing trend toward:

- a more nuanced and situational understanding of gender;
- intersectional analyses of race, class, gender, and sexuality;
- examination of male as well as female experience;
- identifying institutionalized practices maintaining gender domination;
- a focus on self-determination and self-organization;
- studies of new and shifting hazards arising from climate change and conflict;
- illumination of the connection between gender equality and disaster prevention;
- exploration of gender and social justice from a rights-based perspective.

New thinking was also apparent in research design, including much-needed shifts toward more geographically diverse research sites; quantitative and secondary data collection and analysis; population-based representative studies; longitudinal, comparative analyses; and policy analysis. Community-led research assumed an even more central role. Responding to urgent knowledge gaps, researchers and activists in Haiti, for instance, saw glaring gaps in the "official" post-earthquake story on women and compiled an alternative "shadow" post-disaster needs assessment (Horton, 2012). Other research collectives emerged after Hurricane Katrina in 2005 (Weber & Peek, 2012), New Zealand's 2010 and 2011 earthquakes (Du Plessis, Sutherland, Gordon, & Gibson 2015), and in Japan after the 2011 earthquake, tsunami, and nuclear disaster (Steele & Osawa, 2013). While not always leading to peer-reviewed publications, these

initiatives were consequential in the evolution toward more participatory disaster research.

11.2 Key Empirical Findings

In this section, we present key empirical findings in four areas of ongoing concern in the area of gender and disasters. These areas, identified based on our survey of the literature, are: mortality, health, and well-being; gender violence; family and work; and grassroots change. We synthesize important work to further understanding of these topical areas, to elucidate patterns across disasters and global regions, and to help identify where more research is needed.

11.2.1 Mortality, Health, and Well-Being

Disaster morbidity and mortality are influenced by gender norms, the gendered division of labor at home and work, and gendered social structural and demographic patterns, among other factors, thus positioning women and men, and boys and girls, in different spaces when disasters unfold (Alexander & Magni, 2013; Haynes, Handmer, McAneney, Tibbits, & Coates, 2010; Wood & Bourque, in this volume). The 2004 tsunami, in which three times more women than men died in some Sri Lankan villages, remains an especially vivid example of how women's everyday lives may lead to deadly outcomes (Hyndman, 2008). Specifically, women suffered higher mortality rates due gendered skill sets and consequent gendered division of labor in local economies, physical location at the time of the tsunami, caregiving roles, and traditional dress that limited mobility.

Disaster-related suicide rates may be higher among men, as was the case among middle-aged males in a longitudinal study of Japan's 1995 Kobe earthquake (Nishio et al., 2009). High male out-migration and increased suicide were reported among male farmers in drought-stricken parts of Australia as well (Alston & Kent, 2008). Although all genders may experience emotional turmoil after disaster, this can be expressed very differently (see Dell'Osso et al., 2011, for the case of youth affected by the 2009 L'Aquila, Italy, earthquake). For example, when women express more post-disaster emotional stress, researchers acknowledge it may reflect individual coping and post-disaster conditions as well as the gendered order of their world, as Parida (2015) reports in a large-scale study of Himalayan flooding. In a meta-analysis of 17 studies, African American women affected by Hurricane Katrina were found to be profoundly affected physically and emotionally despite strong faith and high levels of cultural support (Laditka, Murray, & Laditka, 2010).

De Alwis (2016) used psychoanalytic theory and ethnographic methods to challenge stereotypes of male alcoholism after the 2004 Indian Ocean tsunami, examining how Sri Lankan widowers coped with their grief in a recovery period complicated by armed conflict. A U.S. study of police who responded to the 9/11 attacks found that female emergency responders expressed nearly double the rates of probable post-traumatic stress disorder as their male counterparts (Bowler et al., 2010). Men also may be more protected by occupational subcultures than their female peers, as reported in a study of resilience and protective mental health among a sample of Italian emergency responders (Pietrantoni & Prati, 2008). In the U.S. after Hurricane Sandy, women reported more fear of future events than men did, but there were no apparent gender differences in sources of support (Hamama-Raz et al., 2015). A study on the experiences of Australian men still in distress five years after the 2009 bushfires found that men frequently spoke of their fear and anxiety, and the barriers they felt to reporting these emotions (Parkinson & Zara, 2016).

Gendered studies of post-disaster health highlight negative health consequences for women in particular (Richter, 2011). In Iran, women's health declined after disasters due to exposure to environmental hazards, lack of safe water, unhealthy living conditions, and a myriad of other factors; many developed chronic diseases and had unwanted pregnancies

(Sohrabizadeh Tourani, & Khankeh, 2016; and see Urrutia et al., 2012, on Haitian women's post-quake health). Reproductive health care is frequently a subject of concern on the ground and in gendered disaster health research, including negative maternal outcomes when infants are exposed to disaster trauma in utero (Maslow, Li, Stellman, & Brackbill, 2016) and lack of access to birth control and maternal care through the emergency period. After Hurricane Ike, African American women in particular had trouble accessing birth control (Leyser-Whalen, Rahman, & Berenson, 2011).

11.2.2 Gender Violence

Since the first edition of the *Handbook of Disaster Research* was published in 2006, evidence has accumulated about increases in violence following disaster (see Phillips & Jenkins, 2016, for an international review). Recent work includes Nasreen's (2010) finding of increased violence in a study involving 600 women from three flood-affected regions of Bangladesh. Chan and Zhang (2011) reported on both physical abuse and "psychological aggression" against women after the 2008 Sichuan earthquake. In Haiti, girls and women endured high levels of sexual violence long before the 2010 earthquake, including deeply embedded structural violence (Schuller, 2015). Once displaced into survivor camps, however, their temporary homes lacked doors that locked or adequate lighting outside, sometimes leading to multiple rapes; others were reportedly forced into sexual negotiations to secure food (Horton, 2012). Lack of employment and diminished social support networks after the earthquake, along with men's controlling behaviors, also help explain increased reports of gender violence against Haitian women and girls (Weitzman & Behrman, 2016). Further, growing evidence suggests that women and girls, and sometimes boys, are at extreme risk of sex trafficking and sexual exploitation in disaster aftermaths (Standing, Parker, & Bista, 2016).

Research has documented that post-disaster gender-based violence also occurs in affluent parts of the world such as the U.S., Japan, Australia, and New Zealand (see Houghton, 2009; Parkinson & Zara, 2016; Saito, 2012, respectively) and among more affluent populations; following Katrina, increasing numbers of mothers and professional women sought help after experiencing violence (Jenkins & Phillips, 2008). Anastario, Shehab, & Lawry (2009) reported that one in five women in their study after Hurricane Katrina were victims of post-disaster sexual violence, a finding consistent with earlier studies of displaced Katrina survivors in trailer parks. New Orleans seemed a city "raining men" as male-dominated response and reconstruction intensified and families in many neighborhoods were forced to leave (Hartman, Dudas, & Day-Sully, 2016); this created an environment some women experienced as threatening (Schippers, 2015). Spikes in domestic violence were recorded following the BP oil spill on the U.S. Gulf Coast, particularly affecting single women living in poverty, unemployed women, those without health insurance and directly affected by the spill, and women whose abusers were unemployed due to the oil spill (Lauve-Moon & Ferreiral, 2015).

Violence may well occur in a climate of psychological distress, anger, and substance abuse, but domestic violence research has consistently shown that these are not the direct causes of violence. Rather, strongly felt values and gender ideologies supporting the notion of men controlling women (and non-conforming men) are at the core of the violence (Sety, James, & Breckenridge, 2014). Those on the front lines of disaster response often are aware of post-disaster domestic violence and the need for services. Research has documented that, even when shelters operate under serious constraints, antiviolence activists are resourceful and innovative in their contributions. For instance, after Hurricane Katrina, a New Orleans-based battered women's shelter continued offering services after having to completely restructure and recover after the flooding and a fire destroyed their building (Brown, 2012; Brown, Jenkins, & Wachtendorf, 2010). Domestic violence advocates in this shelter put their losses aside and

shared resources to protect women in the shelter while keeping staff employed.

While researchers generally have not yet sought information about disaster-related gender violence against men or boys, Fothergill and Peek (2015) found that some boys displaced to new and unfamiliar communities after Katrina dealt with physical bullying in schools and some girls and boys dealt with verbal abuse at the hands of their peers. Bergin (2008) found that men of color were more likely to face violence at the hands of law enforcement and from fellow armed citizens following Katrina.

11.2.3 Family and Work

The expansion of women's labor after disasters has been well-documented. Paradoxically, post-disaster recovery initiatives specifically geared to women may further tax women's time and energy with counter-productive effects on gender relations and their economic recovery (see Bradshaw, 2009, on the "feminization of responsibility" after Hurricane Mitch in Nicaragua). Similar concern has been voiced around climate adaptation efforts specifically geared toward women (Cuomo, 2011; MacGregor, 2014). Recent research suggests that disaster-related family responsibilities increase among youth as well, generally in accordance with traditional gender norms (Tobin-Gurley et al., 2016).

Household conflict is not uncommon after disaster. In drought-striken Australia, rural women's increased financial responsibility contributed to marital breakdown (Whittenbury, 2013). Parenting norms across generations may also diverge, as was the case for displaced mothers caring for children and elderly parents in the Katrina diaspora (Reid, 2011). After Japan's 2011 "triple disaster," Morioka (2016) found that the pull of employment and financial stability on fathers surpassed their concerns about children's exposure to radiation, creating familial conflict about relocation. A similar disparity was found in a quantitative Indian study in which men were found to be less aware of hazards and less engaged in disaster reduction practices relative to women (Roy, Pal, & Pradhan, 2014).

Findings vary on gender and risk perception (Becker, 2011). Attitudes about emergency preparedness may depend on risk awareness and tolerance, prevailing gender norms, hazard type, and other factors (Kano, Wood, Bourque, & Mileti, 2011). McCright (2010) noted U.S. women's higher levels of climate hazard awareness, while a study from Atlantic Canada found men more proactive in reducing risk of climate-driven flooding and storms (Vasseur, Thornbush, & Plante, 2015).

Gender-focused research on post-disaster displacement often yields findings that converge with those from gender and climate research. For instance, female climate migrants who leave home due to environmental degradation, as well as women forced out of their communities due to sudden-onset disaster, are both vulnerable to violence. A growing body of research demonstrates that climate migration is a gendered adaptation strategy, more often available to men than women and with diverse effects. While climate-driven migration is generally found to undermine women's economic security and increase their family responsibilities when men leave (Detraz & Windsor, 2014), Branco (2009) reported that rural women in Brazil from drought-stricken villages felt empowered by the new lives and livelihoods they built when migrating to nearby cities.

In the U.S. after Katrina, single mothers displaced from their former support networks became solely responsible for negotiating the safety, nutrition, and educational circumstances of their children in unfamiliar neighborhoods and school systems (Tobin-Gurley et al., 2010). Displacement was difficult, especially for older women whose sense of place was shattered (Roberto, Henderson, Kamo, & McCann, 2010). Low-income African American women struggled for housing and employment in the Katrina diaspora (Pardee, 2014), sometimes finding that state policies worked against the cooperation and sharing relied upon by their complex families and households (Fussell, 2012; Sterett, 2012). Yet, women also

found that family ties and shared culture sustained them (Browne, 2015) along with shared resources, food, and money (Litt, 2012).

Gender influences local and global economies differently in times of stability and instability, as international data have long indicated. For women, home-based work, the burdens of seeking relief resources, extended family care, gender bias in reconstruction work, and structural unemployment due to cutbacks in heavily female sectors all reduce income and expand unpaid labor. The dependence of many rural women on sustainable natural resources also carries special weight. In climate-stressed communities, everyone struggles but not equally or in identical ways; for instance, gender-typed responsibilities especially burden women who care for those suffering from vector-borne epidemics (but see Kuriansky, 2016, on young men's need for support on Ebola burial teams).

Disaster reconstruction efforts generally neglect women's call for income support (Bhatt, 2016) and the particular demands upon them. After Hurricanes Katrina and Rita in 2005, for instance, single mothers missed more work days than men, likely due to limited social support in the household, resulting in much higher rates of productivity loss (Zahran, Peek, Snodgrass, Weiler, & Hempel, 2011). Economic recovery programs generally fail to address emotional needs specific to men and boys in a time of econonic retrenchment. But, because male identities and livelihoods are so tightly interwoven, livelihood loss often diminishes men's sense of self. Ritchie's (2012) interviews in fishing communities in Alaska hit by the Exxon Valdez spill revealed the high emotional toll men paid as a consequence of economic, environmental, and cultural loss. Research after Katrina demonstrated how the same disaster may affect groups of men and women differently, based on class, race, and other social and economic factors. For instance, incomes rose after the storm for men, mostly white, in sales and professional office positions (Willinger & Knight, 2012), while undocumented Hispanic male workers were subject to exploitation and abuse (Donato, Trujillo, Trujillo-Pagan, Bankston, & Singer, 2007) and many thousands of African American women teachers and others were laid off (Fothergill & Peek, 2015).

Researchers offered yet more evidence of the elasticity of gender relations post-disaster, in the home and beyond. With more longitudinal data now available, long-lasting shifts in power after disaster are found to be very rare, especially when stereotypic disaster relief and recovery projects reinforce rather than challenge structural gender privileges. Revisiting an earlier study focused on women, Bradshaw (2016) offered a trenchant analysis of rural Nicaraguan men responding to potential gender shifts. Putting men's voices forward yielded a more complex narrative of why and how men may accept or resist the vaunted post-disaster "window of opportunity" for more egalitarian relationships and structures. Clearly, a deterministic one-dimensional lens fails us in understanding the complexity of relationships between women and men in periods of crisis (Cupples, 2007).

11.2.4 Grassroots Organizing

Diversity in women's disaster-relevant organizing was evident in research from around the globe. Ikeda (2009), for instance, pointed to women's traditional community leadership in Bangladesh to explain their crucial role in community-based disaster risk reduction. Broad-based community development projects were enhanced by engaging young women in risk reduction, as Fordham (2009a) wrote of a PLAN project in El Salvador. Most grassroots activism, however, arose after the fact in response to gender violence, economic exploitation, lack of affordable and safe housing, inattention to women's maternal and personal health needs, gender bias in financial compensation policies, and exclusionary practices in recovery programs (Goldenberg, 2010; Pyles & Lewis, 2010).

Local efforts most often emerged through pre-existing women's activist groups, and at times powerful governmental or nongovernmental partners supported them. Fisher's (2009)

study of grassroots organizing around domestic violence in post-tsunami Sri Lanka is one of many examples. The case of Haiti also demonstrated the significance of strong pre-existing anti-violence networks when activists responded to the 2010 earthquake (see Schuller, 2015, on the work of the Commission of Women Victims for Victims). Building on their legacy as health care providers, Japanese women emerged as health activists after the Fukushima disaster who organized meetings, gathered information about radiation, submitted petitions, and used the Internet as a tool to amplify their message (Novikova, 2016). The post-disaster Japanese Women's Network for Disaster Risk Reduction united numerous women's groups in a coalition of response to gender inequalities, including for LBGTQ communities, migrants, and foreign brides.

In some cases, grassroots organizing was broad-based and rights-focused. In the U.S. following Hurricanes Katrina and Rita, numerous grassroots initiatives for recovery more sensitive to women's needs and interests emerged. These organizers included Vietnamese women of different generations, indigenous women in the bayous around New Orleans, social justice activists, African American women preserving historic space and memory, elite women, and others (David, 2017; and, for case studies, see David & Enarson, 2012). In indigenous communities where the environmental, economic, and cultural futures of men and women alike are in imminent jeopardy, the local leadership of women has been critical (Vinyeta, Whyte, & Lynn, 2016; Whyte, 2014).

The disaster work taken up by India's Self-Employed Women's Network, a union of women in India's dominant informal sector, illustrated how women's economic need prompts social action (Lund & Vaux, 2009). Writing from the Caribbean, Soares and Mullings (2009) traced the multifaceted efforts of *Women on the Move*, a labor-based network seeking fair economic recovery following a volcanic eruption in Montserrat. Other efforts focused on the convergence of disaster and armed conflict, for example in Sri Lanka when women's lives were upended by both civil war and the 2004 tsunami and relief efforts failed to respond to both (Hyndman, 2008).

New ways of thinking about "man-made" disasters and men's pro-feminist responses to these events suggested the potential power of alternative, progressive masculinities to help reduce disaster and climate risk (Pease, 2016). Men's grassroots activism around gender and disaster risk reduction was noted by Genade (2016) in her examination of men's groups long active against gender violence. In the Australian state of Victoria, in the aftermath of the devastating bushfires of 2009 and informed by research on men's losses and responses, an innovative Gender and Disaster Task Force arose. Through this task force, women health activists and men in fire service roles collaborated to produce gender-responsive policy guidelines and disaster management, laying the groundwork for further steps toward gender equality and disaster risk reduction (Parkinson & Zara, 2016).

11.3 New Lines of Inquiry

As this review indicates, gender and disaster researchers over the past decade took up such long-standing concerns of disaster studies as risk perception, social vulnerability, intimate relationships, and self-organization. They also brought new perspectives and new questions to the field around the topics of queer studies, critical men's studies, and climate science, each introduced briefly below.

11.3.1 Sexual Minorities

Over the past decade, overt bias as well as social justice concerns inspired new research with lesbian, gay, bisexual, transgender, queer or genderqueer, intersex (LGBTQ), or third gender communities and among those not claiming gender. Examining male risk and exposure to urban flooding, for instance, Gorman-Murray, McKinnon, & Dominey-Howes (2016)

documented exclusionary practices in disaster response experienced by a small sample of lesbian, gay, and transgender populations in Brisbane, Australia. Similarly, Dunn (2016) highlighted the vulnerability to floods and hurricanes of gay men in New Kingston, Jamaica. These "Gully Queens," long forced into unsafe living conditions on the banks of a gully and in storm drains, were subject to violence, stigma, and discrimination at the hands of government authorities. Research from India found that the highly stigmatized *aravani* population—individuals who do not see themselves as men or women but who also do not use the term third gender—were excluded from relief systems after the 2004 Indian Ocean tsunami (Pincha & Krishna, 2009). They did not receive aid although they sustained injuries, and their families were not provided financial relief in the event of their death. In Haiti, the 2010 earthquake destroyed LGBTQ safe spaces, leaving nonconforming women subject to violence and "corrective rape" (Dominey-Howes, Gorman-Murray, & McKinnon, 2014).

In addition to underscoring amplified vulnerability, a queer studies lens also revealed a strong degree of solidarity, self-protection, and creative resilience. In the U.S., Stukes (2014) found that racial minorities, elderly, young, and the homeless within the LGBTQ community lagged in recovery after Katrina, but they also created capacity-building support networks through their faith community. Overton (2014) studied LGBTQ adolescent girls and young women in a New Orleans performance troupe who engaged in gender performances, such as putting on drag shows after Katrina. This afforded them opportunities to positively express their sexual identities even in the difficult post-disaster climate.

Following the 2010 Mt. Merapi volcano eruption in Indonesia, most *warias* (a term that comes from two words meaning woman and man) faced hostility in recovery yet were determined to help, drawing on their work in hair salons to provide haircuts and make-up services to over 200 men, women, and children (Balgos, Gaillard, & Sanz, 2013). In this same vein, Gaillard, Sanz, Balgos, and Toelupe (2016) wrote about agency and capacity among gender minorities in Indonesia, the Philippines, and Samoa. When Cyclone Evan hit Samoa, for example, the *fa'afafine* were able to switch from male to female tasks, using their multiple skills from both genders in the disaster aftermath. In turn, *bakla* youth (a gender minority in the Philippines) became valuable participants in hazard mapping projects, allowing the community to acknowledge their capacities and needs while potentially promoting inclusive development to reduce disaster risk (McSherry, Manalastas, & Gallard, 2015).

Importantly, researchers and others calling for a queer-positive lens in disaster research and practice understand the methodological challenges arising when people's identity may be illegal, misunderstood, or in flux (Rumbach & Knight, 2014). A turn toward new terminology may follow as researchers and advocates push back against binary male/female language that reinforces ways of thinking about gender that obscure critical differences.

11.3.2 Masculinities

In our 2006 chapter, we noted that very few studies inquired into gender and disaster "through the eyes of men." Today, this is no longer true. As findings reported here have indicated, however, much of the emerging research on men, boys, and disaster continues to be conducted from a traditional social vulnerability perspective. This work tends to highlight men's socioemotional needs to the neglect of their gender-based social power and available resources in crises. Shedding light on male experiences is important, and so is interrogating their privilege. Scholars have begun to bring a more critical perspective to questions about how manliness is defined, realized, contested, and changed in disasters. This new line of analysis emphasizes that gender identities are not only cultural and experienced subjectively, but reflect gender regimes specific to time and place that are embedded institutionally, including in disaster management. Turning from gender role theory to

an analysis of gender as a dynamic social system invites more critical analysis of how and why men struggle to resist and transform masculinity in periods of crisis and beyond (Pease, 2016).

Rejecting a notion of monolithic or stable male identity or universal male gender power, researchers examined fraught relationships between and among different groups of men drawing on different narratives of masculinity in emergency services and why this matters for women (Eriksen, 2014; Pacholok, 2013). In Sweden, Ericson and Mellström (2016) highlighted male mastery over core technologies as a privileged platform for dominance, also finding that this dominance was challenged by the new skill sets called for in a profession shifting from fighting fire to preventing fire through community outreach and education.

Austin (2016), reflecting on data about increased gender violence in post-Katrina New Orleans, suggested that masculine privilege was aggressively asserted precisely because this event undermined the many institutional structures previously enabling male dominance. In a post-Katrina social justice movement in New Orleans, Luft (2016) found that diverse forms of male dominance were asserted and contested, with significant responses among women to this dominance. Recent work shows disaster landscapes to be symbolically governed by heteronormative images of powerful, independent, and resourceful men, for example in disaster education and disaster imagery (Preston, 2010; Ali, 2014). Landscapes may also be literally dominated by men, especially when response activities are highly militarized or when post-disaster reconstruction jobs are dominated by men (Tierney & Bevc, 2007).

New questions arise about how male bodies and masculine subjectivities are impacted in environmental crises, and how men in all sexual and racialized communities differently interpret, respond, and engage in disaster response and reconstruction (see Enarson, 2016, for an action research agenda). Reflecting on men and masculinities is already widening the community of practice, for example in social work (Pease, 2014) and disability studies (Sherry, 2016).

11.3.3 Climate Change

The subfield is further stretched by the exponential growth of gender-focused climate research, a field to which gender and disaster research has substantially contributed. Findings from gender and climate researchers parallel many in the gender and disaster canon, especially with respect to risk perception, family conflict, health concerns, shifts in gendered labor, the risk of gender violence, adaptation to change, and migration (for excellent entry points, see Alston & Whittenbury, 2012; Terry, 2009; Mercer, Hore, Kelman, & Gaillard, in this volume). Gendered studies of climate change have shown how the deeply embedded values and practices of dominant masculinities both undergird science policy and emerging technologies (Nagel, 2015), and carry forward a dominant set of philosophical assumptions about gender and the "natural" worlds we inhabit (Moosa & Tuana, 2014). Gender and climate researchers push back with empirical data on women as effective risk managers and responders, again echoing findings from gender and disaster research.

Adapting to new climate realities is a highly gendered and contested process, as challenging as reducing the risk of disasters generally. Importantly, gendered climate studies promote more integrated and holistic approaches to risk reduction on the ground, where the lines between climate and disaster are as blurred as those across genders and other divides. A broader approach may soon help both researchers and practitioners transcend the currently isolated "two solitudes" of climate or disaster research and action (Enarson, 2013).

11.4 Future Research Needs

Our chapter in the first edition of the *Handbook of Disaster Research* urged researchers to: (1) think more about bodies and sexuality; (2) focus on girls as well as women; (3) acknowledge capacities and strengths; (4) look inside the household to examine internal dynamics; (5) think globally about international

patterns; (6) engage gender politics; (7) explore difference using an intersectional lens; (8) study and work with men and boys; and (9) collaborate with women's groups to encourage more participatory and community-driven research (Enarson, Fothergill, & Peek, 2006). A decade later, progress has clearly been made in each of these areas, even as pressing questions remain.

We offer a new set of recommendations below, first regarding data and methodology and then regarding fruitful new topical areas for exploration. First, however, we note that some of the knowledge gaps we identify arise simply from lack of translation across the world's languages. We therefore call for crowdsourced collaboration or other sustained efforts to promote multi lingual cross-learning, and for increased effort to make new findings accessible to the widest possible audience. With respect to research design, we call for more studies using the following approaches:

- Move toward more theoretically informed, empirically rigorous research. Researchers should tap into large-scale data sets to inform their work and design studies allowing for multi-site and cross-cultural research.
- Collect data on gendered processes at multiple points in time. This will help address the limitations of the cross-sectional approach generally adopted.
- Conduct more evaluation research. Organizations active in disasters need evaluation research on gender risk reduction strategies and activities to ensure that interventions work as intended or can be refined to maximize benefit for all.
- Empirical national assessments across all domains of disaster management would identify areas for action and enhance gender-responsive risk reduction. Gender concerns should be integrated into all aspects of state, federal, and tribal disaster management policy.
- Pursue gender-focused citizen science studies. By examining how gender initiatives are created, take root, bloom, or die in various contexts, future generations can learn how organizing strategies may, or may not, affect change in diverse risk environments.

We hope and expect that next generation gender and disaster scholars will strive for deeper knowledge in areas already well developed in the subfield. Based on our review of the literature over the past decade, we offer the following recommendations for further expanding the field theoretically and substantively:

- Bringing gender lenses to the study of climate change and disaster risk is an immediate need, as climate instability increases risk and vulnerability around the globe, entrenches existing power structures, and destabilizes gender relations in challenging ways.
- More explicitly, intersectional scholarship is essential to resist the characterization of gender groups as unitary populations with shared experience. Researchers should seek more specific knowledge about disaster in the lives of indigenous women and men, transgender populations, religious and cultural minorities, immigrants with different status, and those living with different (dis)abilities; seek age-disaggregated data in order to use gender analysis in their work with seniors and youth; and examine class and gender as these cut across race, racism, and racial privilege.
- Researchers should explore how women and men from a range of social locations strive for self-determination and equity in disaster contexts, examining both constraints and capacities, and the possible effects of their efforts on disaster risk at different levels.
- With respect to disasters and social change, more inquiry in more diverse contexts is needed to address such questions as: Are more gender equitable societies more resilient to hazards and disasters? Is it possible to sustain short-lived shifts toward women's empowerment in post-disaster contexts? If so, does this translate into broader societal benefits? How do people's vulnerabilities and experiences in disaster change, if at all, when more egalitarian gender relations prevail?

- More gender-specific studies are needed that move across micro, meso, and macro levels to understand the broader forces that so clearly shape diverse outcomes in hazards and disaster contexts. Theorizing these relationships at different levels of analysis is essential.
- Future research should explore the gendered dimensions of the phenomenon of "risk buildup," where risk is socially produced and amplified over time (Tierney, 2014). For example, how and under what conditions do culturally-specific gender identities and institutions influence disaster risk in diverse environments and hazard contexts? When gender relations in society are more equitable, how do indicators of disaster risk change, if at all?
- Examining disaster management practices and policies from a gender perspective is increasingly important as experience accumulates in this domain. What policies effectively support structural change toward more just and gender-responsive disaster management? How do these best address the challenges raised by race, ethnicity, age, sexualities, social class, and other structural differences? What barriers exist to women and to men, respectively, who seek or initiate change toward more inclusive and gender-just disaster management?
- More studies are needed to better understand how policies, law, and international treaties covertly or overtly privilege women, men, girls, and boys differently in different disaster contexts, and at different levels of analysis. Which international frameworks best promote risk reduction through increased gender equality and women's empowerment?
- Gaining gender-specific knowledge about how new technologies inform new disaster risk communication strategies is important, as is understanding how gendered risk messages covertly and overtly target and/or affect particular groups.
- More gender-focused work is essential on disaster prevention, mitigation, and preparedness as currently most of the findings in the subfield relate to response and recovery.

11.5 Using Knowledge to Change Practice

Academic meetings on gender and disaster topics are no longer uncommon, and practical guidance is readily available on relevant governmental and nongovernmental websites. When the Hyogo Framework for Action was revisited in 2015, regional networks of gender researchers, advocates, and activists drew on science-based knowledge as well as practical experience to advocate for focusing on women's capacities and leadership in the new Sendai Framework. Many in this far-flung community of practice now call for "smart" gender-inclusive responses (Ferris, 2013), which both protect human rights and advance shared objectives in order to reduce risk, as shown in a flood mitigation study from Sri Lanka (De Silva & Jayathilaka, 2014). In this same vein, researchers from Turkey (Özden et al., 2015) have called for a universal culture of disaster management prioritizing gender. Other positive examples abound, including a training course on emergency preparedness and reproductive health informed by research in this subfield (Zotti, Sascha, & Perez, 2016). While the ramifications of new knowledge are not always presented with the specificity needed to aid practitioners (Montano & Savitt, 2016), evidence-informed gender analysis has clearly been taken up to some degree across many domains.

As gender and disaster research is unabashedly practice-oriented (Phillips & Russo, 2012), such indicators of progress are heartening. Yet, studying disasters with a gender lens consistently reveals the negative consequences of ostensibly "gender neutral" disaster management approaches which, particularly for women and girls, effectively constitute a "double disaster" (Bradshaw & Fordham, 2014). International disaster case studies bring this to life concretely (among others, see Dasgupta, Şiriner, & De, 2010; Enarson & Chakrabarti, 2009; Phillips & Morrow, 2008; Racioppi & Rajagopalan, 2016). Clearly, disjunctures exist between gender analysis and progressive action on the ground, reading lists

and good practice guidelines notwithstanding (Berber & Dietz, 2015; Tierney, 2012). Pervasive male dominance persists in Japanese disaster management, for example, despite legal mandates calling for more female representation in core committees (Saito, 2014). In Iran, Sohrabizadeh (2016) found female pathways into lead roles in disaster management short-circuited despite women's demonstrated interest and capacity, including as economic actors in crises.

A frequent concern of the past decade was to better understand why and how disaster management organizations actually do change work cultures to promote gender and diversity in recruitment, training, and retention, as well as policy development, field practice, program monitoring, budgeting, and evaluation. Case studies highlighted numerous common failings (e.g., see Fordham, 2009b; Ginige, Amaratunga, & Haigh, 2009; and the powerful legal critique by Aolain, 2011). In addition to uncertain or contradictory goals, lack of political will, and insufficient resources, barriers to effectively bringing gender into the core of disaster management include heteronormative assumptions (Dominey-Howes et al., 2014), the exclusion of women (Mishra, 2009), and lack of attention to cultural gender norms (Castro Garcia & Zúñiga, 2009). Relief programs specifically targeting women may be resisted by women and men alike (Bradshaw, 2009); similarly, women's customary land rights may decline when these are formalized with the intention of protecting women (Veena & Kusakabe, 2015). Even when documenting failure, these findings offer essential guidance about how to advance more successful change strategies. The broad conditions and processes that normalize disaster injustice, including gender bias, must be recognized and challenged. This is essential social change work for the space and time between disasters (Bhatt, Pandya, & Delica-Willison, 2016).

What else can break the knowledge-to-practice logjam? In the academy, mentors skilled in gender analysis can help bring these findings to next-generation disaster scholars—and the inverse, for researchers can collaborate with gender scholars keen to explore issues around place, land, sustainability, climate, and risk. Dedicated scholarships to support early career gender and disaster researchers are needed, and support for climate and disaster researchers working with a gender lens. Workshops engaging gender scholars and those in disaster-related fields would be a positive step toward action undertaken by any university, department, or foundation. Experts can create training and postsecondary teaching modules around such cross-cutting themes as environmental issues, resilience, human rights, and disaster/climate risk. These issues can also be brought to the fore through social media and policy networks, testimony to elected bodies, think tanks, post-disaster investigative bodies, and other avenues in support of disaster risk reduction (Phillips, 2012). We stress the need for sustained funding, organizational infrastructure, and committed leadership to help apply gender and disaster knowledge to the challenges of our future.

11.6 Conclusion

The subfield of gender and disaster has experienced ongoing and meaningful growth over the past decade. This included stronger theoretical grounding and more diverse methodological contributions. The number of researchers using participatory methods that meaningfully engaged locally-affected women in the wake of disaster, and the emergence of more balanced investigation of the interplay of vulnerability and agency were noteworthy advancements.

Key empirical findings demonstrated that women's health and well-being as well as their lives are at elevated risk, and that negative health effects of disasters on boys and men can be anticipated, too. Exploitation and violence against women continue to be a threat in disaster situations. The findings reviewed also shed light on household dynamics, drew attention to disparate patterns of post-disaster work and community engagement, and highlighted gender patterns complicating recovery. Case studies of gender bias in disaster response systems accumulated, along with studies of women organizing

to push back against exclusion, gendered violence, and economic exploitation in disaster contexts. Our review also emphasized the new work that emerged around sexuality studies, critical masculinity studies, and climate science in the gender and disaster space. We drew the chapter to a close with methodological and theoretical recommendations for future researchers, and guidance for building a more gender-responsive academic and practice culture.

Gender and disaster scholarship continued over the past decade to both contribute to and challenge core ideas in disaster studies, including the concepts of disaster risk, social vulnerability, and resilience. It illuminated the gendered substructures of households, organizations, and communities that so strongly affect mitigation, preparedness, response, and recovery. Researchers enriched the cultural analysis of disasters by highlighting gender subjectivities and practices in everyday lives, and began to bridge gaps between climate and disaster research; they expanded our understanding of families and households in disasters; and also introduced gender as an important factor in the political economy of disasters. Concurrently, gender and disaster scholars offered new knowledge bearing on traditional concerns of the sociology of gender and allied fields, including agency and domination, gender relations and communities in crisis, gendered violence, the gendering of organizations and state practices, and environmental contexts and pressures as forces in social life.

Gender is now firmly on the agenda in disaster research, so we expect these synergies to continue. Yet, significant challenges remain. We must learn from, and share knowledge with, persons of all genders and backgrounds in those nations and neighborhoods most at risk. It is also imperative to more effectively integrate our new knowledge into practice in community organizing, development choices, preparedness guides, mitigation and adaptation budgets, emergency plans, risk maps, needs assessments, and outreach campaigns. We must strive to make gender and social justice the "new normal" in disaster risk management at all levels and across all domains. To get there, a change in leadership and ideology is necessary. The push (from academicians) toward gender-responsive disaster and climate work must be matched with pull (from government and institutional actors) to take the modest steps proposed. We leave readers with the certain knowledge that gender and disaster researchers will continue to seek partnership with practitioners and community members in the pursuit of knowledge that matters—and cautious optimism that this knowledge will be used in ways that matter.

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People with Disabilities and Disasters

12

Laura M. Stough and Ilan Kelman

Contents

While considerable research has been published on the effects of disaster on other marginalized groups, studies on the experiences of individuals with disabilities have been limited (Alexander, Galliard, & Wisner, 2012; Kelman & Stough, 2015a; Mileti, 1999; National Council on Disability, 2009). Several elements appear to have inhibited research in this area. Foremost, research on marginalized populations experiencing hazards came to full fruition just 30 years ago (see Bolin & Bolton, 1986; Blaikie, Cannon, Davis, & Wisner, 1994; Peacock & Ragsdale, 1997) and only recently has included individuals with disabilities as a group of concern (see Peek & Stough, 2010; Phillips, 2015; Stough & Mayhorn, 2013). In addition, many researchers have limited expertise as disability studies did not emerge as an academic discipline until the 1980s and related coursework addressing the social, cultural, and historical aspects of disability has been scarce (Society for Disability Studies, 2017). As a result, people with disabilities have been overlooked as a significant minority group by scholars despite the fact that more than over a billion people worldwide live with a disability (World Health Organization & World Bank, 2011). Lastly, people with disabilities are marginalized in most of the world's societies and such marginalization has occurred across millennia of history (Scheer & Groce, 1988; Stiker, 1999; Stough & Kang, 2016; Walker, 1981). Thus, the voices of people with disabilities have been only recently added to social justice movements around the world (Davis, 2006; Irvine, 2014; Shapiro, 1994).

The purpose of this chapter is to discuss research developed by several academic disciplines on the experiences of individuals with disabilities and to situate that research within the

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conceptual and definitional complexities inherent in disability studies.

12.1 Disability Defined

Research and practices surrounding disability must be carefully interpreted as the identification and labeling of disability is complex. Even within a named category of disability, individual functioning, intelligence levels, and behavioral competencies vary widely. Actually, the characteristics of people who have disabilities can be more disparate than similar (Alexander et al., 2012; Kailes & Enders, 2007). Such diversity raises the question whether it is logical to consider people with disabilities as a distinct class of individuals.

Several strong arguments are in favor of conceptualizing people with disabilities as having a shared minority status. First, the historical and widespread discrimination and mistreatment of people with disabilities is an ongoing issue of human rights (Albrecht, Seelman, & Bury, 2001; Oliver, 1986; United Nations, 2006). Historically, and across cultures, disability has been stigmatized to the extent that people with disabilities have been discriminated against, institutionalized, and even killed (Nguyen-Finn, 2012; Scheer & Groce, 1988; Stiker, 1999), and are thus socially vulnerable. Second, individuals who evidence disability are commonly regarded with disfavor and conferred a different, usually lesser, status within their own societies and governments (Mitchell & Karr, 2014; Kelman & Stough, 2015b), again augmenting their vulnerability. While the inclusion and integration of people with disabilities has considerably advanced in some societies (see Stough & Aguirre-Roy, 1997), there remain many places in the world where education, employment, and civil liberties are withheld from individuals viewed as having disabilities (International Federation of Red Cross and Red Crescent Societies, 2007). Third, a phenomenon, such as disability, needs to be described to create a common discourse about the phenomenon. Pragmatically, the construct of disability must be defined and conceptualized so that inequities and barriers can be recognized and addressed effectively.

Disability is both a social construct and a cultural construct in that different societies conceptualize disability in different ways (Lauber & Rössler, 2007; Walker, 1981). For example, dyslexia is considered a learning disability in the U.S. but may not be identified nor problematic at all in South Sudan or Afghanistan, which have low literacy rates. Disability is also labeled differently across societies. For example, "learning disability" in the U.S. entails differences in learning not attributable to intellectual functioning, whereas in the U.K. the term "learning disability" is equivalent to the classification of "intellectual disability" as used in the U.S. Together, these differences in definitions and classifications affect the prevalence and incidence of disability reported across societies and time, as well as muddle the international conversation regarding disability.

Part of the current complexity has arisen due to changes from a deficit or "medical model" conceptualization to a "social model" of disability (Oliver, 2004; Shakespeare, 2006). In the medical model, disability is equated with illness, just as would be cancer or strep throat: The classification and severity of the disability is diagnosed and treatment recommendations follow the diagnosis. There are numerous counterarguments to the medical model perspective including that disability cannot be cleanly equated with illness, that treatment and education should follow function rather than diagnosis of disability, and that variation within classification of disability is considerable, rendering traditional labels inadequate. In contrast, the "social model" of disability argues that society itself creates physical, economic, educational, and cultural barriers that give rise to the experience of disability (Oliver, 2004; Shakespeare, 2006). For example, people with disabilities face barriers when using most transportation systems, in finding accessible housing, and in seeking employment (World Health Organization & World Bank, 2011). Disability is thus viewed as arising from the interplay between the environment and the individual, not as an individual

abnormality, which is the perspective of the medical model.

The World Health Organization (WHO, 2001) uses perhaps the most encompassing definition of disability, the International Classification of Functioning, Disability, and Health (ICF), which is more aligned philosophically with the social model. In the ICF definition, disability is conceptualized as the result of the interaction amongst impairment in body structure or function, limitations in specific activities, and resultant restrictions in social participation (WHO, 2001). Nevertheless, the definition is complex, presents measurement challenges, and is not consistently used across countries (Imrie, 2004; Wiegand, Belting, Fekete, Gutenbrunner, & Reinhardt, 2012).

Elsewhere around the world, a large number of classification systems for disability exist in addition to the previously described WHO definition and include those described by the American Psychiatric Association, the Australian Disability Discrimination Act of 1992, the Law of the People's Republic of China on the Protection of Disabled Persons of 1990, and the Indian Persons with Disabilities Act of 1995. Each of these organizations or acts define, classify, and count disability differently. Given that differences in classification exist not only across countries, but also within national boundaries, an individual may be considered to have a disability under one of these definitions, while not qualifying under another (WHO, 2011).

Adding to the definitional challenge is the emerging usage of "individuals with functional and access needs" within the emergency management field in the U.S (Davis, Hansen, Kett, Mincin, & Twigg, 2013). The functional needs-based approach, first defined by Kailes and Enders (2007), uses a five-part taxonomy of communication, medical health, independence, supervision, and transportation disaster-related needs and is referred to as the C-MIST definition of functional and access needs. The C-MIST was adopted by the U.S. Federal Emergency Management Agency [FEMA] (2010) in the National Response Framework (FEMA, 2010) wherein FEMA defines "Functional Needs Support Services" (FNSS) as "services that enable individuals with access and functional needs to maintain their independence."

The FNSS approach encompasses not only the needs of people labeled as having disabilities, but others as well (Davis, Hansen, Kett, Mincin, & Twigg, 2013; Kailes & Enders, 2007). For example, ramps into shelters assist elderly people who cannot use steps as well as assist parents using strollers. Augmented communication systems support people who are deaf and additionally those with hearing difficulties but who do not use hearing aids. An advantage of the FNSS definition is that it pragmatically focuses on the environmental and social barriers which must be eliminated to ensure equitable treatment of individuals with disabilities in disaster. The conceptualization also aligns theoretically with the social model of disaster.

There are several difficulties with the use of the FNSS definition. As the definition covers additional populations, such as the elderly, children, and prisoners, the particular needs and experiences of individuals with disabilities can be obscured. Moreover, the FNSS definition has not been adopted by governments outside of the U.S., nor is the definition used outside of emergency management circles within the U.S. The definition thus has had limited utility for disaster researchers as the construct does not pertain exclusively to people with disabilities. Thus, existing demographics or research on disability cannot be simply equated to apply to FNSS populations. However, it is a highly pragmatic approach in that it focuses on the actions emergency personnel must take during disasters to accommodate people with disabilities and others with functional or access needs.

Despite the challenges of defining and classifying disability, people with disabilities represent between 10 and 20 percent of the population in most countries, depending on how disability is diagnosed and registered within that particular country (WHO, 2011). Disability prevalence also increases with age: For example, in 2010, 36.7% of those 65 or older in the U.S.

indicated a disability impacted their activities of daily living (Houtenville & Ruiz, 2011). Age is also associated with functional activity measurement in that as adults age they are more likely to report needing assistance with personal needs (Administration on Aging, 2013) as well as in processing information about disasters (Mayhorn, 2005). However, age cannot be used as a proxy substitute for disability measurement without qualifiers as some elderly adults are quite able to take independent actions in disaster, while others might need substantial support in order to do so (Fernandez, Byard, Lin, Benson, & Barbara, 2002; Stough & Mayhorn, 2013).

12.2 Research on Disaster and People with Disabilities

Few studies examined the needs of people with disabilities in disaster before the 1980s. Over the following several decades, relevant research emerged from within several different disciplines, but with little overlap between these disciplines. To illuminate these distinct lines of research, this review is divided into the following sections according to academic genesis areas; 1) disaster-focused research, 2) mental health, 3) epidemiology and public health, and 4) disability studies. Within these subsections, several seminal studies are summarized in detail.

12.2.1 Disaster-Focused Research

Disaster scholars have repeatedly commented on the scarcity of research on people with disabilities, despite the evident vulnerability this population has to hazards (see Alexander et al., 2012; Mileti, 1999; Tierney, Petak, & Hahn, 1988). Disaster research which included disability status as a variable did not emerge until the mid-1980s and was led by sociologists. In an early study, Tierney et al. (1988) examined the effects of earthquake hazards on individuals with disability. The authors noted that, prior to their study, "both researchers and those responsible for natural hazards policy and planning have virtually ignored those millions of persons whose physical capabilities differ from those of the general population" (p. 1). A lack of accessible building egress routes was reported in the 1983 Coalinga, California earthquake. The researchers argued that individuals with disabilities should be able to cope adequately with earthquakes given appropriate modification of the built environment and an increased level of personal emergency preparedness. Towards this goal, the researchers introduced the concept of "functional challenge" (a concept which June Isaacson Kailes would later expand upon) as a basis for describing various barriers which individuals with disabilities face during disaster.

In another early study, Parr (1987) investigated the effect of disasters on individuals with disabilities in New Zealand. Civil service agencies reported having limited knowledge and little urgency about preparing for the needs of individuals with disabilities in disaster. Conversely, members of organizations working with people with disabilities reported that emergency planning was of great necessity for their clients. None of the individuals with disabilities interviewed in the study reported having emergency preparedness plans, although they expressed concerns about their safety in emergencies.

A study of survivors of the 1989 Loma Prieta earthquake in California found that people who had restrictions in physical movement did not experience increased exposure to earthquake hazards. During the earthquake, more than two-thirds of the respondents took protective action (Rahimi, 1993). Respondents were well aware of their home environments and potential obstacles that had to be negotiated within them. In another study, Rahimi (1994) conducted simulation experiments on the abilities of manual versus motorized wheelchair users in negotiating earthquake-related obstacles. Users of powered wheelchairs (which are larger) had more difficulties negotiating obstacles and their users often had to seek alternate escape routes.

Wisner (2002) examined the intersectionality of disaster and disability, pointing out that disasters often cause disability, as well as casualties among people with disabilities. He took issue

with the biomedical model of disability, which ignores the barriers created in built and social environments. Wisner (2002) also explained that recommendations for people with disabilities were typically aimed at caretakers, rather than towards individuals themselves, further contributing to the perception of people with disabilities as passive recipients of care, rather than potential participants in disaster risk reduction.

Van Willigen, Edwards, Edwards, and Hessee (2002) focused on the experiences of individuals with physical disabilities, mobility impairments, and sensory impairments during Hurricanes Bonnie, Dennis, and Floyd. Households of people with disabilities were found to be less likely to evacuate in advance of hurricanes and reported needing more assistance. Some respondents with disabilities lived alone and had either hearing or visual impairments and evacuation orders were not communicated in a way that were accessible for them. Some respondents also believed public shelters did not have needed disability-related accommodations, which disaster scholars confirm is often the case (Twigg, Kett, Bottomley, Tan, & Nasreddin, 2011). Respondent households with disabilities also were found to have greater housing losses and more costly property damages.

In a study of the 2011 Tokoku-oki earthquake and resultant tsunami, Brittingham and Wachtendorf (2013) examined differential impacts for people with disabilities in three Japanese prefectures. They found disparate information, material disaster resources, and disaster-related services at different shelters and temporary housing environments. Displaced survivors housed in general population shelters had better access to information and material resources than did people with disabilities staying at social welfare shelters, which were designated for people requiring specialized care or services. Even when individuals with disabilities were housed within a general population shelter, resource disparities persisted, for example, mats and toilets were often not accessible for people with disabilities and service providers often did not have training to appropriately assist people with disabilities. Finally, people with disabilities had difficulty in reconnecting with their social services post-disaster.

In sum, research conducted by disaster researchers has explored how construction, evacuation, emergency response, and sheltering differ for individuals with disabilities. Without exception, this work has identified inequities in dealing with disaster and how these inequities differentially and negatively affect people with disabilities. Research questions, designs, and sample sizes have varied greatly from study to study and thus this body of research is markedly scattered in focus.

12.2.2 Epidemiology and Public Health Research

Epidemiologists and public health researchers have conducted data analyses on large data bases to identify how people with disabilities are differentially affected by disasters. Most saliently, people with physical disabilities, limited mobility, or mental illness have been found to die at higher rates in disasters (Chou et al., 2004; Osaki & Minowa, 2001). Chou et al. (2004) found individuals with physical disabilities had higher mortality risk during the 1999 Taiwan earthquake, although after adjustment for other socioeconomic variables, mortality differed only in individuals with moderate physical disabilities. The researchers suggested that individuals with more severe disabilities tended to receive care in nursing homes or long-term care facilities, which have stricter housing codes in Taiwan. Also noted was that physical disability, mental illness, or poor health status might have prevented individuals from effectively evacuating after the earthquake. The Osaki and Minowa (2001) study found people with "physical handicaps," including bedridden elderly, physical disabilities, and intractable diseases, were 5.6 times more likely to die in the 1995 Great Hanshin-Awaji earthquake. These empirical studies are supported by reports from the field: For example, none of the 700 people with post-polio paralysis on an island in the Bay of Bengal survived the 2004 tsunami as they were

unable to evacuate to a safe place in the hills nearby (Hans et al., 2008). Among the deaths related to Hurricane Rita in 2005 were 23 nursing home residents in the U. S. with mobility, health, and communicational disabilities who had evacuated in a bus, which caught fire. The driver and six staff members, none with disabilities, all survived (Houston Chronicle, 2005).

A number of studies by public health researchers have examined emergency and evacuation preparedness in individuals with disabilities. Several of these studies have used data from the Behavioral Risk Factor Surveillance System (BRFSS), which collects data annually from over 400,000 U.S. residents about their health-related risk behaviors, chronic health conditions, and preventive services use, making it the largest continuously conducted health survey system in the world. An analysis of data from respondents to the 2006–2007 BRFSS survey (Smith & Notaro, 2009) found only 25.8% of people with a disability believed they were "very prepared" for an emergency while 20.7% reported not being prepared at all. Another study based on BRFSS data found those with fair to poor health were less likely to have emergency preparedness items than others, yet were more likely to have a 3-day supply of medication (Bethel, Foreman, & Burke, 2011). However, the same study found individuals who used special equipment, such as canes or wheelchairs, were more likely to have an emergency evacuation plan in place. A study of BRFSS data from the greater New Orleans area collected before Hurricane Katrina (McGuire, Ford, & Okoro, 2007) found almost one-third of individuals aged 65 or older had a disability, as well as lower income and education levels, and tended to rate their health as only fair or poor. The results illustrate that multiple categories of social vulnerability often intersect with disability, an observation also made by other scholars (e.g. Peek & Stough, 2010; Phillips & Morrow, 2007).

Other studies on evacuation behaviors of individuals with disabilities have focused on specific geographic locations, but with relatively smaller samples. Spence, Lachlan, Burke, and Seeger (2007) found individuals with disabilities who had evacuated from Hurricane Katrina were more likely to prepare an evacuation kit in advance of the storm, but less likely to have an evacuation plan in place. Individuals with disabilities engaged in less information-seeking about the ongoing disaster than others, although they relied on much the same informational sources, for example, television, telephone, and personal contacts. A study of Southeastern Pennsylvania households which included a person with a disability (Usher-Pines et al., 2009) similarly found these households more likely to have an evacuation kit prepared, identify an emergency shelter, and to have an arranged meeting place should evacuation become necessary. While these households were equally as likely as households without disabilities to have an evacuation plan, the authors point out that, given the additional support needed by family members with disabilities, a greater percentage of these household should have had emergency provisions in place. An investigation of the relationship amongst mental health, physical health, disability status, and disaster preparedness in people in Los Angeles County (Eisenman et al., 2009) found individuals with poorer levels of health and with mental illness were less likely to have household preparedness plans or emergency communication plans. The study found no significant difference in personal preparedness or communication plans between individuals with and without disabilities. In sum, these four studies suggest that individuals with disabilities tend to be just as, or in some aspects, more prepared for evacuation than are people without disabilities.

Over 20% of individuals with a disability require assistance with activities of daily living (Brault, 2012), usually from a paid home health care aide or unpaid family member. However, a survey of home-care aides in New York found most (57%) would be unwilling to report to duty at their client's home during a disaster, while 62% reported having competing obligations that would make reporting to duty difficult (Gershon et al., 2010). In a second survey, people with cognitive and/or physical disabilities who received personal assistance services from a paid

provider were interviewed (Gershon, Kraus, Raveis, Sherman, and Kailes (2013). Few had talked with their personal assistant about what to do in the case of an emergency. Although most of the sample had previously experienced a large-scale emergency, less than a third had made basic emergency preparations, such as a go-bag or emergency supplies, and less than half had an emergency plan at all. Similarly, a study of disaster preparedness among older Japanese adults with long-term care needs and their family caregivers who had experienced the 2011 Great East Japan Earthquake found the majority had no concrete plans for evacuation and those caring for adults with dementia were less likely to have a plan (Wakui, Agree, Saito, & Kai, 2016). Together these studies illustrate that leaving evacuation preparedness in the hands of family members and caretakers is not a panacea for people with disabilities in disaster: Even those caring for individuals with significant needs might fail to prepare.

Some promising practices for changing levels of preparedness in caregivers have been documented. For example, Bagwell et al., (2016) provided parents of children with special health care needs with disaster supply starter kits and educational materials on disaster preparedness. Six to ten weeks later, a significant number of caretakers reported they had added supplies to their kit, completed an emergency information form for their child, a fire escape plan, arranged a meeting place outside the home, and communicated with their power company the need for quick return of electricity in the event of an outage because of their child's special needs. However, more research needs to be conducted on interventions effective in increasing the preparedness of individuals with disabilities and their families.

12.2.3 Mental Health Research

A large and growing number of studies from the disciplines of psychiatry and psychology have studied the mental health effects of disasters, foremost the development of posttraumatic stress disorder (PTSD), depression, or anxiety following disaster. A more limited number have examined the effects of disaster on people with preexisting mental health disabilities. In an early study, Bromet, Schulberg, and Dunn (1982) assessed outpatients with preexisting psychiatric illnesses living near the Three Mile Island nuclear facility during the 1979 disaster. When the group's post-disaster mental health status was compared with to that of similarly diagnosed individuals who lived near a different, but unaffected, nuclear plant, no differences in occurrence of anxiety or depression was found between the two groups. Three studies have examined clinically diagnosed pre- and post-disaster mental health in institutionalized populations with preexisting mental illness exposed to disasters (Bystritsky, Vapnik, Maidment, Pynoos, & Steinberg, 2000; Godleski, Luke, DiPreta, Kline, and Carlton, 1994; Stout and Knight, 1990). Findings suggest that individuals with preexisting mental illness do not acquire new disabilities following disaster, but the studied individuals were receiving ongoing psychiatric care in therapeutic environments, suggesting ongoing psychological treatment may be effective in preventing the occurrences of new mental illnesses. Findings from two community-based studies have similarly suggested that ongoing psychological treatment may prevent additional pathology in individuals with preexisting severe mental illness following disaster (Lachance, Santos, & Burns, 1994; McMurray & Steiner, 2000).

Posttraumatic stress disorder (PTSD) is the most prevalent new mental illness found in populations without preexisting disorders following exposure to disaster (Norris et al., 2002; North, Oliver, & Pandya, 2012). Unlike other mental illnesses, the criteria for diagnosis of PTSD is conditional in that requires individuals be exposed to a defined event, specifically "to actual or threatened death, serious injury or sexual violation either through directly experiencing or witnessing the traumatic event or through learning that the event occurred to a close family member or close friend" (American Psychiatric Association, 2013). Repeated or

extreme exposure to viewing the effects of disaster, such as by first responders or medical workers can also lead to a diagnosis of PTSD (American Psychiatric Association, 2013). Several large scale studies have examined how preexisting mental illness contributes to PTSD post-disaster (North, Kawaskai, Spitznagel, & Hong, 2004; Robins et al., 1986). These studies suggest that new psychological disorders, with the exception of PTSD, rarely develop following disaster in people with preexisting mental illness. But, a pre-existing history of mental illness is a predictor for developing mental disorders after disaster, so the prevalence of post-disaster psychiatric illness in a given population will be highly dependent on pre-disaster levels of mental illness (North et al., 2012).

The terrorist attacks of September 11, 2001 led to a number of studies which examined PTSD in populations receiving psychiatric care (see DeLisi, Cohen, & Maurizio, 2004; Franklin, Young, & Zimmerman, 2002; Riemann, Braun, Greer, & Ullman, 2004; Taylor & Jenkins, 2004). No significant increase in morbidity or occurrence of new symptoms was found between patients who did or did not view the destruction. However, it should be noted that participants in some of these studies were far away from the places where the attacks took place and were not directly impacted by them. What is important in considering the validity of disaster studies on PTSD is the level and type of exposure to the event. While PTSD can and does occur following disaster, the disaster-affected person or a close loved one must have been exposed to actual or imminent physical danger, which is not the case for some survivors of disasters. Moreover, while feelings of distress or sadness are common after experiencing disaster loss, the majority of people exposed to disasters in actuality do not develop mental illness (North, 2014).

Together, psychological studies suggest that while higher rates of PTSD do occur in individuals who already have preexisting mental illness, new psychiatric disorders which are unrelated to PTSD usually do not usually develop. In addition, timely mental health support seems to alleviate much of the negative psychological impact of disaster, particularly PTSD. However, as individuals with disabilities are more likely to be exposed to hazards, psychological effects are more likely to be evidenced in this population as well as to be more severe post-disaster (Stough, Ducy, & Kang, 2017). Research also suggests that instrumental and social service supports are of particular concern for people with mental illness post-disaster and that disruption of pharmacological and therapy treatments can exacerbate the mental health status of individuals under treatment (National Council on Disability, 2009). An important line for future research is the extent to which personal, social, and disability-service systems are disrupted for individuals with preexisting mental illness following disaster (Stough, 2009).

12.2.4 Disability Studies Research

Hurricane Katrina in 2005 spawned an increase in the study of disaster by U.S. disability researchers - and also marked a genesis of research reporting direct narratives from individuals with disability. Work from these scholars was often based from a social justice stance and advocated for change in emergency management practices. Notably, a significant proportion of these investigations were conducted by individuals, including June Isaacson Kailes, Barbara White, and Glen White, who themselves have disabilities. Leading these studies was the Special Needs Assessment for Katrina Evacuees (SNAKE), which was conducted in shelters, community based organizations, and emergency operation centers throughout the affected states of Louisiana, Alabama, Mississippi, and Texas during Hurricane Katrina (National Organization on Disability, 2005). Numerous barriers and inequities in response and recovery services were reported, which affected people with a wide range of disabilities. Many shelters were found to be inaccessible, not only entrances to the shelters themselves, but also toilets, showers, cots, and public communications. In addition, individuals with disabilities were often redirected to medical special needs shelters which usually did not

permit their family members to accompany them. Some households reported that they had delayed evacuation, knowing that shelters and transport were unlikely to accommodate the disabilities of their family members. The SNAKE Report noted that mental health services were not available in all shelters and that some individuals with visual disabilities became separated from their assistance dogs or lost their canes during evacuation procedures. The Deaf and hard of hearing populations were identified in the report as the most underserved groups in shelters, the majority having no access to information about disaster-related events. The study drew attention from disability rights advocates, policy makers, as well as funding agencies which later supported additional research in this area.

The Nobody Left Behind project, directed by Glen White at the University of Kansas, has focused a series of studies on the effects of disaster on individuals with physical disabilities (Fox, White, Rooney, & Cahill, 2010; Fox, White, Rooney, & Rowland, 2007; Rooney & White, 2007; Rowland et al., 2007). One major challenge noted was the lack of emergency personnel training on, guidelines for, and interest in the needs of individuals with disabilities in disaster. People with disabilities identified (1) a lack of evacuation plans in their worksite or community, (2) being left behind when people without disabilities were evacuated, (3) inaccessible shelters and temporary housing, (4) disaster personnel unaware of relief options for people with disabilities, (5) inadequate infrastructure post-disaster, including power and public transportation systems, and (6) difficulties returning to daily routines. Respondents suggested that their survival depended most on preplanning and preparedness measures, personal networks, and help from first responders. Individuals with disabilities reported how they built upon personal strengths to cope with disaster, rather than compensating for weaknesses associated with their disabilities.

Christensen and Holt together with their colleagues, (Christensen & Sasaki, 2008; Christensen, Blair, & Holt, 2007; Christiansen, Collins, Holt, & Phillips, 2014; Koo, Kim, Kim, & Christensen, 2013; Manley, Kim, Christensen, & Chen, 2011) examined emergency egress from buildings and other public spaces by individuals with mobility impairments. While their empirical research has been conducted with simulations, rather than in actual emergencies, their scholarship points out that the construction of buildings does not consider the wide range of differences in how people mobilize and how quickly they are able to do so. These scholars point out that evacuation barriers for individuals with physical disabilities are exacerbated by building designs that assume that everyone has the ability to descend stairs, exit windows, or open doors.

Of note is the work of Barile, Fichten, Ferraro, and Judd (2006), who studied the experiences of 15 people with disabilities in the 1998 ice storm in Montreal, Canada. The majority had to remain in their houses throughout the ice storm and most lacked electricity for more than two days. Those who stayed in public shelters encountered inaccessible and crowded conditions. In one case, a woman with polio was isolated at home without electricity for four days, after which she was taken to a rehabilitation center and died a few days later.

Few studies exist on individuals with sensory impairments who have experienced disaster, in part because of the relatively low incidence of sensory impairments in the general population. Barbara White (2006) reported her experiences in a Houston shelter during Hurricane Katrina, where she assisted individuals who were Deaf and hard of hearing, then as an evacuee before landfall of Hurricane Rita. White emphasizes the inequitable access to communication experienced by the deaf and hard of hearing community, for example, translators were not available in shelters and communications from FEMA and Red Cross were not delivered in sign language or another accessible manner. In a study of adults with visual impairments, Good, Phibbs, and Williamson (2016) interviewed people who experienced the Christchurch, New Zealand earthquakes and aftershocks during 2010 and 2011. Participants described concerns regarding communication,

safety, and orienting themselves in the post-earthquake environment. Participants who used guide dogs reported needing to retrain them when landmarks changed and having to calm them during aftershocks. Familiar landmarks often disappeared post-disaster, causing a decrease in independence in self-navigation and mobility. Participants also reported hesitance in using evacuation shelters as they perceived a lack of accommodations and potential loss of independence within the shelters.

Stough, Sharp, Decker, and Wilker (2010) interviewed disaster case workers following Hurricane Katrina. Case workers reported individuals with disabilities required more intensive case management and often had multiple support needs during the recovery period. In a second study, they interviewed individuals with disabilities who had been displaced by Hurricane Katrina to determine the barriers which hindered their recovery process (Stough, Sharp, Resch, Decker, & Wilker, 2015). Findings report that disability status compounded challenges participants experienced in negotiating disaster recovery services related to housing, transportation, employment, and health.

Despite the informed focus that disability researchers have brought to the disaster field, the underpinning of much of this research has been one of advocacy rather than theory building. Disability scholars seem to agree that there are consistent inequities in disaster service delivery but their work, to date, has been on calling attention to the needs of people with disabilities. While research for change is a laudable objective, to move the disaster field forward disability scholarship needs to develop theoretically and to expand methodologically.

12.2.5 Research on Youth with Disabilities

Empirical research on children and adolescents with preexisting disabilities in disaster is particularly sparse (Peek & Stough, 2010; Ronoh, Gaillard, & Marlowe, 2015). Most of this work comes from the disciplines of psychiatry and psychology and focuses on the mental health of children with disability in disaster. Two of these studies were conducted on children with autism spectrum disasters and found some evidence of PTSD resulting from trauma (Mehtar & Mukaddes, 2011; Valenti et al., 2012). Both studies also reported behavioral problems and regression in social interaction skills following earthquakes or other trauma. A clinical psychiatric study of children with a wide range of disabilities, including cognitive, motor, hearing, visual, and seizure disabilities, reported significantly elevated levels of aggression and enuresis one year following the 1988 Bangladesh flood disaster, but these behaviors did not significantly differ from those displayed by children without disabilities. (Durkin, Khan, Davidson, Zaman, & Stein, 1993). Two studies from the field of disability studies (Christ & Christ, 2006; Ducy & Stough, 2011) have examined the role of schools in supporting children with disabilities post-disaster. Both found the role of the special educator to be particularly salient as these teachers had in-depth knowledge of students' pre-disaster behavioral and academic functioning and provided important emotional and social supports post-disaster. These few studies suggest that youth with disabilities may exhibit behavioral problems post-disaster but that their reactions to disaster may be challenging to interpret (Stough et al., 2017). Teachers may be of particularly valuable assistance to students with disabilities post-disaster. The chapter in this volume on children in disaster (Peek, Abramson, Cox, Fothergill, & Tobin-Gurley, 2017) further explores the roles of teachers and schooling in disaster.

12.2.6 Disaster as a Cause of Disability

While this review of literature has focused on the experiences of individuals with preexisting disabilities, disasters can and do cause new disabilities (Alexander, 2015; Kelman & Stough,

2015b). Injuries which often lead to lifelong disabilities include amputations, traumatic brain injuries, spinal cord injuries, and long bone fractures (Reinhardt et al., 2011). Earthquakes and tornados, when accompanied by building collapse, often lead to crush injuries followed by amputation or traumatic brain injuries. Hurricanes, tsunamis, and floods are associated with lacerations, soft tissue injuries, and bone fractures. Extended droughts can lead to famine and malnutrition, which has particularly devastating effects on the cognitive development of children. Landmines cause injuries such as amputations and head injuries, both during wartime and when not removed following them (Alexander, 2015). Disasters can be a major cause of disability in a geographic area, for example, nearly 10% of people living in the Sakarya, Turkey area reported their disability was incurred in an earthquke (Duyan & Karatas 2005).

Research indicates that physical injury obtained during a disaster increases risk for subsequent psychological distress (Briere & Elliott, 2000; North et al., 1999). Other types of support may be required as a result: A study of individuals who had health or disability-related limitations following Hurricane Ike in Texas in 2008 needed immediate assistance with mental health and with social service needs, such as for housing, employment, or financial support (Norris, Sherrieb, & Galea, 2010). Kett and van Ommeren (2009) point out that individuals with mental illness warrant high priority during humanitarian action as they are at risk of abuse or early death during crises. While direct exposure to disasters can lead to increased incidence of PTSD it should be noted new cases of other types of mental illness rarely occur as a consequence of disaster. For instance, an epidemiological study by of the suicide rates in the years immediately prior to and following the 1994 Northridge earthquake did not find an increase in suicide rates (Shoaf, Sauter, Bourque, Giangreco, & Weiss, 2004).

12.3 Limitations of Research on Disabilities in Disaster

Collectively, research across academic disciplines reveals consistent limitations. First, disability is frequently treated as a homogeneous demographic group: Few studies have examined the experiences of people who share the same functional and/or access needs. Second, while studies have found differences in mortality rates, preparedness, evacuation behaviors, and services post-disaster in particular disasters, for robustness these findings would need to be observed across multiple disaster settings. Third, most research to date has been focused on data and reports gathered at a single point in time, rather than following the long term experiences of people with disabilities across time. As research suggests that recovery from disaster is more complex and requires additional support (Stough et al., 2010, 2015), investigations of recovery are particularly of interest. Fourth, limited work has been done on how people with disabilities enact disaster risk, despite evidence they can create disaster risk reduction strategies which are not only personal and local, but structural and systemic (Stough & Kelman, 2015). Finally, as discussed at the beginning of this chapter, multiple definitions and conceptions of disability are used across disciplines and across researchers, making recommendations for people with specific functional needs problematic.

As documented in this review, research on people with disabilities has emerged from different disciplines which have different epistemological assumptions about disability and the origins of disaster. Researchers within these disciplines infrequently cross the boundaries of their own discourse communities and vary in their level of knowledge about disability as a social and cultural construct. As such, there is not yet a coherent theory underpinning most disaster and disability research. While there are

advantages to the multidisciplinary examination of a phenomena, such as disaster and disability, the fragmented nature of research has yet to coalesce into an ongoing interdisciplinary academic discussion. Investigative challenges certainly exist in conducting disability-related research, however given the disproportionate impact of hazards, increased attention from scholars towards this population is merited. Davis and Phillips in their report for the National Council on Disability (2009) provide additional recommendations for research across preparedness, response, recovery, and mitigation, as well as for research which specifically informs practice and policy.

12.4 Social Vulnerability and Disability

A theoretical approach used by disaster researchers for other marginalized populations has been social vulnerability theory which, to date, provides perhaps the most promising explanatory theory for the disproportionate effect of disasters on people with disabilities (Kelman & Stough, 2015b). Social analyses demonstrate that vulnerabilities to disasters emerge from a combination of factors, some due to individual choices but most due to wider social forces at work which create and perpetuate the vulnerability which particular individuals, groups, and communities experience (Hewitt, 1983; Lewis, 1999; Wisner, Blaikie, Cannon, & Davis, 2004). Research from scholars using the social vulnerability perspective (e.g. Morrow, 1999; Phillips, 2015; Wisner et al., 2004) have pointed out that disasters disproportionately affect some individuals who are poor, elderly, very young, migrants, minority-language speakers, and single parents. Disability status appears to stretch across these other social vulnerable categories, leading to a "layering" of vulnerability factors (Hemingway & Priestly, 2006; Peek & Stough, 2010). This view aligns with the social model of disability, which addresses the barriers which give rise to disability status (Oliver, 1986). The intersection of social vulnerability theory and the social model of disability emphasizes both that disaster vulnerability is socially constructed and that disability arises from barriers and inequities constructed by society. As a result, individuals with disabilities subsequently share a larger burden of this vulnerability, not only in disasters, but in other social milieus. Altering these conditions, which include poverty, unemployment, lower levels of education and medical care, and substandard housing will require broad systemic change (Kelman & Stough, 2015a; Phillips & Stough, 2016).

12.5 Future Directions

Research from disability studies notes that perceived disability status is often associated with stigma, creating a separate and unique barrier across societies and across cultures, which we argue augments disaster vulnerability. From interviews (Barile, Fichten, Ferraro, & Judd, 2006; Good, Phibbs, & Williamson, 2016; Kailes, 2015; White et al., 2007) and narratives (Ducy, Stough, & Clark; 2012; Kelman & Stough, 2015a; White, 2006, 2015), people with disabilities have identified stigma, discrimination, systemic barriers, and ignorance as leading to their exclusion from disaster risk reduction. Recent international human rights policy has made promising strides to recognize the marginalized status and needs of people with disabilities, but changes in practice continue to lag behind (Alexander, 2015; United Nations, 2006; World Health Organization & World Bank, 2011).

An important element in reforming practice is changing perceptions that people with disabilities are passive actors in disaster risk reduction. Scholars have documented the importance of individuals with disabilities as participants in their own preparedness, disaster risk reduction, disaster response, and disaster recovery (Alexander et al., 2012; Ducy et al., 2012; Kelman & Stough, 2015a; Rooney & White; 2007). Views of people with disabilities as helpless often occur in societies and environments which

are not inclusive and which place ownership of disability on the individual rather than removing systemic physical, communicative, and attitudinal barriers (Hemmingway & Priestly, 2006). Disability researchers and practitioners assert that people and communities need to take control of their own disaster-related activities, integrating them into development and livelihoods even if external catalysts and resources are needed for doing so (Lewis, 1999; Twigg 1999–2000; Wisner, 2002). At the forefront of the movement advocating for preparedness are researchers who themselves have disabilities (see Kailes, 2015; White, 2015). Further research is needed as part of a wider disability studies agenda on integrating people with disabilities into typical, everyday activities- of which disaster risk reduction is one. Many practitioners around the world (Disability Inclusive Disaster Risk Reduction Network, 2017; Sagramola, Alexander, & Kelman, 2014; Texas Disability Taskforce on Emergency Management, 2017) are successfully implementing training and action for emergency services working with people with disabilities. However, the effectiveness of these initiatives and how to introduce and translate for use in other countries, from Afghanistan to Zimbabwe, is yet not fully known.

A key part of disability and disaster research is exploring how people with disabilities can implement disaster risk reduction for specific hazards. For instance, how can wheelchair users best drop, cover, and hold in an earthquake or find safe places in tornadoes when in a public space (e.g. a mall or gym) or protect their wheelchairs so they are mobile immediately afterwards? How does the wildfire evacuation policy "Prepare, stay and defend or leave early" (Bushfire Cooperative Research Centre, 2017) apply to people with different disabilities? What types of cognitive support do people with intellectual disabilities need both during and following disaster? (Takahashi, Watanabe, Oshima, Shimada, & Ozawa, 1997). Climate change impacts on hazards is also a realm with few investigations on people with disabilities, despite some scholarly observations that it may place them disproportionately at risk (Boon et al. 2001; Johnson 2015). Tailoring disaster risk reduction advice for specific hazards and specific disabilities is a significant area of further research to break assumptions of homogeneity about people with disabilities and how they experience disaster.

Research on disability and disaster should be used to inform policy. Two key international policy documents are the Sendai Framework for Disaster Risk Reduction (UNISDR, 2015)—frequently mentioning disability including the important statement that people with disabilities should be involved in disaster risk reduction activities (Stough & Kang, 2015)—and the Convention on the Rights of Persons with Disabilities (United Nations, 2006). The World Report on Disability (World Health Organization and World Bank, 2011) provides implementation guidelines for CRPD, but country-specific practices and policies vary (Stough, 2015). The CRPD has influenced disability-related disaster guidelines through *The Sphere Project* (Kett & van Ommeren, 2009; Sphere, 2011) in which people with disabilities are a "cross-cutting theme." This guidance highlights the importance of family and community supports and of avoiding separation from these supports. *The Sphere Handbook* (Sphere, 2011) notes that, following disaster, communities should be rebuilt for everyone, including people with disabilities. Further implementation advice comes from the Council of Europe's Toolkit (Sagramola et al., 2014) detailing legal and ethical considerations underlying disaster risk reduction alongside seven steps toward successfully implementing "design for all," including individuals with disabilities. Policy points in these documents are typically supported by research, even if the direct research-policy connection is not always strong.

12.6 Conclusion

Researchers concerned with individuals with disabilities in the context of disaster and disaster risk reduction have, to date, focused on the inequities and disparities experienced by this

group. Attention by disaster scholars to these experiences has come mainly in the last two decades, distinctly later than similar research conducted on children, ethnic minorities, women, and the poor. This limited work, while fragmented by discipline and focus, has collectively established that disasters affect people with disabilities and their families disproportionately and negatively. We contend that both disaster and disability are constructed phenomena that societies have created - and hence which societies can likewise un-create. When the social vulnerability of one part of the population is addressed, the resilience of society as a whole is enhanced. Guaranteeing that people with disabilities can contribute to disaster risk reduction and disasters themselves, both through community design and the design of disaster-related services, will increase the rights and safety of all.

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Children and Disasters

13

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13.1 Introduction

Children's experiences with and exposure to disaster and other adverse events can plant the seeds for far-reaching physical, cognitive, and emotional changes that may not reveal themselves fully for decades (Laplante et al., 2004; Shonkoff et al., 2012). Socially, children are embedded in a number of caretaking relationships—within families, peer groups, schools, and many other organizations and institutions in their lives—that may either buffer or exacerbate the effects of disaster (Fothergill & Peek, 2015). Ecologically, children's capacity to grow and thrive is often contingent upon a supportive balance of these caregivers, networks, and institutions, all within the broader context of a child's built, natural, and cultural environment (Abramson, Park, Stehling-Ariza, & Redlener, 2010a; Noffsinger, Pfefferbaum, Pfefferbaum, Sherrieb, & Norris, 2012; Weems & Overstreet, 2008).

Children and disasters is an emerging subfield of disaster studies which has contributed to a number of disciplines—sociology, psychology, geography, anthropology, political science, and public health, to name a few—as well as to the field itself. In turn, these disciplines have shaped

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the study of children and disasters through methodological and theoretical advancements that have helped scholars better understand, develop, and expand this area of research. Indeed, these different disciplinary approaches to studying children and disasters reveal why some children may be more vulnerable, or resilient, than others to the deleterious effects of extreme events.

The study of children and disasters is particularly meaningful because the imbalance caused by disasters sheds light on many aspects of human development, as well as on the complex adaptive systems involved in protecting, educating, and empowering children. Work in this area, as with much of disaster research, represents a deeply practical undertaking: the insights gained can help families, communities, and entire nations better prepare for, mitigate, and respond to events that threaten the health and welfare of current and future generations. It also informs leaders and decision makers regarding how best to allocate resources and better engage children and their families before, during, and after disasters. The ultimate goal of much of this work is to bring together multiple actors to reduce the risks children face while preparing them to live in a rapidly changing and increasingly turbulent social, economic, and natural environment (Hayward, 2012).

13.2 Chapter Overview

Disaster studies have moved in new and exciting directions in the decade since the publication of the *Handbook of Disaster Research* (Rodríguez, Quarantelli, & Dynes, 2006). Most relevant to the topic at hand, the first edition did not offer a chapter on children and disasters, nor did it include index entries for "children" or "youth." The decision to dedicate an entire chapter to this population group in the second edition of the *Handbook* is in response, in part, to the rapidly growing number of social science studies focused on children in disaster.

In this chapter, we draw upon our review of literature on children and disasters, with an emphasis on the recent dramatic expansion in this area of study. Our overarching goal is to provide an overview of the substantive contributions of scholarship on children and disasters. Through this process, our specific objective is to identify major empirical, theoretical, and methodological trends and patterns. After reading the chapter, our hope is that others will understand the major contributions of this area of study—both for the field of disaster research and practice, and for the social sciences more generally—while also recognizing the need for new lines of inquiry and approaches.

We begin by defining key concepts that frame this chapter and by describing our approach to reviewing the literature. Next, we offer a summary of publication patterns associated with children and disasters; here we underscore the growth in this subfield and highlight how a relatively limited number of large-scale catastrophic events have served to spur research in this area. We then turn to six major waves of research that have been most prevalent over time. These include contributions to enhanced understanding of (1) the effects of disaster on children's mental health and behavioral reactions; (2) disaster exposure as it relates to physical health and well-being; (3) social vulnerability and sociodemographic characteristics; (4) the role of institutions and socio-ecological context in shaping children's pre- and post-disaster outcomes; (5) resiliency, strengths, and capacities; and (6) children's voices, perspectives, and actions across the disaster lifecycle. We also emphasize advancements in methods, theory, policy, and practice, and offer suggestions for future directions in research.

13.3 Definitions

Children and disasters are the central focus of this chapter, and accordingly, we begin by defining each in turn, with the acknowledgement that these are, and have long been, contested terms. The United Nations Convention on the Rights of the Child, which was first adopted and ratified on November 20, 1989, says that a *child* is anyone below the age of 18 (Office of the United Nations

High Commissioner for Human Rights, 1989). In the United States, the Census Bureau and various other government agencies also define children as people under the age of 18. The United Nations defines *youth* as those aged 15–24.[1]

Disaster researchers most often use the general terms "children" or "children and youth," while also differentiating between categories based on chronological age and stage of development. For example, emergency management plans may distinguish between infants, very young children, elementary school age children, and adolescents, teens, and/or youth and young adults (Peek, 2012a). In practice, as well as in social vulnerability scholarship, children are often defined as "at risk," "special needs," or a "vulnerable population" (see Thomas, Phillips, Lovekamp, & Fothergill, 2013). They are subsequently grouped together with women, racial and ethnic minorities, the elderly, persons with disabilities, the medically dependent, persons with special transportation needs, and/or persons with limited proficiency in the dominant language.

Disaster is likewise a contested term (Perry & Quarantelli, 2005). In this chapter, we follow Kreps (1984: 312) in defining disasters as "events, observable in time and space, in which societies or their larger subunits (e.g., communities, regions) incur physical damages and losses and/or disruption of their routine functioning. Both the causes and consequences of these events are related to the social structures and processes of societies or their subunits" (for further discussion, see Perry in this *Handbook*). The vast majority of studies reviewed for the present chapter focus on events that would fall into the following categories: *natural disasters* (i.e., geophysical, hydro-meteorological, and climatological events including earthquakes, landslides, floods, hurricanes, and tornadoes); *technological accidents* (i.e., hazardous, chemical, or nuclear releases, oil spills, train derailments, vehicle accidents, and power outages); *violent acts* (i.e., war, terrorist attacks, mass kidnappings); and *multiple events* or *all-hazards* (i.e., scholarship that addresses multiple hazards or that takes an all-hazards approach). It is worth noting that scholarship on school shootings—incidents that would be categorized as *violent acts*—remains largely disconnected from the children and disasters literature.

13.4 Approach and Limitations

This chapter draws upon a limited systematic review (Grant & Booth, 2009) of the social and behavioral science literature on children and disaster. The purpose of this review was twofold. First, we wanted to establish how and in what ways the subfield of children and disaster research has grown over time. Second, we set out to identify the major trends in research that have shaped the study of children and disasters as well as the broader field of disaster research.

To conduct our literature search, we used Web of Science and Social Sciences Abstracts via ProQuest. We used the keywords *children and disaster*[2] and searched across all time categories. We then narrowed the results within the databases by focusing on peer-reviewed journal articles, books, and reports published in the English language (conference papers and book reviews were excluded from the search).

The research team organized the search results by decade using the following categories: (1) publication title; (2) year of publication; (3) author(s); (4) journal/publisher; (5) volume/issue; (6) page numbers; (7) full

[1]See Fothergill and Peek (2015, Appendix A) for a discussion of the definitional complexity surrounding the terms *children* and *youth* in disaster studies.

[2]The following factors informed our final decision to focus on "children" rather than "children and youth" in our literature search and review. First, our initial searches using the terms *children and disaster* and *children and youth and disaster* returned many duplicate results. This is because many of the studies with *children and disaster* as keywords also included *youth* as a keyword. Second, the diverse use of the term *youth* limited its utility as a search term in this review (see www.un.org/esa/socdev/documents/youth/fact-sheets/youth-definition.pdf). Third, the sheer volume of results returned for *children and disaster* combined with the timeframe available to review the studies made it unfeasible to conduct a second systematic review of additional publications of youth and disaster.

citation; (8) abstract; (9) keywords; and (10) search engine. Once the publications were entered into the file, we completed a second review to eliminate duplicate publications and those studies that upon reading the abstract and full text did not actually focus on children and disasters. We also added additional columns for inventorying the studies,[3] including: (11) disaster type (i.e., natural, technological, violent acts, and multiple or all-hazards); (12) disaster event(s) studied; (13) sociodemographic variables considered (i.e., age of the child, race/ethnicity, gender, disability); (14) geographic location of the study; (15) theoretical approach; (16) methodological approach; (17) data source(s) and data type(s); (18) cross-sectional or longitudinal design; (19) disciplinary focus; and (20) comments from members of the research team.

Our approach to compiling and reviewing the literature on children and disasters offers particular benefits. First, the content indexed in Web of Science and Social Sciences Abstracts via Proquest represent a substantial portion of the peer-reviewed research published in disciplines that focus on the study of children and disasters. These databases are highly regarded in academic research and include the largest catalogue of English language disciplinary and interdisciplinary research over the past 100 years. Second, searching the terms *children and disaster* captured the most references across disciplines. This allowed our research team to better understand the breadth of research that has been published over the decades. Third, cataloguing the references on children and disaster in a data file allowed our multidisciplinary team to systematically identify changing trends and patterns in the field.

As with any review, there are limitations to our approach. For instance, our decision to search only two scholarly databases potentially excluded important articles published in other fields (e.g., medicine, education, and engineering) that may only be found in disciplinary specific databases such as PubMed, ERIC, and Engineering Source, respectively. In addition, by using two databases and setting our search parameters for peer-reviewed journal articles, books, and reports, we excluded many non-peer reviewed publications. Similarly, by focusing on English language publications we eliminated a growing and important body of work on children and disasters published in other languages. By using the search terms *children and disaster* we may have excluded important organizational studies, such as those focused on the role of pediatric healthcare facilities in emergency preparedness, response, and recovery. Even with these limitations in mind, the database we compiled suggested major trends within the children and disasters realm.

[3]Page limitations prohibit a full accounting of the literature inventory, although it informed every aspect of this chapter.

13.5 Foundational Studies and Publication Patterns on Children and Disasters

The first relevant entry from our search appeared in print in 1945 and was published by the U.S. Office of Education, Federal Security Agency. It was concerned with securing "authentic information" for schools and educators on behalf of children in the United States regarding the effects of World War II and the resultant enemy occupation of countries in Europe and Asia. While this study focuses on the "suffering" of "less fortunate fellows" and the "tragic casualties" of war, it also offers "renewed appreciation of the valiant manner in which youth of character meets disaster." As described below, these themes of vulnerability and capacity echo throughout the subsequent decades.

Other foundational works, all published in the 1950s, also established key scholarly themes that would inform research trajectories over time. For example, early studies elaborated on the role of schools (Perry & Perry, 1959) and the family (Chapman, 1957; Perry & Perry, 1959; Young, 1954) in shaping children's responses to disaster, with a specific focus on parent-child interactions in the disaster aftermath (Silber, Perry, & Bloch, 1958). Other research from this period examined

evacuation behavior of children and families (Anonymous, 1957) and emotional reactions of children to disaster (Bloch, Silber, & Perry, 1956). This formative research for the subfield was conducted by initial field research teams in response to two disasters, the 1953 Vicksburg Tornado and the 1953 North Sea Flood.

Our search for studies on children and disaster resulted in 1,657 unique publication entries, which appeared in print between 1945 and 2016. As shown in Fig. 13.1, fewer than 100 peer reviewed studies on children and disaster were published between 1945 and 1989. Publications in this area multiplied beginning in the 1990s, with the largest increase occurring in the most recent decade beginning in 2010. Quite notably, nearly half of all publications on children and disaster have appeared in print in just the last six years.[4]

Over the past eight decades, most research on children and disasters has taken an "all-hazards" approach or has focused on natural disasters. Furthermore, a large proportion of available publications have involved the study of a relatively limited number of large-scale events. The major events that have received the most frequent and sustained attention in the published literature on children and disaster include: the Chernobyl Nuclear Release (1986); Hurricane Hugo (1989); Hurricane Andrew (1992); the Oklahoma City Bombing (1995); the 9/11 Terrorist Attacks (2001); the Indian Ocean Earthquake and Tsunami (2004); Hurricane Katrina (2005); the Victoria, Australia Bushfires (2009); and the Haiti Earthquake (2010). While most research in this subfield is cross-sectional in design (Pfefferbaum & North, 2008), the aforementioned events are also the ones that have been most likely to generate longitudinal studies following child cohorts over time.

[4]The dramatic rise in the number of publications on children and disaster may reflect broader trends related to publishing, including the increase in the number of journals focusing on disasters as well as those dedicated to child and youth studies. The increase may also be due to the number of catastrophic events that have affected large numbers of children over the past several years, and the body of the research that has been generated in turn. Regardless of what is driving the increase, there has been a clear and sharp upward trend in the number of child-specific disaster publications.

13.6 Children and Disaster Research: Past, Present, and Future Directions

In reviewing the numerous studies that have been published over the past several decades on children and disaster, we identified six major waves of research (see Fig. 13.2). In the sections below, we briefly describe each wave and summarize key associated themes. Throughout, we reference publications that are illustrative of the particular wave as well as highlight the dominant approaches within a given wave.

It is important to note that these waves are not discretely sequential but instead are overlapping; the introduction of a new wave of research does not mean that a prior wave of work ended. Instead, new waves began in earnest as more longstanding waves continued unabated.

13.6.1 Wave 1: Assessing Children's Psychological and Behavioral Reactions to Disaster

The vast majority of published and cited literature on children and disasters focuses on children's emotional and behavioral responses to extreme events (La Greca, Silverman, Vernberg, & Prinstein, 1996; Norris, Friedman, & Watson, 2002a, Norris et al., 2002b; Wright, Masten, & Narayan, 2013). Researchers working in this domain tend to draw on mainstream psychological theory and contextual theories of exposure (Weems et al., 2010) and have long used standardized scales to measure traumatic reactions to disaster and associated symptoms such as intense fear, disorganized and agitated behavior, emotional numbness, and anxiety (Veenema & Schroeder-Bruce, 2002). Increasingly, researchers are also studying other dimensions of mental and emotional health including depression (Kanter, 2010; Lai, Auslander, Fitzpatrick, &

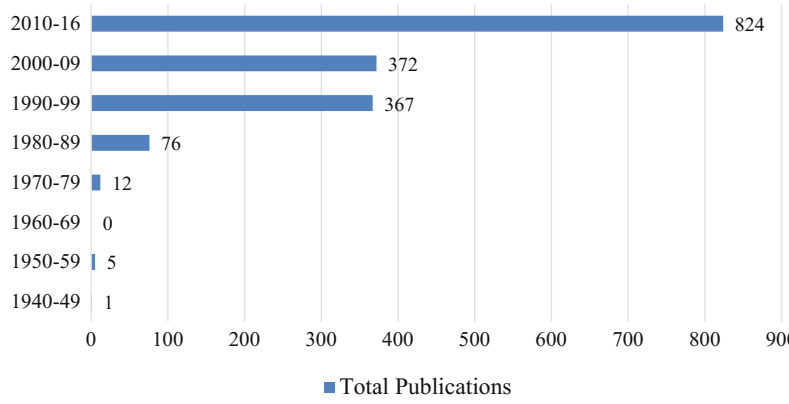

Fig. 13.1 Number of publications on children and disasters

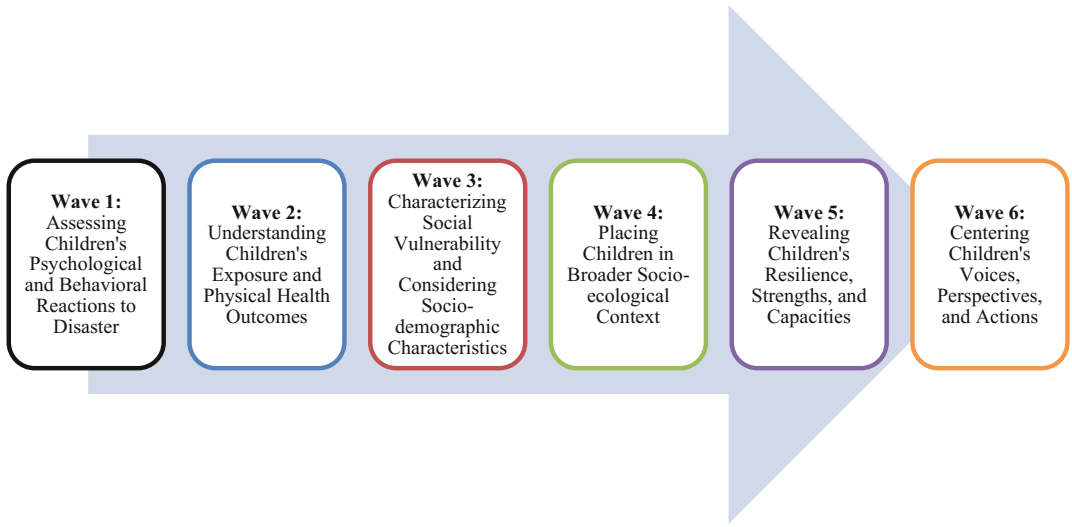

Fig. 13.2 Major waves of research on children and disaster

Podkowirow, 2014a, Lai, La Greca, & Llabre, 2014b), serious emotional disturbance (Abramson et al., 2010a), and suicidal ideation (Tang et al., 2010).

Most of the available work on children's emotional health in disasters is, for obvious reasons, conducted during the response and recovery phases. However, major changes have occurred in this particular wave including a shift from a heavy reliance on parental and teacher assessments of children's post-disaster mental health, to a stronger emphasis on direct assessments administered to children themselves within home and classroom environments (La Greca, 2006; Lai, Esnard, Lowe, & Peek, 2016); more longitudinal research designs and associated measures that assess mental health outcomes at multiple points in time (Chen & Wu, 2006; McFarlane, 1987); movement from convenience sampling to representative probability-based sampling techniques; integration of geospatial and secondary data to compare stress reactions of exposed children to non-exposed children in different places (Taormina et al., 2008); and the

use of genetic markers (La Greca, Lai, Joormann, Auslander, & Short, 2013a) and a variety of other factors (Lai, La Greca, Auslander, & Short, 2013) in predicting risk and resilience among diverse child cohorts. In addition, studies are now more likely to include assessments of social support, adaptive coping strategies and styles, and other protective mechanisms and resources that may buffer against the most severe effects of disasters (Paardekooper, de Jong, & Hermanns, 1999; Pfefferbaum et al., 2012a, Pfefferbaum, Noffsinger, & Wind, 2012b; Wright et al., 2013).

Researchers have long been interested in assessing how disasters influence children's behaviors in the home, within peer groups, and in school (Stuber et al., 2005). Indeed, mental health experts recognize that one of the primary ways that psychological distress is expressed after a disaster is through behavioral reactions or the externalizing of mental health symptoms and responses (La Greca et al., 1996; Pynoos et al., 1993). Various negative behavioral reactions have been studied after disaster and, when disaggregated by age, have revealed substantial differences between infants, toddlers, young children, and adolescents (for summaries see Norris et al., 2002a, b; Peek, 2008). For instance, while very young children may experience regressive behaviors such as bed wetting, hitting, or otherwise acting out, adolescents and teens are more likely to engage in high-risk behaviors such as drinking, drug use, and unprotected sexual activity (Maclean, Popovici, & French, 2016).

Disasters may also influence children's ability to focus on schoolwork and may create or amplify behavioral issues within classrooms. Research has shown that school-aged children who are displaced for extended periods of time after a disaster tend to have higher dropout rates, to receive lower grades and lower testing scores, and to suffer from other educational and behavioral problems (Fothergill & Peek 2015; La Greca, 2006; Masten & Narayan, 2012). Much of the work on children's educational attainment in the aftermath of disaster has been conducted during the short- and longer-term recovery phases; a limited number of rigorous studies have drawn on pre-existing educational data to assess how disasters have affected a number of behavioral and educational outcomes.

13.6.2 Wave 2: Understanding Children's Exposure and Physical Health Outcomes

The spaces where children live, go to school, play, and work may expose them to elevated levels of risk before, during, and after a disaster. Mounting evidence now even suggests that children exposed in utero to moderately severe to severe levels of stress caused by disaster may experience serious developmental consequences (Charil, Laplante, Vaillancourt, & King, 2010; Laplante et al., 2004; Laplante, Brunet, Schmitz, Ciampi, & King, 2008).

Environmental health assessments and epidemiological studies suggest that children who are exposed to lead (Pb) and other environmental contaminants may suffer a number of neurobehavioral impairments throughout the life course (Healey, 2009). Exposure to polluted air, water, and soil is especially dangerous for young children, and may result in acute as well as chronic health problems (Xu et al., 2012). In fact, according to the World Health Organization (WHO), more than one in four deaths of children under 5 years of age are attributable to unhealthy environments. Further, approximately 1.7 million children under age 5 die each year due to environmental risks, and climate change will exacerbate the challenges that young children face (WHO, 2017).

When disasters strike, children may be killed or injured due to a variety of causes (see Roberts, Huang, Crusto, & Kaufman, 2014; Thabet, Ibraheem, Shivram, Winter, & Vostanis, 2009). In one of the only studies available on child mortality in U.S. disasters, Zahran, Peek, and Brody (2008) found that extreme cold and extreme heat were the mostly deadly hazards for children and that boys across all age cohorts were more likely to perish than girls. Still, estimating child mortality in disaster events is challenging, both because there is no standardized global disaster mortality data (Borden & Cutter, 2008)

and because available data are rarely disaggregated for child populations age 0–18 years. Additionally, the deadliest hazards for given populations change across time and space. For example, pandemics claimed the most lives globally in the early 20th century whereas droughts and heat waves have resulted in the highest disaster mortality rates since the mid-1900's (Roser, 2016). In places like the United States, Japan, and New Zealand, child mortality in earthquakes, for example, has fallen dramatically during the 20th century, largely due to state-of-the-art seismic design, enhanced building codes, and stringent code enforcement. In other places, like China, Pakistan, and Haiti, tens of thousands of children lost their lives when their schools and homes collapsed in seismic events (Hu, Wang, Li, Ren, & Zhu, 2011).

In addition to direct physical exposure to disaster, a growing number of studies have focused on secondary shocks that follow disaster events and further endanger children. For instance, Biswas, Rahman, Mashreky, Rahman, and Dalal (2010) examined children who sustained injuries due to abuse at the hands of adult caregivers after disaster. Lai et al. (2014a, b) documented a rise in sedentary activity among children after disaster. Researchers have also examined longer-term physical health concerns among children and parents living in communities contaminated as a consequence of technological disaster, such as the 2010 Deepwater Horizon oil spill (Abramson et al., 2013) and the 1986 Chernobyl Nuclear Release (Yablokov, 2009). Thomas et al. (2008) studied respiratory problems and post-event asthma diagnoses among children exposed to the dust cloud following the collapse of the World Trade Center Towers on September 11, 2001.

13.6.3 Wave 3: Characterizing Social Vulnerability and Considering Sociodemographic Characteristics

Social science research on children and disasters has increased markedly over the past decade, and much of this work has been framed using a social vulnerability approach.[5] Social vulnerability scholarship has a rich intellectual history that links historical and economic root causes of disaster to current unsafe conditions to help explain the progression of vulnerability among particular people in specific geographic places (Wisner, Blaikie, Cannon, & Davis, 2004). Because children have increasingly been recognized as a potentially vulnerable population, they now regularly appear on lists that emergency managers and public health responders use when attempting to conduct rapid needs assessments after disaster or to prepare populations before an event occurs. Social vulnerability scholars use quantitative, qualitative, and geospatial methods to understand the social, political, environmental, and economic factors that place children in harm's way and the ways that loss and suffering may unfold in their lives in the short and longer-term aftermath of disaster (for an overview, see Peek, 2008).

Although scholars have increasingly called for more fine-grained analyses of children's vulnerability and experiences in disaster (Masten & Osofsky, 2010), much of the work that fits within this wave does not disaggregate children's experiences by age, stage of development, race, or gender. Instead, much of this scholarship refers to "children" or "children and youth" as a uniform category. This represents a challenge to the progression of the subfield, as children of different ages are obviously quite different developmentally and thus have different needs and vulnerabilities. This is equally true for children with different national, racial, ethnic,

[5]We think this increase is due, at least in part, to Anderson's (2005) appeal for more sociological disaster research on children as well as to the publication of the 2008 special issue on children and disasters, which appeared in the journal *Children, Youth and Environments*. Both Anderson's seminal article where he asked "Where are all the children and youths in social science disaster research?" (p. 161) and the special issue used a social vulnerability framework and encouraged researchers to look beyond the mental and physical health effects of disaster to expand the subfield in more sociological directions.

gender, religious identities, sexual orientations, socioeconomic backgrounds, and so forth.

Children and disaster scholarship written from a social vulnerability perspective, at present, is rarely explicitly intersectional in nature, meaning that the work often does not account for the dynamic interaction between important individual and social characteristics. This is not meant to imply, however, that scholars ignore the importance of socio-demographic and socio-contextual characteristics in shaping children's pre- and post-disaster experiences. Yet, when these characteristics are considered, they are often treated as control variables at the individual and household level. The work that is available has revealed important interactions between a child's age at the time of disaster and other characteristics such as racial minority status, disability, gender, household composition, and recovery conditions in the home and neighborhood (Green et al., 1991; Peek & Stough, 2010; Weems et al., 2010). These efforts have also helped to identify certain characteristics of children most vulnerable to negative outcomes following disaster exposure (Lonigan, Shannon, Taylor, Finch, & Sallee, 1994; Masten & Narayan, 2012). This wave of research underscores the importance of identifying and understanding the role of development and developmental timing, gender, and a range of other characteristics (e.g., cognitive skills, personality, previous exposure, attachment relationships) when assessing vulnerability for children in disaster.

13.6.4 Wave 4: Placing Children in Broader Socio-ecological Context

Although children are at the center of the studies we have reviewed for this chapter, they obviously do not exist in isolation. They are embedded in families, peer networks, schools, neighborhoods, communities, media and technology cultures, and political and economic structures (Bronfenbrenner, 1986). While earlier studies acknowledged this fact, research over the past two decades has more explicitly drawn on socio-ecological theory to place children and youth in broader context.

Work associated with this wave has revealed the roles that institutions play in children's lives before, during, and after a disaster. The family and schools—as two of the most prominent institutions in most children's lives—have received the most attention in the disaster literature historically and to date.

Parents, especially mothers, have been identified as key to helping children prepare for, evacuate, and recover from disaster (Peek & Fothergill, 2008). Research has also demonstrated that parental mental health, particularly the mother's mental health status, is a significant predictor of children's physical and emotional well-being after disaster (Lowe, Godoy, Rhodes, & Carter, 2013; Tees et al., 2010). This research emphasizes how children's fates are closely tied to the fates of their adult caregivers before, during, and after disaster.

A growing body of work is now available on the roles of schools and teachers in helping children and families to prepare for and recover from a variety of hazards events (U.S. Department of Education, 2013; Johnston et al., 2016; Tipler, Tarrant, Johnston, & Tuffin, 2016). Schools have also been identified as important sites for emotional and behavioral health interventions (Lai et al., 2016; Pfefferbaum et al., 2012a, b). Childcare centers and after school programs have been the focus of a more limited number of studies, but these institutions have received increased attention over the past decade (Singh, Tuttle, & Bhaduri, 2015). This is due, in part, to initiatives such as the U.S. Disaster Report Card, published annually by the advocacy group Save the Children, and by regulatory reforms instituted more recently by the U.S. Administration for Children and Families.

Research is beginning to emerge that examines the role of place attachment and place disruption in shaping the wellbeing, emotional regulation, identity development, and self-esteem of children in the home, school, and other post-disaster contexts (Cox, Scannell, Heykoop, Tobin-Gurley, & Peek, 2017; Scannell, Cox, Fletcher, & Heykoop, 2016). Case studies of

Hurricane Katrina and other disasters have revealed that children can experience disorientation and diminished wellbeing as a result of displacement from culturally familiar surroundings (Fothergill & Peek, 2012; Peek, 2012b; Robinson & Brown, 2007). This includes studies documenting increases in stress and stress-related disorders (Wickrama & Kaspar, 2007); behavioral problems (Reich & Wadsworth, 2008), and other issues related to academic achievement, cultural practices, and social relationships (Peek & Richardson, 2010).

13.6.5 Wave 5: Understanding Children's Resilience, Strengths, and Capacities

Much of the available scholarship on children and disasters has focused on assessing negative responses and outcomes or their overall vulnerability before, during, and after disasters. At the same time, there is ample evidence of children's resilience in times of disaster as well as some limited, but growing, work on children's capacities and strengths.

Other scholars have completed impressive reviews of the child resilience literature, which we will not duplicate in detail here.[6] Recently, Wright et al. (2013) published an updated extensive review of the study of resilience, with a focus on the key concepts and findings resulting from four distinct waves of research over the past four decades. Masten and Narayan (2012) and Meyerson, Grant, Carter, and Kilmer (2011) have also summarized the literature on posttraumatic growth among children and adolescents.

In addition to this body of theoretically informed and empirically rich research on children's resilience, scholars have begun to more systematically document children's strengths and capacities. Anderson (2005: 162) called for work in this area, saying that it was "crucial to understand… what children do for themselves and others to reduce disaster impacts." There is now more published evidence of the ways that children help their peers, their family members, their schools, organizations to which they belong, and their communities before, during, and after a disaster. For example, in their research after Hurricane Katrina, Fothergill and Peek (2015) offer a typology of ways that children helped adults; children helped other children; and children helped themselves after the storm. A few examples among many of their efforts included assisting relatives during evacuation, caring for younger children in shelters, and drawing, singing, and keeping journals to help themselves cope. Tobin-Gurley et al. (2016) explored gendered dynamics of helping behaviors among youth in communities affected by wildfire, flooding, and a tornado, respectively.

Children and youth are now active in preparedness activities around the globe, and research has demonstrated that these efforts may be especially effective if they link individual preparedness with preparedness in schools and communities (Ronan, Alisic, Towers, Johnson, & Johnston, 2015; Ronan, Crellin, & Johnston, 2012). In the U.S., teens have the opportunity to take part in various preparedness efforts sponsored by the Federal Emergency Management Agency (FEMA, 2016) as well as to receive disaster education through the American Red Cross and other organizations. Internationally, children are increasingly engaged in participatory action projects aimed to enhance their strengths and to build their personal and collective resilience (Zeng & Silverstein, 2011).

13.6.6 Wave 6: Centering Children's Voices, Perspectives, Actions, and Rights

Most recently, a wave of child-centered research and child-led action-oriented initiatives has emerged, which has further centered children's voices, perspectives, and activities (Towers,

[6]Some of the most widely cited reviews and empirical studies of children, resilience, and disasters include: Caffo and Belaise (2003), Cryder, Kilmer, Tedeschi, and Calhoun (2006), Masten (2015), Masten and Narayan (2012), Masten and Obradovic (2008), Masten and Osofsky (2010), and Zolkoski and Bullock (2012).

Haynes, Sewell, Bailie, & Cross, 2014). Some of the research has focused on the roles that children can and do play in disaster risk reduction and climate change adaptation across the globe (Martin, 2010; Tanner, 2010). In addition, with the introduction of the United Nation's Convention on the Rights of the Child, there has been more explicit discussion of children's human and political rights in post-disaster contexts (see Hayward, 2012).

This wave, perhaps more than any that came before it, is distinguished by the diverse methods and approaches that researchers and advocates have used to work for and with children living at risk and child disaster survivors. New creative methods and participatory approaches have allowed researchers and practitioners to understand and highlight children's stories and perspectives, while often developing community-based engagement strategies with an explicit goal for social justice (Fletcher et al., 2016; Haynes & Tanner, 2015). This wave has also been distinguished by its unabashed and unapologetic concentration on child-led and adult-led youth advocacy efforts (Cox et al, 2017; Peek et al., 2016). This work, in particular, has blurred the line between research and action with social change as an ultimate goal.

13.7 Advancements

The research in the six waves illuminate substantive advancements in the area of children and disaster. This section discusses how scholarship on children and disasters often intersects with and contributes to disaster studies and the social sciences more generally while also highlighting the theoretical, methodological, and policy implications of this work.

13.7.1 Theoretical Contributions

Theoretical contributions to the subfield of children and disasters sit at the nexus of many disciplines and areas of inquiry. As discussed in Wave 1, psychologists were central to establishing the subfield of children and disaster studies and their work continues to have a strong theoretical influence. Children and disaster scholarship has also drawn from and contributed to other theoretical and empirical lines of inquiry, as further described below.

Research on children has expanded and enriched the social vulnerability paradigm in disaster studies. In line with other social vulnerability scholarship, research on children has linked vulnerability to economic, historical, structural, and political root causes. This research has highlighted the importance of examining social forces, social structures, and access to resources in the context of disasters. A growing body of evidence has illustrated that children may be more vulnerable to the deleterious health effects of disaster and may suffer lifelong consequences from major exposure to disaster, further underscoring the importance of examining this population group across time.

This subfield has also used and expanded social-ecological models that consider the influence of micro-, meso-, and macro-level social, cultural, political, and economic forces in shaping children's lives. Work that employs this theoretical lens reminds us that children are embedded in various social and civic institutions, which clearly have a powerful influence on how they prepare for and recover from disasters.

Children have demonstrated resilience and adaptive capacities to disaster, especially when given the opportunity to contribute in meaningful ways. Although the power of volunteerism and the benefits of being actively included in community efforts has long been documented in the disaster literature, the examination of children's roles and contributions allows for broader theorizing about new skill sets and contributions from different generations. Children, often identified as vulnerable, passive, and even helpless, have demonstrated that participation from all members of a community is invaluable to disaster risk reduction and individual and collective resilience.

Just as we are seeing the field of disaster studies align more closely with environmental justice efforts and climate change research, there

has been an expansion of literature focusing on child- and youth-based adaptive strategies and a growing body of knowledge focusing on the impacts of environmental- and war-based migration patterns for refugee children (Sirin & Rogers-Sirin, 2015). Continuing research in this area is critical to solidify and learn from the intersections between disasters, environmental justice, and climate change.

13.7.2 Methodological Contributions

Scholars studying disasters have long utilized traditional social scientific methods such as surveys, qualitative interviews, focus groups, and participant observation. Work in the subfield of children and disasters adheres to this pattern, but has also led to methodological advances in numerous areas including psychological evaluations and interventions in school-based settings (La Greca, 2006; Lai et al., 2016), mobile, child-led methods (Gibbs, Mutch, O'Connor, & MacDougall, 2013), arts-based and creative methods (Peek et al., 2016; Scannell et al., 2016), participatory action research (Tanner, 2010), and participatory mapping and video (Gaillard & Pangilinan, 2010; Haynes & Tanner, 2015).

In their review of children and disaster mental health research, Steinberg, Brymer, Steinberg, and Pfefferbaum (2006) concluded that in order to continue to advance the subfield, researchers would need to increase the use of representative samples, control groups, and longitudinal designs. Pfefferbaum et al. (2013) conducted a systematic review of methods used while studying children in three major disasters. They found that researchers are now using a more diverse set of approaches including experimental designs with control and randomization, hypothesis testing, and intervention evaluations. Yet, they also noted gaps in terms of the lack of longitudinal research designs, the need for more focus on biological stress reactions, and more careful investigation of the role of family and community in shaping children's disaster recovery.

Researchers working in the subfield have increasingly employed advanced statistical techniques such as structural equation modeling (Abramson, Stehling-Ariza, Park, Walsh, & Culp, 2010b; McLaughlin et al., 2013) and latent growth curve analyses (La Greca et al., 2013b). All the while, scholars continue to draw on more traditional ethnographic and mixed-methods studies (Towers, 2015) to test and extend Bronfenbrenner's foundational work on child development.

13.7.3 Policy Implications

The 1989 United Nations Convention on the Rights of the Child focused attention on the responsibility of adults to protect the human rights and welfare of children, while the 2011 Children's Charter for Disaster Risk Reduction, developed in consultation with more than 600 children in 21 countries, identified children's priorities for a child-centered approach to disaster risk reduction. The growth of children and disaster research has helped solidify the need to better understand how children, adults, and entire communities can and should better prepare for and respond to disasters that threaten the health and well-being of children. Moreover, the majority of research outlined in the six waves has an explicit goal to inform and influence policy and practice to reduce the risks as well as the harm and suffering experienced by children in disasters.

Advancements in the subfield of children and disasters have already led to many positive changes in disaster policy and practice, such as improved building codes and safety and preparedness standards for child occupied buildings and ongoing efforts to improve disaster education, preparedness, response, and recovery efforts. For example, the Federal Emergency Management Agency (FEMA), the American Red Cross, and the U.S. Department of Education recently partnered to create a national strategy that provides a clear vision for youth preparedness. FEMA also has a webpage dedicated to "children and disasters" that offers a variety of preparedness, emergency management, response, and recovery resources as well as

information to help children cope with the negative effects of disaster.

In 2017, a bipartisan bill, the Homeland Security for Children Act (H.R. 1372), was introduced in the House of Representatives to ensure that the needs of children are included in the thinking and planning for a disaster throughout the U.S. Department of Homeland Security. Among other things, this bill directs FEMA to include children in disaster response planning and integrates House and Senate Homeland Security committees into the process of meeting children's needs (Schlegelmilch & Serino, 2017).

Globally, the United Nations International Children's Emergency Relief Fund (UNICEF) responds to the needs of children in regions that are most vulnerable to and hardest hit by emergencies and disasters. These efforts are supplemented by the important work being done in some of the most vulnerable communities and countries by advocacy organizations such as Save the Children, Plan International, and the International Red Cross and Red Crescent Societies.

13.8 Future Directions and Enduring Questions

As scholarship on children and disasters has continued to grow and expand, enduring challenges have remained and new questions have emerged. We bring this chapter to a close with some reflections on new directions for research on children and disasters.

First, there remains a need for more explicitly intersectional research, which helps to elucidate how nationality, race, class/caste, gender, disability status, sexual orientation, immigrant status, indigenous status, and many other diverse characteristics shape children's lives and experiences in pre- and post-disaster contexts globally. Although researchers are increasingly using more sophisticated statistical models to control for these characteristics, the dynamic ways in which they interact and play out in young people's lives deserves more attention, as does the shifting climatic, cultural, and economic contexts in which children are coming of age (White, 2011).

Second, with the increased number of studies focused on children's strengths, capacities, and actions, we see a need for more nuanced analyses of how cultural, social, political, and technological practices and values within communities and broader societies influence children's participation in disaster risk reduction and climate change adaptation strategies. How do these different structures encourage or constrain their voices, actions, and involvement at the local and national levels? Anderson (2005) previously observed that children are often excluded from these very conversations about hazards and disasters (and other issues of social importance) because they cannot vote and are rarely included in decision-making processes. Yet, there has been movement for a more inclusive child-centered disaster risk reduction agenda in recent years, such as the efforts witnessed at the Child and Youth Forum of the Third United Nations World Conference on Disaster Risk Reduction in Sendai, Japan (Cumiskey, Hoang, Suzuki, Pettigrew, & Herrgård, 2015). At that conference, young people from around the world made their desire to become critical players in disaster risk reduction apparent. How much systemic change will result from that action is still an open question.

Third, we see a need for sustained support and funding for life course research and other longitudinal studies to capture the enduring impacts of trauma on child-to-adult post-disaster trajectories over time. The biological and psychological sciences have long focused on how children age and develop. Disaster research is equally interested in how the stress of calamitous events disrupts conventional timelines and life course development, for children, adults, and more broadly for communities. Disaster events often compel individuals, communities, and institutions to rapidly rebuild their lives and routines in what Olshansky, Hopkins, and Johnson (2012) refer to as "time compression." Altogether, such a focus on time-varying effects of disasters is perhaps most productively studied in children, particularly with longitudinal study designs. Children are acutely sensitive to time because

their own physical, emotional, and cognitive development continues inexorably regardless of a disaster's stressors, and they may be particularly sensitive to perturbations in their environment. A disaster's effect is likely to be revealed sooner among children than adults; a 30-year time frame can capture effects from prenatal exposure through young adult life course transitions and any number of critical developmental time points in between. Furthermore, even in more abbreviated time spans, disaster research on children can illuminate the effects of rapid changes on social and civic institutional stability, as well as on successful individual and collective adaptation and coping strategies. These are emerging areas of considerable interest in the broader field of disaster studies, and represent especially fruitful areas of scholarship in the subfield of children and disaster studies.

Fourth, as underscored throughout this chapter, mental health studies continue to predominate, and psychologists and psychiatrists are the most often-cited scholars working in the children and disaster space. We applaud this important work and want to see it continue. At the same time, we see a need for more disciplines and more inter- and multidisciplinary teams to conduct research to push the boundaries of this field. Engineers and social scientists, for instance, have successfully partnered to assess where the most unsafe school structures are located, and how this varies by the sociodemographic characteristics of the school children enrolled in the buildings. Continuing to bring together experts from different disciplinary backgrounds will further encourage new and exciting research questions. Environmental justice scholars could help those in disaster studies think more carefully about the unequal distribution of risk and how this increases children's vulnerability. Gender scholars could partner with disaster researchers to offer more nuanced analyses of how boys and girls experiences differ in pre- and post-disaster environments. Educational researchers could design longitudinal studies to assess how disasters influence a variety of educational outcomes for school-age children affected by disaster. Climate change scholars might engage with disaster researchers to explore how and where children are experiencing the combined impacts of climate change and disasters and elucidate the growing role of children and youth in climate adaptation initiatives. The young median age of many indigenous populations combined with a growing acknowledgement of the value of local knowledge and particularly of indigenous knowledge practices, can and should prompt the greater inclusion of and collaboration with indigenous scholars. With the rising number of children and youth under correctional supervision in the U.S., criminologists could partner with vulnerability scholars to understand how juvenile justice facilities prepare for disaster to ensure that juvenile populations are not left behind during a crisis.

Fifth, children are now considered "digital natives" (Prensky, 2001), given that they are born into a world marked by the rapid and widespread dissemination of electronic information through the web and various social media platforms. For eight decades, children have been the object and subject of many research studies. However, casting them as digital natives also recognizes their power and capacity as drivers and creators of new knowledge and information, especially in digital form. How, if at all, these realities will shape their engagement with and involvement in the hazards and disaster field more generally is yet to be determined.

Sixth, there is a pressing need for more scholarship that focuses on how key organizations and institutions produce (or reduce) risk in children's lives and promote (or hinder) resilience. As Tierney (2014) observes, powerful organizations and institutions socially produce much of the risk that populations face. Yet, most children and disaster scholarship focuses on the individual child as the primary unit of analysis. The family, childcare centers, schools, healthcare, religion, political structures, the juvenile justice system, and other core organizations and institutions that shape children's lives and affect risk levels warrant further study.

Seventh, as more interventions and policies are established to protect, engage, and empower children, there is a need for more

evidence-informed evaluation research as well as more policy-focused research to analyze how current policy does, or does not, help reduce children's risk and speed their recovery in the aftermath of disaster. Annual reports from Save the Children, for instance, have repeatedly shown that many childcare centers and schools across the U.S. fail to meet basic preparedness standards. A study of a national sample of licensed prehospital emergency medical service agencies revealed that while most agencies (72.9%) reported having a written plan for response to a mass-casualty event, only 13.3% had such a plan available for pediatric-specific mass-casualty events (Shirm, Liggin, Dick, & Graham, 2007). Evaluation research would help policy makers, emergency managers, and other practitioners to understand which programs are successful and why (Catalano, Berglund, Ryan, Lonczak, & Hawkins, 2004) and to assess whether educational interventions are actually working (Johnson, Johnston, Ronan, & Peace, 2014). The National Commission on Children and Disasters (2010) offered a series of policy recommendations to enhance the nation's preparedness, response, and recovery capacity for children and families; there is a need for a systematic assessment of the policy implementation that has, and has not, followed from that seminal report.

13.9 Conclusion

This chapter summarized eight decades of research by presenting six enduring and emerging waves of study on children, disaster, and mental health and behavioral reactions; exposure as it relates to physical health and well-being; social vulnerability and sociodemographic characteristics; socio-ecological context; resiliency, strengths, and capacities; voices, perspectives, and actions. Each new wave of research has opened up novel lines of inquiry by individual researchers as well as disciplinary and multidisciplinary teams and has involved a wider range of diverse child participants both nationally and internationally.

Although researchers have studied children's reactions to disaster since the 1940s, the field has expanded tremendously over the past decade. Indeed, as our review demonstrated, nearly half of all studies on children and disaster have been published since 2010. This work has focused on natural disasters, technological accidents, and violent incidents, although a relatively small number of large-scale events has driven much of the research in this subfield. While mental health research continues to predominate, research from the social sciences has increasingly focused on children's vulnerability, voices, and human rights before, during, and after disaster. This has led to the introduction of new methodological approaches including more participatory, ethnographic, longitudinal, and mixed methods designs as well as more diverse theoretical frames.

Given the tremendous growth of research on children and disasters, especially over the past decade, we assume and hope this momentum will continue. Children make up somewhere between 20 percent to over 50 percent of the population in countries around the world. Although often cast as invisible, they are an important segment of any given population worthy of sustained research attention and specific policy- and practice-oriented actions. Moreover, children, who have inherited a changing climate and a world marked by more weather extremes, are increasingly involved in initiatives to reduce their own risk as well as the myriad risks that they will confront over the life course. Children often have the time, energy, creativity, and capacity to contribute to disaster risk reduction, and their involvement in these efforts should be encouraged and recognized by researchers and practitioners alike.

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Social Capital in Disaster Research

14

Michelle A. Meyer

Contents

Interest in social capital by disaster scholars and policymakers has grown dramatically. This increased interest may be due in part because social capital—defined broadly as "involvement and participation in groups [that] can have positive consequences for the individual and the community" (Portes, 1998: 2)—describes the collective action, cooperation, and the therapeutic community that disaster researchers have highlighted since the earliest studies. As Quarantelli noted, "social capital might be a very useful concept to capture one major kind of resources that those involved in disaster-related activity might or might not have" (2005: 357). While interest in the topic has grown, more empirical research is needed to fully understand social capital's positive and negative effects in disaster and implement effective resilience programs across the disaster phases (e.g., mitigation, preparedness, response, and recovery). This chapter reviews the current state of knowledge around social capital in disaster and how these findings relate to social capital research in general.

14.1 Social Capital Theory and Definition

Social capital is used across many contexts and academic fields (see Portes, 1998 for a review of the concept). As a central theory in sociology and political science, it can be traced back to early theorists, including De Tocqueville (2002 [1889]) and Hanifan (1916), and is now associated with a prolific amount of contemporary research (Woolcock & Narayan, 2000). Within this burgeoning literature, several differing conceptualizations of social capital exist. Two distinctions are individual and collective social capital

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(Portes, 1998). For some scholars, social capital is a resource for individuals and represents the resources available through social networks that affect individual and network outcomes (Bourdieu, 1985; Lin, 1999). This type of social capital may also be referred to as relational, structural, network, or micro social capital. In contrast, others describe social capital as a collective resource for a community or group and focus on associations along with norms, trust, and civic nature (Putnam, 2001). This type has been referred to as collective social capital, communitarian social capital, or macro social capital.[1]

14.1.1 Social Capital as a Private Good and the Importance of Networks

The conceptualization of social capital as a social network-based asset for individuals grew from the work of Bourdieu (1985), Coleman (1988), or Lin (1999). Bourdieu defined social capital as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition" (Bourdieu, 1985: 248). While it is located in social structure, social capital is available for use by individuals to reach their goals. He considers social capital as one of four forms of capital individuals possess along with economic, cultural, and symbolic capitals. In his theory, these four capitals are unequally distributed across society and in tandem determine an individual's trajectory within a specific social space. Coleman (1988) developed a similar definition focused on resources available to individuals through their interactions with others. He offers six types of social capital: obligations and expectations, informational potential, norms and effective sanctions, authority relations, appropriable social organizations, and intentional organizations.

This view describes social capital as a resource that can be exclusive to specific members of a network, is activated and maintained by interaction (often intentional), and can be passed to other individuals or inherited based on personal relationships and norms of reciprocity within a network. As a private resource, this conceptualization of social capital can be applied to individuals or organizations, for example, to understand how organizational members' networks are used to promote the advancement of that particular entity. Further, this form of social capital can be built into economic models of exchange, in that specific rules of exchange and social interaction affect access to social resources. Most importantly, benefits of individual social capital most commonly accrue to individuals, which distinguishes it from collective social capital in which benefits become a public good. The use of social capital can result in the acquisition of other forms of capital, such as economic or job opportunities (e.g., Granovetter, 1973) or cultural prestige (e.g., Anheier, Gerhards, & Romo, 1995), among others.

Individual social capital focuses often on networks (Woolcock & Narayan, 2000), and as such has two clear components: 1) a durable social network and 2) some amount and quality of specific resources available to oneself through those network ties (Lin, 1999). Variation in social capital rises from strength of social ties (e.g., strong versus weak), social location of various individuals in a network (e.g., wealthy versus poor), frequency of social interaction, and the types of resources shared through those ties. Bonding, bridging, and linking social capital is a common typology to understand variation in social capital. Bonding social capital identifies close-knit relationships, such as family and close friends, that offer social solidarity. Bridging social capital identifies connections with individuals who are different than oneself or external to one's community, and thus provide access to more diverse resources. Bonding social capital describes within group ties whereas bridging can describe between group ties without one type

[1]Woolock and Narayan (2000) identify four types of social capital: networks and communitarian, which correspond to the two categories identified here, and also institutional that focuses on state and governmental environments, and a synergy view that combines networks and institutional perspectives.

necessarily being strong or weaker than the other (Paxton, 1999). Linking social capital describes connections with individuals in power that provide opportunities that neither bonding nor bridging social capital could provide (Woolcock & Narayan, 2000). The combinations of different types of social capital generate various outcomes for individuals across society.

14.1.2 Social Capital as a Collective Resource: Importance of Civic Nature

In contrast to social capital as a private good, some definitions of social capital describe it as a collective or public good. Putnam's definition clearly identifies "mutual benefit" as the outcome of social capital: "[Social capital is the] features of social organizations, such as networks, norms, and trust, that facilitate action and cooperation for mutual benefit" (1993: 35). This line of research focuses on the general ability and willingness of individuals within a group or community to work together towards shared goals and generate shared outcomes (Tolbert, Irwin, Lyson, & Nucci, 2002). Here, the focus is on the "externalities" of interactional processes "that affect the wider community, so that not all the costs and benefits of social connections accrue to the person making the investment" (Putnam, 2001: 20). These interactional processes highlighted as important for positive community outcomes are commonly seen as a general form of "civic virtue." This type of social capital has also been referred to as a communitarian view, in which associations, memberships, and groups are viewed as central (Woolcock & Narayan, 2000). This definition also implies two components: cognitive and structural social capital. Cognitive social capital focuses on shared norms and values, whereas structural social capital involves associations, group memberships, or networks.

14.1.3 Critiques of Social Capital

As the social capital literature has grown, critiques have been identified. The increased use of social capital has led to increased conceptual confusion, with multiple definitions and typologies existing, and often authors using social capital without a clear definition. This lack of clarity results in some of this research being tautological—social capital is both a result of social connections and a proxy of social connections (Portes, 1998). For example, social capital has been described as developing from associations, trust, norms and reciprocity but also defined as associations, trust, norms, and reciprocity.

Further, social capital is often described as a "cure-all" concept that can explain everything in a community. The social capital tradition drawn from Putnam often focuses on the perceived decline of social capital in contemporary society (Paxton, 1999), in line with the title of his famous book, *Bowling Alone* (Putnam, 2001). While, it has been noted that social capital can have a "dark side," for example the bonding social capital among members in a criminal gang, there is less attention to how networks, norms, and reciprocities result in negative outcomes (Landolt & Portes, 1996). As Sampson (2012) argued, research needs to hold up to analytic rigor *and* avoid normative and nostalgic assumptions about what is a "good" community.

14.2 Social Capital in Disaster Research

As Adger (2003: 389) stated, "From civil society's response to Hurricane Andrew to the networks of reciprocity and exchange in pastoralist economies, it has long been recognized that social capital is central to the lived experience of coping with risk." From the earliest research by Prince (1920), disaster scholars have studied the planned (e.g., policy, fire, emergency management) and emergent collective action that occurs immediately following a disaster (Quarantelli & Dynes, 1977). For example, disaster researchers have dispelled common myths about panic and disorganization following a disaster, instead showing the emergence of an altruistic community and mutual helping behaviors from social networks that support survivors emotionally and

physically (Barton, 1969; Fischer, 2008; Rodríguez, Quarantelli, & Dynes, 2006). Several scholars have written about how findings from early disaster research fit within the umbrella of social capital theory (Aldrich, 2012a; Dynes, 2005, 2006; Patterson, Weil, & Patel, 2010; Ritchie & Gill, 2007; Tierney & Oliver-Smith, 2012). For example, Dynes (2002: 9) placed social capital at the heart of social processes during emergency response:

> Most importantly, of all the forms of capital, [social capital] is less damaged and less affected. Consequently, during the emergency period, it is the form of capital that serves as the primary base for a community response. In addition, social capital is the only form of capital, which is renewed and enhanced during the emergency period.

These reviews show the fertile ground in disaster scholarship for social capital to explain numerous outcomes across the emergency management life cycle. To address how social capital theory is intentionally used in disaster scholarship, a systematic literature review was undertaken to assess the use of "social capital" in disaster research and synthesize the findings from this line of research. Literature searches of the *Web of Science* and *Academic Search Complete* databases were completed in September 2016. Search terms were: 1) "social capital" AND disaster, 2) "social capital" AND hazard.[2] The terms were searched within the "topic" field, which returned articles with social capital as a keyword, in the title, or abstract. To capture articles not indexed in these common databases, disaster-specific, sociology, and political science journals were also searched individually.[3] Further, article reference lists were reviewed for articles that the database searches missed. These searches together resulted in over 200 potential publications. All articles were assessed for their focus on social capital in disaster or hazard experiences, those not focused on the relationship between the two were removed. Book reviews and articles not available in English were also not included in this review.

There were 195 publications from 1998 through 2015 that focused on social capital in disasters or hazards (Fig. 14.1). The number of articles on social capital in disaster or hazard research grew slowly from 1998 until 2007, when the number of publications soared. These articles appear in 127 journals across numerous disciplines. *Disasters* had the most publications with 14, followed by *International Journal of Mass Emergencies and Disaster* (11 articles), *International Journal of Disaster Risk Reduction* (8 articles), *Global Environmental Change* and *Social Science and Medicine* (5 articles each), and *Disaster Prevention and Management, International Social Work,* and *Natural Hazards* (4 articles each). Disasters in 43 different countries have been studied, with research in the U.S. (52 publications) being most common, followed by Japan (15 publications), Canada, China, and India (7 publications each).

Scholars have studied social capital across disaster types (Fig. 14.2). Disaster type is important since the social processes vary based on disaster agent. For example, social processes following natural disasters vary compared to

[2]Articles included in this chapter address natural or technological disasters. Articles focused solely on infectious diseases, migration, development, war, or crime were removed unless they related to these topics during a natural or technological disaster situation. The intersection of disaster and climate change research has grown in recent years, and articles that focused on climate change and included the extreme events that accompany it were included. The literature on social capital in environmental stress or climate change could fill a whole chapter on its own and there are several reviews worthy of reading, such as Pretty and Ward (2001).

[3]Journals searched included: *International Journal of Mass Emergencies and Disasters*, *Disasters*, *International Journal of Disaster Risk Reduction*, *Journal of Homeland Security*, *Disaster Medicine and Public Health Response*, *Disaster Prevention and Management*, *International Journal of Emergency Management*, *Natural Hazards*, *Natural Hazards Review*, *Journal of Disaster Research*, *Risk Analysis*, *Global Environmental Change*, *Social Problems*, *Social Forces*, *American Journal of Sociology*, *American Sociological Review*, *American Political Science Review*, *American Journal of Political Science*, *Public Administration Review*, *International Journal of Urban and Regional Research*, *Social Networks, Population and Development Review*.

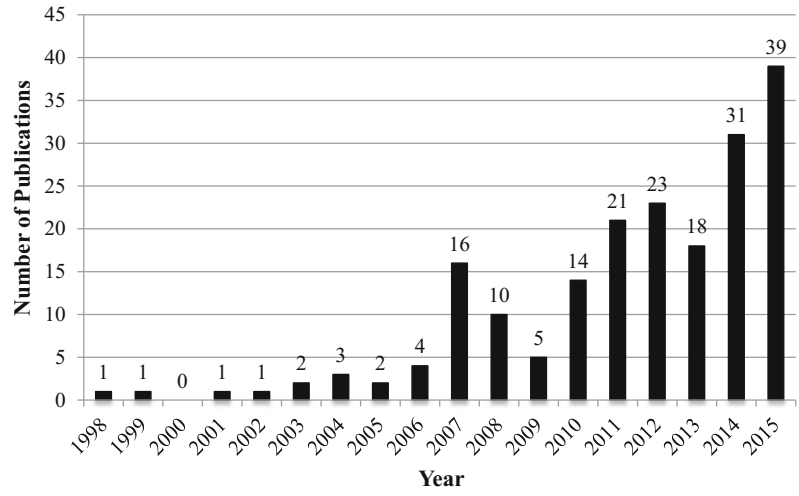

Fig. 14.1 Publications on social capital and disaster or hazard per year

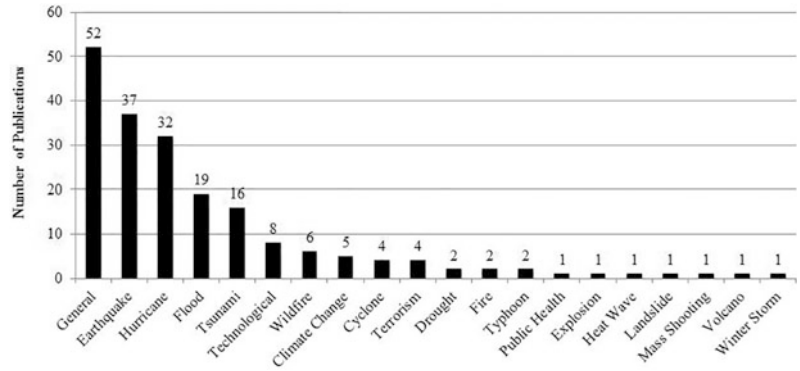

Fig. 14.2 Social capital publications by disaster type

technological disasters, riots, terrorist attacks, and other human-caused events (Peek & Sutton, 2003; Ritchie & Gill, 2007). Further, sudden-onset events (such as earthquakes) may compel different types of social interaction than slow-onset events (such as drought). Earthquakes, hurricanes, and tsunamis received the most attention. The least studied were heat waves, typhoons, and volcanic eruptions. Fifty-two articles did not specify a disaster type, which included many conceptual articles or literature reviews. More comparative research across disaster types is needed to understand how social capital may vary.

Of the 195 articles, 47 (24 percent) were conceptual articles. These conceptual articles included literature reviews (Ada & Bolat, 2010), conceptualization of social capital theory in various disaster scenarios (Aldrich, 2012a; Donner & Rodriguez, 2008; Dynes, 2005, 2006; Hurlbert, Beggs, & Haines, 2001; Ritchie & Gill, 2007; Tierney & Oliver-Smith, 2012), or models of adaptation, resilience, or recovery that incorporated social capital (Norris & Stevens, 2007; Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008; Sherrieb, Norris, & Galea, 2010). Across these conceptual articles, social capital is usually described as a positive influence on disaster outcomes across disaster types.

To organize the state of knowledge on this topic, articles are divided according to their heuristic of social capital theory discussed above —individual or collective outcomes—and then by phase in the emergency management cycle. Articles were identified as individual or collective based on the level of analysis for empirical

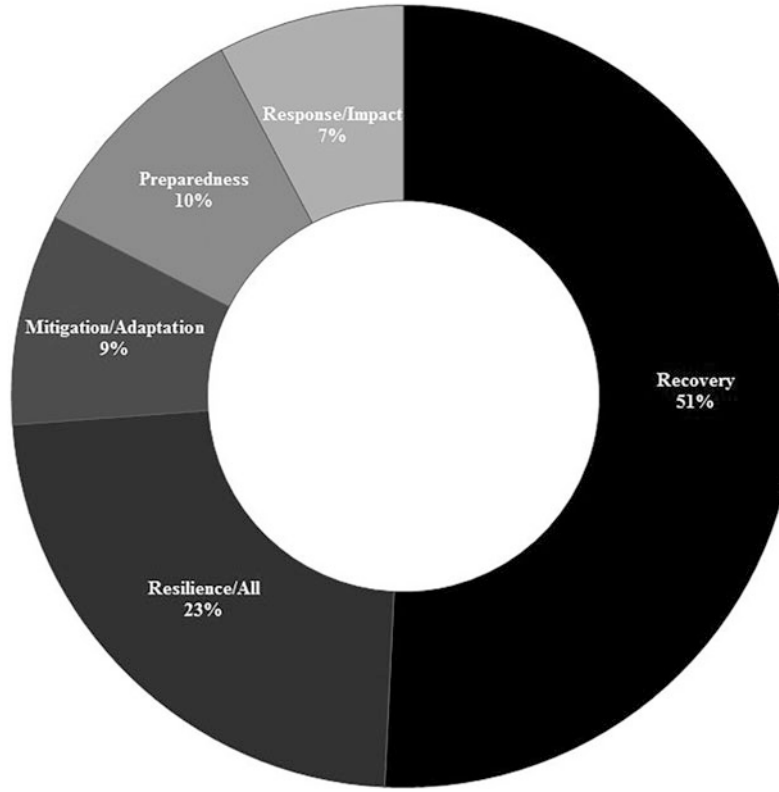

Fig. 14.3 Percent of social capital articles by disaster phase

articles or stated focus for conceptual articles. This identification proved difficult as some scholars discussed community outcomes when they measured individual variation or individual perceptions of community attributes. The assumption that community can be assessed as an aggregate of individual outcomes has been a critique of the social capital literature (Sampson, Morenoff, & Gannon-Rowley, 2002). Because of this critique and because disaster researchers often focus on either individual (or household) or community-level disaster processes, articles that use individuals as the unit of analysis and compare variation in individual outcomes were grouped together. Articles that measured community outcomes, such as rates of damage, or focused on collective action processes, including participatory processes, were categorized as collective. The majority of articles focused on collective outcomes (64%), while a little over a third used social capital to understand individual outcomes (36%).

Looking at disaster phase, the majority of social capital articles focused on recovery or resilience (Fig. 14.3). Fifty-one percent of articles addressed recovery, which included reconstruction activities along with physical and mental health. Nearly a quarter of the articles addressed resilience or the entire disaster cycle (23%). Nine percent of articles researched mitigation or adaptation. Ten percent of articles focused on immediate pre-disaster preparedness or evacuation. Seven percent of articles focused on emergency management response or the impacts of disaster, such as damage or mortality.

14.2.1 Social Capital as a Private Resource in Disaster

Beginning with research looking at the individual level of analysis, research on social capital in disaster highlights the propositions by Bourdieu and Lin—access to social capital affects individuals' and organizations' life

chances and disaster outcomes. The articles in this section focus on how social capital is a private good, a resource accessed via social networks, or provides benefits for specific individuals or individual organizations within the network.

14.2.1.1 Mitigation and Adaptation

Social capital has been found to positively influence the implementation of mitigation and adaptation strategies by people and organizations, though there are few studies on this topic. Social capital, in the form of social ties with others who have information about mitigation, increased the likelihood that farmers undertook mitigation strategies (Chen, Wang, & Huang, 2014; Fernandez-Gimenez, Batkhishig, Batbuyan, & Ulambayar, 2015), and positively influenced pastoralists decisions to mitigate the effects of drought (Miller, Leslie, & McCabe, 2014). Petrikova and Chadha (2013) found positive effects of mothers' social capital on mitigating disaster-related health risks for children in India.

14.2.1.2 Preparedness and Evacuation

The social capital lens provides context for understanding whether and how social connections contribute to disaster preparedness activities and evacuation (Levac, Toal-Sullivan, & O'Sullivan, 2012), and the results are mixed. Higher amounts of social capital were found to increase individual preparedness for floods (Linnekamp, Koedam, & Baud, 2011; Lo, Xu, Chan, & Su, 2015), terrorism (Hausman, Hanlon, & Seals, 2007), and wildfires (Bihari & Ryan, 2012). Reininger and colleagues (2013) found that Mexican Americans with more social capital reported increased feelings of preparedness. In research that compared different types of social capital, more bridging social capital was positively related to disaster preparedness, while community social capital, as small group participation, only increased awareness of disaster committee responsibilities (Brunie, 2009, 2010). Teo and colleagues (2015) used agent-based modeling to understand evacuation timing and found that individuals who followed others during evacuation reached the evacuation destination faster. Looking at outcomes for organizations, businesses leaders with stronger social ties to supply chain partners felt their businesses were prepared for a disaster (Ojha, Salima, & D'Souza, 2014).

In contrast, other studies have shown that those with more social capital may take more risks during disaster by following others' risky behavior or putting themselves in danger to help others. For example, MacDougall, Gibbs, and Clark (2014) learned that participation in community fire groups increased the amount of preparedness activities individuals undertook for wildfires, but the bonding social capital generated in those groups caused individuals to help others first and potentially put themselves at greater risk of death or injury. Horney, MacDonald, Van Willigen, Berke, and Kaufman (2010) similarly found that some forms of social capital increased "evacuation failure." Specifically, individuals who were members of local groups were less likely to evacuate, while other measures of social capital, besides group membership, had no effect on evacuation likelihood. Wolf, Adger, Lorenzoni, Abrahamson, and Raine (2010) also concluded that social capital could increase risk-taking behaviors among elderly persons. Thus, social capital can both increase preparedness and in some cases increase risk.

14.2.1.3 Response and Impacts

Social capital is conceptualized as supporting individuals during the disaster impact and response period (Durant, 2011). Braun and Assheuer (2011) found that slum dwellers cope with flooding through the use of social networks. Casagrande, McIlvaine-Newsad, and Jones (2015) found bonding social capital in the form of family was most important to securing life during the disaster response. Procopio and Procopio (2007) found that interactions over the Internet during the response period fostered weak ties and bridging social capital that helped individuals garner social support following a disaster.

14.2.1.4 Recovery

Social networks are argued to play a primary role in recovery, especially when state-level interventions are slow or non-existent (Adger, 2003; Assheuer, Thiele-Eich, & Braun, 2013; Minamoto, 2010). Research includes assessments of social capital for both individual or household recovery and organization recovery. The overwhelming conclusion was a positive impact of social capital on disaster recovery, except for mental health, which had mixed results.

For individual persons, social capital research in disaster recovery has focused on health, access to supplies and information, and recovery decision-making. Social capital positively influenced physical health recovery (Adeola & Picou, 2012), except that more social capital was related to increases in drinking (Beaudoin, 2011). Several studies showed that social capital reduced the likelihood of negative mental health effects including PTSD and depression (Adeola & Picou, 2014; Ali, Farooq, Bhatti, & Kuroiwa, 2012; Beaudoin, 2007a, 2007b; Greene, Paranjothy, & Palmer, 2015; Wind, Fordham, & Komproe, 2011; Wind & Komproe, 2012). Other studies have found no effect or mixed effects of social capital on mental health outcomes. Flores, Carnero, and Bayer (2014) found that perceptions of social capital available in the community lowered the likelihood of a person experiencing PTSD while social networks had no effect. Augustine (2014) found no effect of social capital on PTSD, and neither high nor low social capital among African Americans predicted happiness or health following Hurricane Katrina (Pyles & Cross, 2008). Weil, Lee, and Shihadesh (2012) argued that the effect of social capital on mental health may fluctuate over time. Individuals with high levels of social capital experienced more stress early after Hurricane Katrina because they were busy helping others, but this effect reversed later and allowed these persons to access support and thus recover faster than others. Greene and colleagues (2015) and Beaudoin (2007b) found small positive effects of social capital on mental health following disaster, but question the time order of the relationship. Worse mental health may result in less social interactions and more negative views of those social connections, rather than social capital causing variation in mental health. More research is needed to determine the direction of the relationship between social capital and mental health outcomes.

Several articles focused on variation in bonding versus bridging social capital, and all found that these two types operate differently during disaster recovery. Bonding social capital (close ties with friends and family) affects recovery outcomes through the sharing of supplies, addressing immediate needs, and improving perceptions of information quality, but bridging social capital (ties with individuals who may be different than oneself) provides access to different resources during recovery (Bhandari, 2014; Brouwer & Nhassengo, 2006; Cao, Lu, Dong, Tang, & Li, 2013; Casagrande et al., 2015; Elliott, Haney, & Sams-Abiodum, 2010; Horton et al., 2008; Islam & Walkerden, 2014; Lowe, Sampson, Gruebner, & Galea, 2015). Some research notes that bridging social capital may become more important over time following disaster (Bhandari, 2014; Elliott et al., 2010; Hawkins & Maurer, 2010), although other research indicates both types of social capital may become less effective or are depleted over time (Islam & Walkerden, 2014). Two articles focused on social capital in online communications found that perceptions of quality of information from online ties related to bonding social capital (Lu & Yang, 2011; Tang, Tang, Weng, Cao, & Lu, 2012).

A few scholars incorporated social vulnerability into their research on social capital in disaster recovery. For example, marginalized populations have difficulty accessing social capital, which increases their time spent in relief camps and reduces their receipt of aid (Aldrich, 2010, 2011a). The results show that class, race, gender, and disability affect how individuals access and use social capital during disaster. Brouwer and Nhassengo (2006), Elliott and colleagues (2010), Hawkins and Maurer (2010) found that lower income individuals and racial minorities were more reliant on bonding social capital during disaster recovery and had less

access to bridging networks that are important to long-term recovery outcomes. Bosher, Penning-Rowsell, and Tapsell (2007) found that caste and gender in India were important predictors of access to linking or bonding social capital for vulnerability reduction and cyclone recovery. Persons with disability may be especially dependent upon bonding social capital such as family when community-level services are unavailable (Fox, White, Rooney, & Cahill, 2010). In two studies on women following an earthquake in Turkey, social capital was found to have both positive and negative effects (Ganapati, 2009, 2012). Women's involvement with recovery groups and organizations provided emotional support, but also increased the frequencies of negative interactions between the women and local government officials.

Social capital also affected decision-making and collective action participation among individuals during recovery. For example, social capital, in the form of trust, was found to positively influence individual decisions to participate in a flood buy-out program (Vries & Fraser, 2012) or accept a tsunami house (Joshi & Aoki, 2014). Jicha, Thompson, Fulkerson, and May (2011) found that associational membership affected participation in collective action following disaster, but that age was a stronger predictor than associational membership. Cheng, Wang, and Huang (2015) found that communication and media consumption increased intentions to participate in collective action.

For organizations, scholars have found that organizational leaders use their personal and professional social networks to gather information, supplies, find temporary business locations, and foster recovery of their organizations (Blanke & McGrady, 2012; Chamlee-Wright & Storr, 2014; Doerfel, Chewning, & Lai, 2013; Doerfel, Lai, & Chewning, 2010; Hartel & Latemore, 2011; Marin, Bodin, Gelcich, & Crona, 2015). Organizations' internal social capital networks may change and allow for better response to emergent needs (Powley, 2009). Social capital may be especially important for informal businesses (Biggs, Hall, & Stoeckl, 2012). A series of articles on organizations affected by Hurricane Katrina specify that dense, bonding networks of organizational leaders pre-disaster were most helpful during recovery, since building new relationships and trust takes time that is limited in disaster aftermath (Doerfel et al., 2010, 2013; Doerfel & Haseki, 2015). Olcott and Oliver (2014) concluded that connection with business associations provided access to workers or alternative supply chains for organizations during recovery.

14.2.2 Social Capital as a Collective Resource in Disaster

Disaster scholars have commonly described social capital as a "public good" that affects disaster outcomes for groups or communities. These articles differ from the previous articles by focusing on community processes that support the entire community to better mitigate, prepare, respond, or recover from disaster. Further, these articles often use communities, cities, neighborhoods, or counties as their unit of analysis rather than individuals. The articles on mitigation and preparedness focus the participatory mechanisms of social capital for disaster decision-making, while the articles on response and recovery generally compare impacts or recovery rates across communities based on levels of social capital.

14.2.2.1 Mitigation and Adaptation

Authors have developed models of community adaptation that include social capital either as a central feature or one component (Dhakal & Mahmood, 2014; Dolan & Walker, 2006; Eakin et al., 2015; Grothmann, Grecksch, Winges, & Siebenhuner, 2013; Pelling & High, 2005; Petzold & Ratter, 2015; Schilderman, 2004; Sultana & Thompson, 2010). Scholars describe trust, reciprocity, and participatory mechanisms of community engagement as key features of social capital that improve mitigation and adaptation.

These articles argue that greater participation and inclusion in community-level strategies

increases the potential for successful community-wide mitigation and adaptation. For example, two articles focus on local leadership in mitigation or adaptation (Bankoff, 2015; Pelling, 1998). Bankoff (2015) argues that informal leaders are a central component of social capital for adaptation, and uses the example of one leader in the Philippines. Pelling (1998) highlights the importance of participatory adaptation strategies but indicates that elites can often coopt these mechanisms for their own benefit. Everett and Fuller (2011) and Loebach and Stewart (2015) described networks that facilitate adaptation, each highlighting the successes and the challenges. Loebach and Stewart (2015) found that fire safe councils provide a way to encourage mitigation, through monthly meetings, coordination with other groups, and public outreach, but faced challenges in fostering participation and maintaining high levels of volunteer activity. Everett and Fuller (2011) found that local institutions and linking social capital are important to communities but the effects of social capital were limited compared to a strong development state that could construct new safe housing and large-scale mitigation or adaptation projects.

14.2.2.2 Preparedness and Evacuation

Bottom-up social capital or participation was described as important to community preparedness (Allen, 2006; Ebi, 2011), and bonding social capital could contribute to participatory preparedness activities (Dzialek, Biernacki, & Bokwa, 2013). Buckland and Rahman (1999) made a similar argument that social capital is a useful concept to explain the effectiveness and egalitarian nature of community-based management of flooding. Having a community organization focused on disaster within a neighborhood was correlated with increased citizen preparedness and participation in disaster-related activities (Mimaki, Takeuchi, & Shaw, 2009). Similarly, Koh, Elqura, Judge, and Stoto (2008) argue that social capital among public health agencies improves preparedness.

14.2.2.3 Response and Impacts

The research on social capital and community disaster impact and response showed that communities with higher social capital experienced less aggregate impacts and may do so through improved emergency response capacity. For example, social capital has positive, though often small, effects on disaster impacts at the community level. Aldrich and Sawada (2015) found that social capital, assessed through crime rates, was positively correlated with mortality rates in disasters, thus low social capital, as indicated by higher crime, resulted in more disaster deaths. Matsubayashi, Sawada, and Ueda, (2013) found that when social capital, measured as the proportion of the community donating blood, increased, suicide rates following disaster slightly decreased. Yamamura (2010) found that the number of community groups or activities, such as pubic baths or community centers, was negatively correlated with disaster damage (i.e., more community activities resulted in less damage). Social capital in terms of coordination and networks between emergency management and nonprofits supports effective response (Kapucu, 2007; Oh, Okada, & Comfort, 2014). Following the September 11, 2001 terrorist attacks, Kapucu (2006) found that cooperation pre-event facilitated communication between organizations during the response phase. Reimer, Kulig, Edge, Lightfoot, and Townshend (2013) argue that social capital, especially the early incorporation of local networks in formal response mechanisms, improves disaster response. These empirical articles support several conceptual articles about the importance of social capital in disaster impact and emergency response. Several scholars also argue that social capital is central for effective emergency formal and informal response (Baker & Refsgaard, 2007; Jaeger et al., 2007; Munasinghe, 2007).

14.2.2.4 Recovery

Researchers have frequently described social capital as a component of disaster recovery, again indicating it contributes to more equitable

and efficient recoveries (Kawarada & Suito, 2013; Smith & Birkland, 2012; Somasundaram, 2014; Tierney & Oliver-Smith, 2012). The results from empirical articles generally support this view, though there are some mixed results.

Several authors agree that social capital can have a positive influence on disaster recovery, such as faster reconstruction or redevelopment (James & Paton, 2015; Nakagawa & Shaw, 2004; Ozcevik, Turk, Tas, Yaman, & Beygo, 2009). Social capital has been identified by disaster scholars as one component of recovery, along with education and employment, physical revitalization, safety, housing, health, and children and families (Pyles, 2011). Positive recovery outcomes were related to sense of place (Cox & Perry, 2011), sense of community and shared identity (Chamlee-Wright & Storr, 2011b; Oteng-Ababio, Sarfo, & Owusu-Sekyere, 2015), feelings of togetherness (Moore et al., 2004; Sherrieb et al., 2012), levels of participation in community activities (Chandrasekhar, Zhang, & Xiao, 2014; Komlósi, Richter, Rózsa, & Fodor, 2015), and coordination with volunteers (Haraoka, Ojima, Murata, & Hayasaka, 2012).

Several quantitative studies in Japan have found that social capital is positively linked to population return (Aldrich, 2011b, 2012a, 2012b). Specifically, areas with more new local emergent organizations saw faster population return (Aldrich, 2011a). Areas with a history of higher voter turnouts and political demonstrations had faster population growth and the effect of social capital was stronger than the effect of damage, economic capital, and population density (Aldrich, 2012a, 2012b). Shimada (2015) found that suicide rate and crime rate were both negatively related to population growth, while participation in disaster activities had a small positive effect. Lowe and colleagues (2015) found that living in a community with fewer people who lived alone (a proxy for lack of social capital) predicted higher PTSD but not depression.

Several scholars focused on institutions, such as nonprofits and religious institutions as markers of social capital. Existing nonprofits were found to address recovery and incorporate resilience into their previous missions following disaster (Vallance & Carlton, 2015). In terms of economic recovery, a comparison of two cases of earthquakes revealed that a long-term drop in Gross Domestic Product was prevented by effective institutions that avoided corruption (Barone & Mocetti, 2014). Bin and Edwards (2009) found that managers' involvement in community organizations, including religious organizations, increased corporate giving to employees and the community at large following disaster. The authors concluded that organizational involvement allowed managers to become aware of local needs and increased their likelihood of being asked to provide charitable donations to disaster recovery. On the other hand, McCarthy (2014) argues that social capital approaches to recovery are often at odds with other drivers of nonprofit disaster recovery goals such speed, transient nature, and the need to show quick successes to the philanthropy community and thus nonprofits do not automatically improve recovery. Similarly, Long and Wong (2012) found that a focus on speedy recovery ignores the need for social capital to be rebuilt.

Social capital provides one theoretical tool in disaster research to understand how collective action or the therapeutic community arises, and scholars argue that more social capital should generate more collective action following disaster (Shaw & Goda, 2004). For instance, social capital may affect the assessment of community problems and thus the amount of community participation to address those problems (Wickes, Zahnow, Taylor, & Piquero, 2015). Yet, studies on the role of social capital in creating collective action post-disaster have mixed results. Li, Chen, and Suo (2015) found that the proportion of strong ties in a network affected participation in the therapeutic community after disaster. On the other hand, larger networks decreased the likelihood of participating in informal collective action, but increased the likelihood of participating in government-led collection action. In contrast, Mukherji (2014) and George (2008) found that high bonding social capital did not

necessarily result in collective action following disaster.

14.2.3 Social Capital and Disaster Resilience

Many authors have written conceptually about the role of social capital in resilience to all types of disasters and put forth models that could be used to predict community and individual resilience before a disaster occurs (Aldrich & Meyer, 2015; Aldrich, Sawada, & Oum, 2015; Houston, Spialek, Cox, Greenwood, & First, 2015; Kulig, Edge, Townshend, Lightfoot, & Reimer, 2013; Norris & Stevens, 2007; Norris et al., 2008; Sherrieb et al., 2010; Skerratt, 2013; Ungar, 2015). Several scholars discuss the role of social capital across all phases of disaster to improve resilience (Chui, Feng, & Jordan, 2014; Ingham, Hicks, Islam, Manock, & Sappey, 2011; Mathbor, 2007; Murphy, 2007; Richardson, 2005). Others scholars have discussed social capital's role in specific types of resilience such as health (Bajayo, 2012; Castleden, McKee, Murray, & Leonardi, 2011), ecosystem (Berke & Glavovic, 2012), tourism (Sydnor-Bousso, Stafford, Tews, & Adler, 2011), security (Helm, 2015), and business (Prasad, Su, Altay, & Tata, 2015). Social capital is often viewed as one component of resilience, along with economic and physical capital, among a variety of other components.

Based on the prediction that social capital increases disaster resilience, several studies offered descriptions of programs or circumstances that can increase social capital and thus resilience (Kropf & Jones, 2014; Lizarralde et al., 2015). Collective action networks for farmworkers (Rivera, Kapucu, & Hawkins, 2015) and network ties that can support marginalized populations who are fighting for social justice (van Voorst, 2014) have shown how social capital networks can improve some facets resilience. Carpenter (2015) found that physical aspects of neighborhoods that would facilitate social capital, such as land use mix, residential and intersection density, open space, presence of networking organizations, and organization density, affected resilience along the Gulf Coast of the U.S. Takahashi and colleagues (2015) found that participation in a collective farm program in a temporary housing community increased feelings of well-being and reduced body mass index. Beaudoin (2007a) found that a media campaign targeted to an African American community following Hurricane Katrina increased perceptions of neighborliness, but not social support. Hamiel, Wolmer, Spirman, and Laor (2013) described an urban resilience program for children that incorporates social capital. Asset-based pre-event recovery and resilience planning can support social capital development (Freitag, Abramson, Chalana, & Dixon, 2014). Asset mapping can increase inclusiveness of resilience planning and foster knowledge as well as intentions for collective action (O'Sullivan, Corneil, Kuziemsky, & Toal-Sullivan, 2015). Development of community response teams can increase social capital and thus resilience (Lionel, 2015). Consideration of social capital in the design of transitional housing may increase resilience (Spokane, Mori, & Martinez, 2013) and incorporation of farmers markets can foster social capital and thus resilience (Menck & Couto, 2013).

If social capital is a positive good for resilience, scholars have asked what may make it ineffective in producing resilience. Research has shown how external, formal government structures or large nonprofits erode, ignore, or otherwise undermine local social capital, which negatively impacts disaster resilience (Alipour et al., 2015; De Silva & Yamao, 2007; Imilan, Fuster, & Vergara, 2015; Larenas, Salgado, & Fuster, 2015; Rubin, 2015; Zanotti, 2010). National or international government structures and top down approaches to resilience may turn communities into victims, which suppresses their internal capacity for collective organization that fosters resilience (Alipour et al., 2015; Imilan et al., 2015; Larenas et al., 2015).

14.2.4 Effects of Disaster on Social Capital

A portion of the articles reviewed assessed the opposite relationship—that disasters affect social capital. If Dynes' (2002) presumption is true, social capital should grow due to disaster experience, specifically during the response and recovery phases. Dussaillant and Guzmán (2014), Pena, Zahran, Underwood, and Weiler (2014), and Toya and Skidmore (2014) support his proposition and found positive effects of disaster on social capital using longitudinal data. Disasters in U.S. counties were found to have a small positive effect on overall assets among nonprofits and generate a small increase in the number of nonprofits operating in a county (Pena et al., 2014). Disasters were found to increase trust over time (Toya & Skidmore, 2014; Veszteg, Funaki, & Tanaka, 2015), but trust may increase most in areas that had high levels of trust before disaster (Dussaillant & Guzmán, 2014). Olcott and Oliver (2014) found that disasters affect the diversity and density of organizational networks for at least a short period of time. Similarly, linking social capital (e.g., involvement in organizations) may increase following disaster resettlement but bonding social capital may decrease, which may reduce mutual helping behaviors (DaCosta & Turner, 2007).

Yet other studies have found that disasters have mixed, negative, or no effect on social capital. For example, Besser, Recker, and Agnitsch (2008) found no effect of disaster on bonding or bridging social capital across 99 communities in Iowa, whereas economic shocks did affect social capital. Berke, Chuenpagdee, Juntarashote, and Chang (2008) found a variable effect of disaster on collective action, but a small effect on awareness of ecological issues. Fleming, Chong, and Bejarano (2014) found no effect on trust and a small, negative effect on reciprocity in Chile. Using a large survey across three countries, Carlin, Love, and Zechmeister, (2014) argued that the effect of disaster on trust is moderated by the state. The authors found that worse opinions of the government resulted in a greater negative impact of disaster on trust. Furthermore, if a disaster is very large, it could have negative impacts on social capital by destroying networks and reducing local capacity (Aghabakhshi & Gregor, 2007).

The above mixed results of disasters' effects on social capital focuses on natural disasters. One consistent finding in this literature is the negative effect of technological disasters on social capital. Since technological disasters have been shown to generate a corrosive community, this corrosiveness has been argued as a sign that technological disasters negatively affect social capital (Couch & Coles, 2011; Ritchie, 2012; Ritchie & Gill, 2007; Ritchie, Gill, & Farnham, 2013). The theoretical piece by Ritchie and Gill (2007), especially, provides meaningful discussion of how social capital can be conceptualized in technological disasters. Research on the Exxon Valdez Oil Spill has shown that technological disasters affect trust, reciprocity, and social networks (Ritchie, 2012; Ritchie et al., 2013). Sauri, Domingo, and Romero (2003) found that an oil spill decreased social capital, specifically community involvement and trust. Survey research has found similar but more complex relationships between disaster type and effects on social capital. Scott, McSpirit, Breheny, and Howell (2012) found that a coal waste incident increased environmental concerns, but decreased trust, initially. Over time, they found that this impact on trust weakened. Tan and Pulhin (2012) found that collection action and networking in formal, informal, and spontaneous groups did occur following an oil spill in the Philippines, but that these collective activities did not last long, nor increase the adaptive capacity of the community.

14.3 Moving Disaster Scholarship Forward

Social capital, as an interaction-based resource that provides individual and collective resources, has been applied across varies disasters and geographic contexts. This literature review has shown several key findings about the state of social capital knowledge in disaster research. First, most social capital research in disaster focuses on recovery or resilience, with limited

research on mitigation or preparedness. As other chapters in this book show, there are numerous studies that describe how friends, neighbors, and family members also communicate warnings, encourage disaster preparation, and provide supplies (Dash & Gladwin, 2007; Hurlbert, Haines, & Beggs, 2000; Lindell & Perry, 2012; Norris et al., 2002; Peacock, Morrow, & Gladwin, 1997). The "social capital" framework has yet to be fully applied within these phases of disaster.

Relatedly, this literature search highlights how classic research in the field, for example on the therapeutic community, does not use the framing of "social capital." Many articles in this review included references to earlier research that falls under topics such as "social networks," "social support," "collective efficacy," or "collective action" as evidence of the effect of social capital in disaster—yet those original articles do not specifically use the phrase "social capital." Furthermore, a literature search of "social capital" also leaves out a prominent models of community resilience, for example Cutter and colleagues (2008). They used the phrase "community capital" rather than "social capital" in their model, highlighting how the empirical phenomenon of interest—networks, norms, and interactions that foster mutual benefit—are referred to by a variety of names. A search of just "social capital" overlooks these pieces and underrepresents the foundational knowledge about social ties in disaster. Thus, scholars should review the conceptual articles that discuss how social capital applies to early findings and search the literature for phrases used in early scholarship.

Third, few longitudinal or comparative research articles exist that untangle pre-event social capital from social capital post-event and thus elucidate appropriate causal mechanisms. As highlighted by the mental health and social capital research, it is unclear whether positive post-event perceptions of community affect mental health or if positive mental health causes positive perceptions of social capital. Questions about the role of social capital in recovery need further specification as to how emergent social capital compares to existing social capital in quantity, quality, and effects on disaster outcomes. This clarification is important for disaster practice as fostering emergent social capital may be different than activities that strengthen pre-event social capital that would transition into post-event collective action.

Fourth, more research is needed that assesses the relationships between social vulnerability and social capital in disaster. Building on results from non-disaster settings, scholars have assumed that marginalized populations rely on bonding social capital and generally lack bridging or linking social capital compared to other groups. These hypothesized results have proven true in a few studies but much more work is needed to understand how social capital mediates or multiplies the effects of social vulnerability and how social capital interacts with other forms of capital, such as economic, human, and symbolic capital. Increased incorporation of Bourdieu's theory (1985) would support this research as he clearly positions social capital among the milieu of resources available to different individuals based on their social location. Questions about social capital for whom and for what purpose are central to contributing to the growth of this field of research within disaster studies.

Fifth, social capital in disaster research faces similar concerns to social capital research in general including a lack of consistent definitions and theoretical grounding. Social capital is a complex concept and highly debated within general social science literature. The use of various definitions and theorists will continue to perpetuate that confusion about the concept in the disaster scholarship. But further, this review of the literature on social capital in disaster shows there is a potential concern about grounding in the general social capital literature. Thirty percent of articles reviewed here do not cite any of the four theorists discussed in this chapter: Bourdieu, Lin, Putnam, or Coleman. Thirty-seven percent cite one of those theorists, 15 percent cite two, 13 percent cite three, and six percent cite all four. Putnam is the most common scholar referenced (55% of all articles), followed

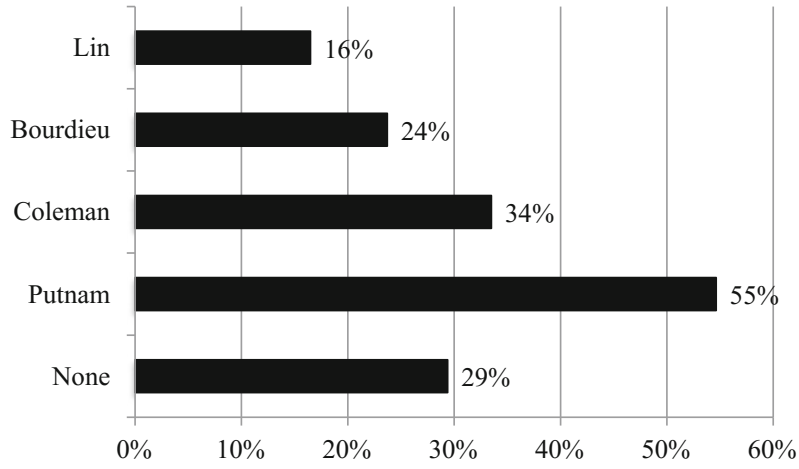

Fig. 14.4 Social capital theorists referenced in articles reviewed

by Coleman (34%), Bourdieu (24%), and Lin (16%).[4] As stated above, social capital within the tradition of Putnam has been highly criticized for its tautological and normative reasoning. The predominance of scholarship following this tradition may generate similar concerns within disaster literature (Fig. 14.4).

Finally, and relatedly, the empirical findings show positive, negative, and no effect of social capital on disaster outcomes depending on the study. Yet conceptual models overwhelming identify social capital a benefit to disaster resilience, adaptation, preparedness, response, and recovery. Social capital in disaster, just as in general social capital research, is assumed to be a "cure all" for social problems. For instance, below is a quote from one conceptual article that identifies how low social capital affects communities:

> [Communities with low social capital] are likely to have ineffective local government and civic structures in which individual residents do not have the opportunity to give positive input. They lack effective voluntary associations, or when they exist, they are isolated from the larger community. Residents lack positive friendship and associational networks within the community; in addition, they lack economic resources to meet the needs of the community and its residents. Instead of trust within the community and between the community and larger institutions, there is distrust and disdain, and the belief that people cannot count on each other or on larger institutions to help them meet their needs. (Couch & Coles, 2011: S141).

While the conceptual articles and models of resilience promote a purely positive view of social capital, research has shown the "dark side" of social capital. For example, Rahill, Ganapati, Clerisme, and Mukherji (2014) found that social capital increased between-group tensions and violence following disaster. Social capital was found to be correlated with "NIMBY" (Not-in-my-backyard) actions in which areas with more social capital were able to prevent the placement of temporary housing in their neighborhoods (Aldrich & Crook, 2008) or limit rebuilding opportunities (Lawther, 2014). In other instances, disaster scenarios provide the opportunity to use resources for personal or organizational gain, such as increasing social and symbolic capital within the field of philanthropy or maintain power relations (Bennett, 2014; Hollenbach & Ruwanpura, 2011), target resources towards lobbying rather than mutual aid (Chamlee-Wright & Storr, 2011a), or create processes that lack community participation or involve bribe taking (Islam & Walkerden, 2015). The models in which social capital is used for predicting resilience have very normative, positive views of "community" and collective action that ignores the body of work on socio-ecological theory that highlights variation and conflict

[4]Some articles that do not cite one of these four, cite other work in social capital, such as Woolcock and Narayan (2000) and Portes (1998), among others.

within communities (Peacock & Ragsdale, 1997). Better specification of social capital and incorporation of other social capital theorists may help disaster researchers combat these issues.

14.4 Conclusion

The breadth of social capital research is expanding rapidly, and the concept provides fertile ground for understanding both individual and collective processes that affect all phases of disaster, as well as developing research-grounded programs that improve disaster resilience. Social capital has the potential to contribute to increased understanding of both pro-social and negative outcomes for communities and individuals in disaster. In disaster research, as in all research on this topic, careful consideration is needed in defining and operationalizing social capital. As social capital is integrated into policy and programming, this line of research is needed to ensure policies and programs are effective at reducing impacts of disasters and do not put people at further risk of disaster or social marginalization. How and when social capital promotes resilience or, conversely, greater risk and *for whom* are central questions for future disaster research to answer.

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Part IV

Methods and Methodological Issues in Disaster Research

Methodological Issues in Disaster Research

15

William Donner and Walter Diaz

Contents

This manuscript owes a great debt to and draws significant inspiration from Robert Stalling's chapter in the first edition of this volume, as well as his wide collection of writings outlining, critiquing, and synthesizing the various methodologies that have come to define the empirical foundations of the field.

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15.1 Introduction

Social scientific inquiry into environmental hazards is, in relative terms, a fairly recent enterprise. At the turn of the 20th century, Prince's (1920) classic study of the Halifax Explosion drew increasing attention to the social and psychological dimensions of disaster, but without a critical mass of scholars devoted to the subject, nor, much less, a common definition of "Disaster," findings tended to lack a broader theoretical perspective within which to find meaning and application. As the field evolved conceptually, largely due to the work of Quarantelli, Dynes, Kreps, Drabek, and other scholars, so too did its methods. What was once a discipline largely devoted to qualitative research began to rapidly borrow and integrate data collection, sampling, and analytic techniques from fields as diverse as statistics, public health, geography, engineering, communication, and various sub-disciplines of the humanities. Today, one witnesses advanced statistical applications, electronic cartography, and social network analysis applied alongside more traditional fieldwork approaches. What is more, recent history has witnessed growing collaboration between scholars of the social sciences, physical sciences, and humanities.

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The following chapter is aimed towards providing a survey of modern approaches to disaster research methodology and the unique challenges of executing studies in which disaster is a central focus of investigation. As will be seen in the forthcoming paragraphs, the field is fundamentally different from other substantive areas in sociology with regard to conducting research—from planning fieldwork, developing measures, keeping with ethical standards, and analyzing data. Frequently, disaster scholars contend with limited time frames, vague or incomplete background information, and the emerging need to work collaboratively with natural and physical scientists.

As such, scholars new to the field are encouraged to consider in this chapter the distinctions between how we, as sociologists of disaster, go about doing research and how sociologists of gender, education, and crime go about doing theirs. While the similarities of method are many, so too are the differences. It is the authors' goal that this chapter offer new scholars insights into these distinctions, as well as perhaps encouraging more established researchers to reflect on new concepts, approaches, and technologies within the field. Indeed, the disaster research of today, with its new approaches to data collection and analysis and emerging interdisciplinary focus, stands in sharp relief to its appearance just two decades ago. We hope to highlight these importance advances in the chapter as well.

With these two goals in mind, the chapter is structured in two broad ways. The first section of the manuscript summarizes, briefly, the origins of the field and then moves on to discussing common methodological problems that occur within the context of data collection, causal modeling, and sampling. The second part of the manuscript addresses techniques and perspectives that, while new in relative terms, are becoming increasingly mainstream in their use due to demonstrated benefits in the collection and analysis of data. These include multilevel modeling, GIS, and interdisciplinary approaches. The manuscript concludes with a summary and discussion of future directions of the field within the context of the previous discussion.

15.2 The Origins of Disaster Research: A Brief History

Historians and academics have from classical times been drawn to the significance of disasters for human society and culture. Pliny the Younger, the son of a Roman Court Official, described in vivid detail through series of letters to Tacitus the social and psychological dynamics touched off by the eruption of Mount Vesuvius, providing what might be regarded as the first "field study" of disaster response among Pompeii's citizenry. Citizen debates over evacuation concerns, the prevalent need for confirmation in order to act ("the flames and smell of sulphur which gave warning of the approaching fire drove the others to take flight"), and improvisational sensemaking in the face of uncertainty anticipated in nascent conceptual form several theoretical themes, observations, and questions central to the literature on disasters today (Spielvogel, 2012, p. 166). Indeed, the philosophical and social significance of disasters would remain a crucial subject for later thinkers, perhaps none more notable than Voltaire, for whom the 1755 Lisbon Earthquake served as a chief theme in several writings. According to scholars, the Earthquake evoked considerable debate and discussion in Renaissance social, political, and philosophical thought, particularly in philosophical exchanges between Voltaire and Rousseau (Dynes, 2000).

Despite a common concern with disasters, early writings were predominantly focused on what philosophical lessons might be drawn from disasters and were far less directed toward theory development, a pattern which would hold for decades prior to Prince's Halifax study. Samuel Henry Prince is widely regarded as the first scholar whose work would systematically explore disasters from what most closely resembles social scientific perspective (Scanlon, 1988). Following the explosion of a French

munitions vessel at a harbor in Nova Scotia, Prince, at the time a Ph.D. student in Sociology at Columbia University, was encouraged by his advisor to study the disaster from a sociological perspective as part of a thesis project. The resulting dissertation, *Catastrophe and Social Change*, offered the first formal and systematic study of organizational response to disaster and accordingly set the stage for further theoretical developments in the field. Scanlon (1988) notes that Prince's study, despite advancing perspectives that are today unfashionable, nevertheless addresses core themes that have emerged in the field, including convergence, scapegoating, emergent behavior, and role abandonment. These themes would find central relevance in work conducted soon thereafter at the National Opinion Research Center (NORC) and the Disaster Research Center (DRC).

Originating with Likert's research into WWII bombing raids in Nazi Germany (Gentile, 2000), the formal origins of the field can be traced to research funded largely through U.S. military organizations in the late 1950s largely driven by an interest within the Department of Defense (DOD) of developing military applications from studies of community and organizational response to domestic disasters (Quarantelli, 1987a). Through a series of fieldwork studies organized and led by Charles Fritz, Shirley Star, and Eli Marks, the National Opinion Research Center (NORC) developed what would become the first long-term research program devoted to the study of human behavior and disaster (Ruben et al., 2011). Early research focused on a wide variety of disasters, including airline disasters, a coalmine explosion, earthquakes, and a tornado, which resulted in the field's first systematic insight into panic, emotional distress, and warnings (Fritz & Marks, 1954). For the next decade, Cold War concerns would drive and fund a majority of the inquiry into disaster events from a sociological perspective.

With the conclusion of the NORC studies, disaster research, as an independent and institutionalized field of academic study, originated in the 1960s at The Ohio State University (OSU) through the work of Russel Dynes and Henry Quarantelli. Dynes and Quarantelli would go on to establish the Disaster Research Center (DRC), the first research center devoted exclusively to the social scientific study of natural and technological disasters. Borrowing from the NORC model of disaster field studies, The DRC operated at OSU from 1963-1984, during which time it conducted large scale population surveys, fieldwork, and participant observations, on the basis of which many of the foundations of the field were developed and articulated in scientific terms (DRC would later permanently relocate to the University of Delaware). Within this time period, several important conceptual advances were achieved through the synthesis of fieldwork results. Dynes' *Organized Behavior in Disaster* (1970), a classic work in the field, set about conceptualizing the institutional and emergent contexts that shape organizational response to disaster events. At the same time, empirical works in the form of ethnographic fieldwork also flourished, most notably the study of collective stress following the Buffalo Creek flood (Erikson, 1976), organizational response to a Fairgrounds Coliseum explosion in Indiana (Drabek, 1968), and the emergence and management of community trauma (Barton, 1969).

Contributions from scholars outside of the discipline of Sociology also shaped the history of the disaster field. "Social geographers," namely Burton, Kates, White, and others, reconceptualized the problem of society and disasters: "Rather than asking, 'how do people behave during and after a flood,' they have asked instead, 'how do people perceive and try to use lands that are flood prone?" (Drabek, 2012, p. 4). It is not unthinkable that without the contributions of past geographers, whose work raises issues of spatial patterns and dynamics in disaster research, powerful tools such as electronic cartography may have not seen widespread use among disaster scholars.

Today, disaster studies has evolved significantly over the course of the past three decades in

terms of theoretical and methodological approaches. While the field relies heavily on traditional methodologies such as qualitative fieldwork and surveys, advances in the areas of GIS and computer simulation modeling offer new ways to solve unresolved methodological issues.

15.3 On the Distinctiveness of Disaster Studies as a Field

Disaster research retains a unique position within the social sciences given the character of the phenomena which it investigates. Similar to other areas in sociology, the field is principally concerned with human society, behavior, and psychology. At the same time, however, disaster research is fundamentally different than other fields in several ways, the principle reason being that disaster research is oftentimes (although not exclusively) focused on the occurrence or result of some discrete event that occurs in the natural environment. This leads to a fundamental question: in what ways is the research methodology of disaster research different from the research methodologies of Sociology in particular and the social sciences in general? Put another way, in what ways would the scientific protocol, on the one hand, to study tornado warning response and, on the other, to study institutional education policy, gender dynamics in the workplace, or healthcare access diverge in terms of theory and practice - if indeed they do diverge at all? Holding a significant distinction to exist, Stallings (2007), in his chapter in the original version of this Handbook, identifies and summarizes three elements of disaster research that make it unique, which we preserve for this chapter:

1) Timing
   Timing refers to the limited amount of time within which fieldwork can be planned and executed. Disaster events happen rapidly, evolve quickly, and with little warning, thereby leaving little time for the planning and execution of fieldwork. Naturally, time constraints vary from disaster to disaster, but, as a general rule, mobilization for fieldwork operates under the need for rapid deployment.
2) Access
   Researchers also may have limited *access* to individuals and organizations within the field for a variety of reasons, ranging from targeted populations leaving the area, preoccupied gatekeepers and informants, and prohibitions against entering certain affected areas. Anticipating access issues remains difficult as the circumstances surrounding disasters are apt to change.
3) Generalizability
   Finally, the conditions under which information on disasters is collected and the limited number of informants and interviewees make it difficult to abstract findings to other disaster scenarios. What makes generalizability in the context of disaster research more difficult in comparison to other fields is that it is not only the *population* that limits generalizability, but also the *event characteristics* as well. Just as no two populations are the same, no two tornadoes, hurricanes, or earthquakes share the same characteristics in terms of duration, scope, and intensity. For disaster research that is strictly event based, the populations affected by a disaster tend to have unique characteristics, which for comparative studies forces researchers to identify similar populations as controls. In mental health studies of earthquake disasters, for instance, this creates problems because changes in psychological outcomes within both the affected group and the unaffected groups may be due to either the effect of the disaster or differences between the groups themselves (North & Norris, 2006).

Modern developments in the field have led to a fourth concern that should also be noted. To these three, we add:

4) Interdisciplinarity
   Although there is wide debate over the definition of a disaster (see "Defining Disaster: An Evolving Concept" in this Handbook),

scholars at the very least agree that a disaster involves some level of interaction between a physical event and society. As such, there is an implied need for collaboration between those scholars who study the environment and those that study society - between meteorologists and sociologists, seismologists and psychologists, volcanologists and anthropologists, etc.

Because disasters involve a physical event, this may draw the interest of meteorologists and seismologists. There are many important, developing areas methodologically, including agent-based modeling and computer simulation. Here, however, we focus mainly on the traditional areas of disaster studies: qualitative fieldwork, quantitative surveys, and the emerging-yet-increasingly-common use of electronic cartography (GIS). We also loosely adhere to the conceptual model set forth by Stallings (2007) for the reason that the three (or, presently, four) distinctive elements that make disaster research distinct from other fields of inquiry oftentimes overlap. For example, access to sufficient informants or generalizability (or, what can be generalizable in the context of qualitative work) is frequently the product of timing issues and, also, the short window within which data can be collected may make it difficult to collect solid, generalizable data for some disaster scenarios, such as tornadoes.

15.4 Conceptual, Methodological, and Ethical Issues in Disaster Research

As discussed at length here, there is a debate in the literature over whether the methods of disaster research are unique or not. Indeed, disaster scholars employ many of the same techniques of other disciplines (e.g., interview guides, surveys, etc.) in studying disaster, and the applications of those techniques are, in a purely technical sense, unchanged in this use. In practice, however, the application of disaster methods stands in sharp relief to applications in other sub-fields, such as the sociology of race, gender, medicine, etc. Disaster research shares many of the problems sociology and other social scientific disciplines confront, from fuzzy definitions, sampling difficulties, and problems operationalizing and conceptualizing vague concepts. However, just as disaster research is unique, so too are unique the challenges it confronts in conceptualizing and researching disasters.

15.4.1 What Is a Disaster?

Any field which hopes to understand and explain something about the physical or social world is first tasked with defining the very thing it hopes to study. Physicists and astronomers would not proceed without a definition of gravity, nor would psychologists embark on studies without clear definitions of cognition, affect, or IQ. So too is it a requirement for Sociologists of Disaster: a disaster must be defined and a model for identification developed in order for "disaster" to be studied systematically. There is a general consensus that a disaster results from some interaction between a potentially hazardous event and society (again, see "Defining Disaster: An Evolving Concept" in the present Handbook). Fundamentally, a disaster is a "social phenomenon" (Perry, 2006) and the accompanying hazard, while necessary, is insufficient to bring about a disaster per se. A tornado, however violent, would not be regarded as a disaster were it to occur in an uninhabited space, such as an empty field. Despite this agreement among disaster scholars, a broad spectrum of perspectives and theories offer somewhat limited consensus on what is precisely the field's fundamental object of inquiry. Indeed, such little consensus exists that entire books have been devoted to the problem of conceptualizing a disaster and developing a common definition on which research may be grounded (Quarantelli, 1998).

Fritz's (1961) classical definition of disaster is as follows:

> …an event, concentrated in time and space, in which a society or a relatively self-sufficient subdivision of a society undergoes severe danger and incurs such losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of essential functions of the society is prevented (p. 655).

Fritz's definition borrows implicitly from structural-functionalist perspectives originating with Durkheim and later refined by Parsons in identifying the most central and important features of society as being its structural and functional attributes, the widespread disruption of which is labeled "disaster." Yet the scope of the definition is too narrow to be useful. A disaster that strikes a vulnerable population might have devastating effects for that population in particular, but may not necessarily contribute to the decline in functioning of society as a whole as specified under the original definition. Furthermore, Fritz's largely functionalist definition of disaster invites criticism, for example, largely because what constitutes an "essential function" remains highly vague. This objection is deeply relevant for methodological approaches to disaster, for, as Quarantelli (1987b) observes, a strict functionalist interpretation of disasters inevitably "would leave out of consideration… the vast bulk of what most disaster researchers have studied as disasters." Other scholars share Quarantelli's concerns (O'Keefe, Westgate, & Wisner, 1976; Wisner, Blaikie, Cannon, & Davis, 2004). For instance, the Bhopal disaster, which had tremendous human costs both immediately and over time, had little effect on the functional or structural integrity of Indian local, regional, or national society in the long- or short-term, thereby highlighting conceptual gaps in a strictly functionalist approach to the conceptualization of the relationship between society and disaster. Further upending the structural-functionalist view is a theoretical branch of disaster studies that focuses on the "constructed" or subjective elements of disasters, ignoring the objective features of the event partially or entirely (Stallings, 1997). Tierney, Christine, and Erica (2006), to illustrate, examined how media myths construct false images of disasters in the public consciousness, an approach undertaken by previous scholars (Fischer & Drain, 1993; Stallings, 1990).

15.4.2 Planning and Ethical Issues

A fundamental assumption of the qualitative approach in disaster studies is that researchers, prior to entering the field, are as familiar as possible with the people and setting around which the study will revolve. Within the context of disaster studies, however, time is more often than not a limited commodity: researchers must rapidly enter the field in order to identify key informants and in so doing acquire rapidly-perishable information. Data on disaster events have a very short existence within the field, and researchers must work very quickly to comprehensively collect information. While this presents numerous methodological issues, several ethical and bureaucratic obstacles also emerge within the context of university-supported fieldwork.

Institutional Review Board (IRB) approval presents one possible challenge. Although there are no reliable data, it is not unreasonable to assume that many IRB boards will place quick response studies under relatively greater scrutiny as interviewees may be asked to recall traumatic experiences either unexpectedly or expectedly, a form of inquiry which might be expected to exceed the threshold of "minimum risk" under which studies are commonly evaluated. As a result, all else equal, quick-response fieldwork focusing on trauma may be flagged for full review. If this is the case, IRB reviews may take longer in comparison to other research falling below the minimum risk threshold. At the same time, however, disaster fieldwork must be initiated immediately for fear of data loss, thereby creating an administrative dilemma for

researchers. Depending on the culture of the university, fieldwork may be delayed if proposals go through full or perhaps even expedited reviews.

Once in the field problems also occur vis-à-vis human subjects' issues. Since emergence is a well-known feature of disaster (Turner & Killian, 1957), field researchers may encounter unexpected and evolving personnel, groups, events, and organizations during fieldwork. (Indeed, sometimes the emergence of new behaviors, groups, networks, and organizations is in itself the very object of inquiry!) The result is the need to quickly revise survey instruments to account for new and theoretically-relevant phenomena unanticipated in the process of preparing for fieldwork. Again, depending on the IRB culture of the university at which researchers work, this may or may not present challenges. Some universities offer blanket IRBs that preemptively cover minor changes to instruments and sampling; other universities may require contact with IRB; whereas others may require a full re-evaluation. Higher levels of review are more likely when a vulnerable population is studied, which presents a unique set of ethical issues (Ferreira, Buttell, & Ferreira, 2015). The net result is that fieldwork may be delayed while waiting for human subjects' approval, thus risking the loss of perishable data.

Fieldwork in disasters also presents a rather unique ethical challenge. While ethics is oftentimes framed in terms of individual responses, disaster field researchers, especially within the context of major events, often attempt entre into what Barron Ausbrooks, Barrett, and Martinez-Cosio (2009) aptly call "stressed institutions." The human subjects' dilemma here lies in whether it is reasonably ethical to take time and resources away from emergency response organizations on whom many victims rely for aid. Hospitals, emergency shelters, and governmental and non-governmental organizations typically enjoy limited time and resources when activated during a disaster. Granting time to researchers for the purposes of interviewing and observations may take time away from the treatment of the sick, relief efforts, and other activities central to the organization's mission (Kelman, 2005). In such contexts, as with any other organization, consent is vital, and the identification of gatekeepers who may or may not grant entre is critical to maintaining ethical standards.

Another important question remains whether traumatized groups remain capable of fully and freely consenting to participation in research. While concerns have been raised over the ability of trauma survivors to fully consent to research, some argue that it is nevertheless "inaccurate to assume that all disaster survivors have impaired decision-making capacity, especially when evidence has shown that those with acute stress disorder and posttraumatic stress disorder do not generally possess diminished capacity" (SAMHSA, 2016, p. 5). Nevertheless, the report goes on to mention the need for screening to determine if potential interviewees are mentally fit to participate in disaster surveys and interviews (Collogan, Tuma, Dolan-Sewell, Borja, & Fleischman, 2004; Ferreira et al., 2015; NIH, 2007).

15.4.3 Issues in Qualitative Fieldwork

Disaster studies owes a great debt to qualitative sociology and anthropology, the methods of which formed the empirical foundations of early research at NORC. Such methods formed the basis of investigation of human behavior during disaster. Thus, research called for methods of an exploratory nature which could account for the uncertainty with which early researchers were faced when in the field. Today, qualitative research has retained status as the central method of data collection and analysis of disaster studies because much research is event based, meaning that researchers wait for a disaster to strike, then deploy accordingly. Qualitative research offers the flexibility in terms of design, data collection, and analysis necessary for collecting data under the often-times uncertain physical and social environments in which disaster scholars perform their work. As emergent behavior is the norm under such circumstances, the qualitative approach is in many cases ideal.

Qualitative fieldwork and case study constitutes a majority of the methodological approaches seen in the field of disaster studies, comprising the principal methodological tools in canonical works such as *Catastrophe and Social Change* (Prince, 1920), *Disasters in Aisle 13* (Drabek, 1968), *Communities in Disaster* (Barton, 1969), and *Everything in Its Path* (Erikson, 1976). Such methods saw widespread early use because the nature of disaster phenomena aligns well with the epistemological and ontological rules of the qualitative approach. Phillips (1997, p. 185) argues that "disaster challenges communities in unexpected ways, and with unanticipated consequences, [and therefore] qualitative disaster research can capture human behavior at its most open, realistic moments". In a study of behavior following the WTC attacks, Kendra and Wachtendorf (2003) applied qualitative inquiry to understand the complex and emergent behaviors and interrelationships between responders that may have been lost had a more static quantitative approach been used.

When qualitative fieldwork is used to study disaster, its application tends to take a much different course when compared to other fields. When a qualitative sociologist might study some social process (e.g., adopting a role, rite of passage) or perceptions (e.g., opinions on issues, attitudes towards policies, etc.), the object of interest to the researcher tends to exist over the long term and is, more or less, readily identifiable (the lack of consensus over disaster definitions making them less so). For example, if a qualitative sociologist is interested in the socialization process by which civilians become soldiers, there is little waiting and uncertainty involved since military training is an ongoing, continuous, and institutionalized process. In addition to emergent phenomena, disaster researchers also study social phenomena that are similarly established and ongoing. Disaster sociologists might study the long-term everyday processes and functioning (e.g., factors that affect mitigation planning) of an Emergency Operations Center (EOC), in which case planning is less urgent in terms relative to quick-response fieldwork. However, if disaster sociologists hold more interest in how an EOC responds to a tornado or earthquake, deployment must be rapid, and the planning process is many times much more urgent. Acknowledging this, there is a very robust funding regime at the Natural Hazards Center (NHC) and elsewhere that supports quick response research.

The structure of the fieldwork enterprise in the Sociology of Disaster therefore reflects this lack of uncertainty in practice. Researchers must rapidly prepare for and plan fieldwork excursions, often with limited time and resources, many times applying for grant funding contemporaneously with the planning process. Typically, the first stages of fieldwork involve the acquisition of news articles and other media providing details about where the disaster struck, institutional involvement, mortality rates, and other information relevant to the planning and preparation processes. In some cases, this may reflect researchers' specific interests. As an illustration, a researcher with a background in public health might be interested in studying the management of abnormally high mortality rates, so he or she might focus an initial search on areas with the highest rates of morbidity (DMORT). Organizational sociologists might be interested in shelter management issues, which would lead them to find out where shelters are located. The integration of Geographic Information Systems (GIS) into this process has assisted in this regard. For example, if researchers would like to focus on communities that were nearest a series of tornadoes, and the information is available, the locations of tornado events may be located with latitudinal and longitudinal coordinates. Further decisions may be made by overlaying census maps if factors such as poverty, population density, and racial groups are of theoretical or empirical interest to the research, as well.

The nature of the relationship between interviewer and respondent is quite different within the context of fieldwork, particularly with respect to how field researchers relate and are expected to relate to actual and potential interviewees, informants, and gatekeepers within the field. Stallings observes that "in non-disaster research, research

subjects are *respondents* who are sources of data on their personal attitudes, behaviors, and characteristics. In disaster research, especially field studies, research subjects are more often treated as *informants* who describe not only their own actions, but also those of the people around them," warning that "often the researcher's goal is to obtain a holistic picture of some social process or bundle of processes…ideally, one would like access to organizational informants from all levels of the chain of command and from different subdivisions…when officials deny researchers access to specific elements within organizations, a bias is introduced into the data." (Stallings, 2007, p. 62, authors' emphasis). Because disasters involve a complex interworking of organizations, groups, and individuals from both the public and private sector, fieldwork interviewing may evolve into a highly complex affair as the data collection process progresses. Interview only members of the community, and vital information about organizational response is lost. Interview only organizations, and lost are data on individual behavior during the disaster. In either case, the outcome of such a narrow approach to data collection is the forfeiture of a holistic representation of disaster behavior—which is precisely what the qualitative approach intends to deliver. Adding to the dilemma is that data on disasters tends to be highly perishable (Browne & Peek, 2014), meaning that the complex task of capturing the full spectrum of organizational and interpersonal complexity during a fieldwork excursion is made all the more difficult. People with relevant information leave the area or take different positions, memories must be resurrected from traumatic contexts, and the details of recollection, however memorable and unique the event, deteriorate over time. What is also problematic, as Stallings reports (2007), is that qualitative work holds a certain "serendipitous nature," reporting how Scanlon's (2002) re-analysis of the Nova Scotia disaster yielded new archival records overlooked or unavailable in the original analysis. All this must be conducted in many cases under very limited time constraints and travel schedules.

15.4.4 Challenges for Quantitative and Statistical Analyses

Advances in quantitative research in the 1990s and 2000s, especially in the areas of statistical modeling, offer new opportunities in developing knowledge about issues ranging from warning response, disaster mortality and morbidity, recovery trends, and so on. Within the context of statistical surveys, which are "quick response" in nature, one of the advantages of survey research is that issues of timing are far less problematic in comparison to qualitative research. Although quantitative research and qualitative research differ substantially, the problems of quantitative research shares many of the challenges of qualitative in the context of disasters. Again, quantitative research may explore established trends and patterns in a non-quick-response context - as a classic example, Hank Fisher's well known work on disaster myths among emergency managers (Fisher, 2008). Other quick response studies focus on specific disasters and their associated response. For example, in a large-scale study of tornado warning response, the Disaster Research Center (DRC) initiated a series of quantitative surveys intended to measure people's response to a series of tornadoes in the Midwest.

While a range of statistical techniques have been applied to the study of disaster, advances in regression analyses over the past two decades offer opportunities for scholars in overcoming problems implicit in the analysis of complex, multilevel institutional and community behaviors. In a meta-analysis of disaster research methodology, Norris (2006) calls for a wider application of Hierarchical Linear Models (HLM), multilevel models, and other more advanced techniques in statistical works in the field of disaster research. The problem with human behavior in the context of disaster is, in nearly every regard, the problem of quantitative sociology *writ large*: human behavior is nested implicitly within larger structural frameworks, the most prevalent of which include groups, organizations, institutions, and geographic units

as small as census tracts and as large as nations (Raudenbush & Bryk, 2002). Alternatively, observations may also be nested within multiple time periods, cohorts, or panels, which may also confound results because observations are therefore not, as assumed by regression, independent (Singer & Willett, 2003).

In more technical statistical terms, "Within–cluster dependence violates the assumption of ordinary regression models that responses are conditionally independent given the covariates (the residuals are independent). Consequently, ordinary regression produces incorrect standard errors, a problem that can be overcome with multilevel models" (Rabe-Hesketh & Skrondal, 2012, p. 2). Statistically, whether in the context of disasters or other sociological topics, ignoring the reality of "nesting" results in a violation of statistical independence, an assumptions of regression analysis the violation of which results in biased estimates and predictions. The problem has recently been recognized and acknowledged in the literature on disasters. Knack, Chen, Williams, & Jensen-Campbell (2006, p. 182) remark on several ways in which statistical nesting may occur within the disaster setting: "Participants housed within the same shelter are likely to be bonding, receiving similar support services, and dealing with the disaster in similar ways, thus making their reaction to the disaster dependent. Also, where people live before the occurrence of natural disasters could also raise concern for the issue of dependency. For example, people living in one particular area might be affected by the disaster similarly, and thus be facing and dealing with similar issues." Treating individuals as independent under these circumstances would limit an ability to make causal generalizations about populations.

These considerations are important because disaster research often investigates organizational, institutional, and geographic contexts. Consider clusters of emergency management organizations nested within counties. If the researcher's goal is to predict, for instance, the effects of training on preparedness within a sample of 200 randomly selected emergency organizations, to ignore the fact that each organization is nested within a county would risk overestimating the effect of training on preparedness in the model because each organization is dependent on county-level factors. If a correlation between training and preparedness is discovered, there are two possibilities: a) training has a causal effect on preparedness, or b) training has merely a correlation with preparedness because access to training and good preparedness is produced by a range of other factors (e.g., Socioeconomic Status). A multilevel approach, specifically a random effects regression model, would work to parcel out statistically the effects of these other factors, providing a more accurate and unbiased estimate of training's effect on preparedness. Several recent studies have employed a multilevel approach on topics predominantly in the field of mental health (Lowe, Sampson, Gruebner, & Galea, 2015) as well as mortality (Lin, 2014) with successful outcomes.

15.4.5 Research Design and Causation

The most basic model of causation in the social sciences rests on three assumptions: a) covariation, b) time order, and c) non-spuriousness. Classical experiments typically fulfill all three conditions if implemented with rigor and precision and thus have come to be viewed as the gold standard against which most methodologies are evaluated (Babbie, 2014). Classical experiments typically meet these conditions well due to the structure of the experimental approach. However, the social dimension of disaster events are very difficult to model experimentally.

There are two principal reasons why disasters are difficult to study via classical experimental methodologies. The first problem is similar to that of social science in general: organizations and institutions make it difficult to apply an experimental approach and may not be easily isolated within a laboratory setting. Planning, long-term recovery efforts, and preparedness

outcomes occur at the level of society, over a long period of time, and involving the interactions of complex institutions, so applying classical experimental methods is difficult if not impossible. Second, even at the psychological and social psychological level, many of the questions that disaster researchers find to be of central theoretical relevance simply cannot be isolated in an experimental setting largely because they are so context bound. Risk perception, a key theoretical concept in the field, is very difficult to simulate within an experimental context largely because risk perception is a feature of groups and not individuals, and involves a process rather than a series of discreet activities (Lindell & Perry, 1992; Mileti & Sorensen, 1990).

15.4.6 Obtaining Reliable and Valid Measures

As with other fields, both quantitative and qualitative methodologies are vulnerable to random and non-random error within the context of research, but tends to be a more important issue for quantitative research. In particular, quantitative methodologies must contend with respondents asked to recall events that have taken place rapidly under stressful or uncertain circumstances, which is not uncommon during periods of disaster. For example, we might be interested in measuring the amount of time respondents took to seek shelter following a warning. Since shelter seeking or evacuation is more likely than not to occur under stressful circumstances, the result is that respondents, if asked about how quickly shelter was sought, will likely have difficulty recalling this value with sufficient reliability. An alternative might be to use aggregate lead time data for the community, but the average community level lead times may not be reflective of any given individual's lead time, thus leaving researchers with a dilemma. While there are numerous other disaster constructs such as preparedness, mitigation, and organizational response well known to defy easy measurement, with space in mind we limit our discussion to three concepts that suffer significant measurement issues: warning response, mortality/morbidity, and economic losses.

From a measurement standpoint, hazard warnings present difficulties because they are sometimes presented in complex terms with various meanings, making their measurement difficult. This is because in the last several decades the communication of risk has evolved into a technical language with which the public may be partially or wholly unfamiliar. As well, the evolving technical language of warnings borrows terms from lay vernacular with pre-existing meaning, thereby creating the potential for confusion. The warning of tornadoes may take several forms - "warnings," "watches," "alerts," and so on, and there is some evidence to suggest that the public may not fully comprehend their distinction (Donner, Rodriguez, & Diaz, 2012). Accordingly, respondents may confuse terms and definitions on survey instruments, resulting in the potential for inaccurate or unreliable data. Among a public who rarely reflects on such distinctions, respondents may "recall" receiving a warning on surveys in spite of only having received only a watch or alert. As a result, if the definition of "warning" varies considerably across sample respondents, a considerable crossection of data may suffer problems with validity.

Another significant challenge in measuring warnings remains the many formal and informal channels through which warning information may be received. There may be circumstances where the public encounters warning information not directly through the National Weather Service (NWS) or emergency managers, but through informal channels, such as family, friends, and co-workers. A respondent who receives a warning from friends and family is no less warned than one who received a warning through the media or NOAA weather radio. Nevertheless, respondents may not view themselves as having been warned per se if the prevailing definition of "did you receive a warning" is one received through a formal institution. If warning information is not received directly through the media, the respondent may answer "no" because

the manner in which the warning received did not conform to the held definition of the warning. Thus, the person was in reality warned, but the data do not indicate such, resulting in error.

Demographic measures of mortality and morbidity also present problems with respect to disaster research. As Thomas (2001, p. 65) observes, "Another continually vexing question involves how to count deaths, injury, and damage." By way of example, disaster-related injuries may be difficult to measure accurately given that the standards by which an "injury" is attributable to a disaster event may differ between institutions. Thus, if a scholar were using hospital records to identify hurricane injuries, Hospital A might indicate that a victim who struck a tree while fleeing the hurricane was injured by the tornado. Hospital B, on the other hand, may not regard this as a "hurricane injury" per se, but simply an automobile accident. Thus, results of the analysis may be different depending on whether the scholar in question received data from Hospital A or Hospital B.

Finally, economic losses also present unique and significant problems with respect to measurement, in particular when to begin and when to stop counting economic losses, and the sometimes vague distinction between direct and indirect disaster losses (Thomas, 2001). Thus, a hurricane of sufficient strength damages and destroys buildings, cars, residential housing, business, etc., the costs of which may be estimated through property value documents and repair costs. However, there are additional costs unaccounted for in this case that may also be regarded as "economic loss" but go unregistered in the measurement protocol: a) loss of tax revenue, b) unemployment, c) loss of work and so on. Also of concern are the less tangible psychological and social costs - trauma, PTSD, etc. - which may affect work and productivity, which, taken together, contribute directly or indirectly to a loss of economic security

Though less commonly acknowledged, qualitative research also suffers similar problems with reliability given once again the rapid nature of data collection in disaster fieldwork. This is a problem for the qualitative approach because it relies heavily on details and depth of narrative - rich descriptions of people, processes, and events on the part of respondents - to work properly as an investigative tool (Lichtman, 2006). Although there is no formal metric, delays in entering the field may lead to unreliable data as respondents struggle to recall events with the vivid detail on the basis of which qualitative analysis draws its key explanatory strengths.

15.4.7 Sampling

As with reliability and validity, sampling problems are also due to the event-based, transient nature of disaster phenomena. Defining populations, sampling frames, and sampling procedures becomes difficult largely because the definition of disaster itself is fraught with difficulties. And without a common definition of disaster, there may be a lack of guidance on whom or what is meaningful or important to sample.

Sampling injuries, for instance, remains highly vulnerable to both random and non-random sampling error for a variety of reasons. Whereas all deaths will be reported, not all injuries will be reported, and often this reporting may lead to problems later with statistical inference, generalizability, and bias. This is because within the context of smaller disasters, which may result in minor injuries, victims *en masse* may forgo emergency care, which might decrease sample size and therefore threaten statistical power. Also, the decision to seek emergency care may form a pattern contingent upon race, class, age, gender, or other social classifications, thereby leading to a biased sample of the injured population. Consider a major earthquake in California, resulting in thousands of injuries in addition to hundreds of deaths. Among those injured, only 50 percent seek medical care, and thus appear in the injury database. It is later discovered, however, that those who do appear in the database tend to be of a higher socioeconomic status (SES) because they held the resources (e.g., insurance) to seek medical attention in the first place. Thus, the final

sample tends to be of a higher SES in comparison to the population from which it was drawn, resulting in sampling bias.

Furthermore, there is the issue of obtaining a representative sample, which may prove difficult within the context of disaster events. Indeed, challenges of post-event surveys in disasters mimic those in other substantive areas: sample sizes may be too small, hidden populations are missed, and evolving technologies may make it difficult to contact certain groups. Disasters themselves may also disrupt the communications technologies through which sampling is to take place. Following a disaster, for instance, potential respondents may have lost telephone service, which may affect generalizability (Bourque, Shoaf, & Nguyen, 1997). In this example, if there is no systematic element to the loss of respondents, and the sample size remains sufficient for statistical inference, then no problem exists. However, since disasters tend to take a heavier toll on vulnerable populations, there is the strong possibility that systematic sampling bias may be introduced into the data collection process. Poorer individuals are more likely to live in less resilient areas and are more likely to be affected by disasters (Wisner et al., 2004). As a result, telecommunications may be disrupted in their neighborhood, and without access to telephones, they may be missed during the sampling process. During the analysis process, one result might be the overestimation of the average income of disaster victims, which holds both theoretical and policy implications. Other populations may be inherently difficult to sample, including the homeless and undocumented, especially during times of community disruption that occurs after major disaster events.

Indeed, what is inherently vexing about the issue of representative sampling in the context of disasters is that the populations most likely to be affected by disaster are those that appear to be the most difficult to reach. Undocumented migrants may avoid shelters out of fear that assistance from the authorities may lead to deportation (Fothergill, Maestas, & Darlington, 1999), leading to their exclusion from the final sample. When hidden populations are interviewed, there are further concerns among some scholars that only certain sections of the population studied may return for follow up (Lavin, Schemmel-Rettenmeier, & Frommelt-Kuhle, 2012), leading to further problems with sampling bias.

15.4.8 General Concerns with Qualitative and Quantitative Research in Disaster Studies

Throughout the history of disaster research, there has been, in large part, a pattern favoring the use of qualitative research to some degree. In many ways, the reliance on qualitative approaches was born of need: disasters were, and in many ways continue to be for sociologists, new phenomena which presented difficulties for quantitative approaches due to the frequent emergent characteristics of social behavior and social structure during periods of catastrophe. It is difficult to overstate the critical importance of qualitative approaches to the field: qualitative research established, and, arguably, continues to establish, fundamental concepts and dispels long-held and deeply-entrenched myths about the relationship between people and disasters (e.g., panic, the assumption of antisocial behavior, looting, etc.). Qualitative research, due to its flexibility and reflexive approach to sampling, data collection, and analysis, offers the strong approach to studying new or unknown social setting, of which today there is no short supply. How local emergency managers in Northeast South Dakota manage flooding, the vulnerability of fishing communities in Bangladesh, how Hispanics negotiate shelter use given modern day politics, and how Amish in Indiana and Pennsylvania make use of disaster technologies despite religious bans cannot be understood initially with a quantitative approach. Notwithstanding these contributions, the qualitative approach for disaster research suffers the same limitations as qualitative research in general.

Primarily, the subjective and anecdotal nature of qualitative fieldwork makes prediction practically impossible. Observation and measurement on interview guides are in principle standardized,

but such standardization yields data—rich, narrative data—intractable to statistical modeling processes. Qualitative research often struggles as well to make reliable forecasts of human behavior in part due to small sampling and convenience techniques employed. Convenience sampling, the primary method by which subjects are recruited in qualitative research, will by nature yield biased samples because interviewees cannot in principle be selected randomly.

The use of quantitative research, in spite of its predictive and inferential strengths relative to qualitative research, faces challenges in collecting original and secondary quantitative data on disasters. The General Social Survey (GSS), for example, provides Sociologists of Race and Sociologists of Religion with large amounts of data collected under well-controlled conditions. Unfortunately, while disaster databases do exist in abundance, oftentimes it is difficult to determine how concepts were measured. Furthermore, datasets may lack integration—that is, it is common that datasets hold exclusively physical data on hazards, epidemiological data, *or* social data on natural hazards, thus requiring a bit of hunting and exploring on the part of the disaster scholar.

15.5 New Directions in Research: Interdisciplinary Approaches

The National Science Foundation defines interdisciplinary work "as a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice" (CFIR, 2004, p. 2). Among present scholars, there is a general consensus that the future will be increasingly defined by interdisciplinary and collaborative work between researchers of various disciplines (National Science Foundation, 2011). For perspective, interdisciplinary work might include collaborations between a sociologist and engineer, a psychologist and computer scientist, an anthropologist and civil engineer, or some combination thereof. A sociologist and a radar engineer might collaborate to develop a remote sensing system that is both technologically advanced and at the same time receptive to the social and psychological needs of communities facing the threat of severe weather. The overarching problem of interdisciplinary work is that there currently exists no concrete model for interdisciplinary collaboration, but great strides have been made in encouraging scholarly cooperation and defining the terms of collaboration between fields with heretofore little intellectual interaction.

15.5.1 Strengths of the Interdisciplinary Approach

By far, the greatest strength of an interdisciplinary approach remains the ability to refine the knowledge of an individual field by challenging its assumptions. More often than not, engineers and natural scientists, while well intentioned, lack the training and understanding in sociology, anthropology, economics, and political science to make reasoned and informed judgements about the bearing of new technologies on society. Will the new technology be accessible and why? If accessible, how will it be used and what are the limitations of its use? And how might it be used most effectively? Answering these questions requires a deep understanding of the empirical and theoretical foundations of human behavior.

Here we illustrate the strengths of an interdisciplinary approach by way of example. Through an initiative by the National Science Foundation (NSF), a series of interdisciplinary Engineering Research Centers (ERCs) were institutionalized at universities in the U.S. One common goal of ERCs was to establish a structure and culture of interdisciplinary collaboration between natural and social scientists in the pursuit of new technologies. One ERC of note, ERC-CASA (Collaborative Adaptive Sensing of the Atmosphere), proposed to develop novel

radar technologies, which, in practice, would return more accurate and more reliable forecasts of severe weather above what was possible with the present remote sensing equipment at the time. But how these advancements, however sophisticated, might reduce improve warning response and reduce mortality and morbidity remained a separate question outside the realm of the physical sciences. A principle concern from the beginning pertained to emergency managers: the new system assumed that the average emergency manager for whom the system was intended was well-equipped, well-trained, and well-informed. It was assumed that the average emergency manager could harness the new system's full potential. This was not the case, as was observed in a series of fieldwork studies and natural experiments aimed at evaluating the needs of emergency managers and emergency management institutions in the region where the system was to be deployed. Indeed, a vast majority of the emergency managers in the test-bed region held neither the knowledge, training, nor equipment to make use of the data (Rodriguez, Diaz, Donner, Santos, & Marks, 2005), and, furthermore, even among trained emergency managers, there were notable difficulties in organizing and managing real-time information (Baumgart, Bass, Philips, & Kloesel, 2008) of the quantity and kind the system offered. There was therefore a conflict between system design and the realities within the end-user communities, thereby making the radar technology, for all its sophistication, of limited use among these communities. However, through this research, engineers, computer scientists, and physicists, who had designed the system, were better able to adjust design and align technical parameters with the needs of community stakeholders.

15.5.2 Challenges of the Interdisciplinary Approach

In practice, interdisciplinary work faces both traditional challenges inherent in the fields and sub-fields involved in collaboration, but also theoretical and logistical challenges brought about through the necessity of interaction between researchers whose disciplines may differ in terms of theory, philosophy, data collection, publishing standards, etc. More specifically, Domino, Smith, and Johnson (2007, p. 256) identify several key challenges in developing an interdisciplinary Women's Health Center, including, but not limited to, "arranging times to meet, developing a common language and knowledge base, dealing proactively with expectations and misunderstandings, focusing on a conceptual model, and providing timely feedback."

A core problem is that conceptual models for the collection and analysis of data differ dramatically between natural and social sciences, most notably in the collection and quantitative and qualitative data (Lach, 2014). Natural science, and a great deal of social science, as well, overwhelmingly uses mathematics to answer empirical questions, such as when meteorologists apply algorithms and storm models in understanding storm development. A considerable number of social scientists, on the other hand, collect data through qualitative fieldwork, the results of which are generally non-numeric and not easily reconciled with the modeling process on which natural science so heavily relies. While quantitative social science allies itself more naturally with the natural sciences, statistics and mathematics cannot capture the holistic or contextual nature of human behavior (Philips, 2014), inquiry into which and a full appreciation thereof requires a qualitative approach. When a qualitative approach is indeed required, this may lead to difficulties in communication and understanding among interdisciplinary collaborators, a problem that has yet to be fully resolved despite a growing pattern of collaborative work.

Another key challenge lies in the reward structure of interdisciplinary research. Although interdisciplinary research is growing in frequency, there may nevertheless remain potential professional difficulties for new and established interdisciplinary scholars that must be addressed in the future. A recent study of how scholars view interdisciplinary research demonstrated that 16% of those who

engaged in interdisciplinary scholarship reported that such activities had negative effects on their careers (Rhoten & Parker, 2004). Among faculty, there may be concerns that interdisciplinary work may not count towards tenure or promotion, or that interdisciplinary research may not be viewed as "serious" by colleagues and administrators whose judgements may reflect a lack of familiarity with the approach.

15.6 The Growth of Geographic Informations Systems (GIS) in the Field

GIS applications have made strong headway into the field since the late 1980s/early 1990s in both an academic and practitioner context due to the introduction of more powerful computing (Thomas, Ertugay, & Kemec, 2007), but, according to scholars, have only seen major use in the analysis of disasters since roughly the late 2000s. Indeed, Cappock (1995) reports that, as of 1995, the connection between GIS and disasters had been "scarce" (see Dash, 1997). As a methodological tool, GIS offers researchers and practitioners a wide range of options in the collection, organization, building, visualizing, and analyzing of datasets, as well as the prediction and projection of data trends. The use of GIS as a research tool falls into three categories: a) as a method of presenting findings, b) as a method of building datasets, and c) as a planning tool that links research and strategic decision making. Borden and Cutter (2008) mapped spatial distributions of mortality outcomes for natural hazards. Other scholars have used GIS to present the geographic distributions of vulnerable populations in the United States and Puerto Rico (Cutter, Boruff, & Shirley, 2003; Peacock, Van Zandt, Henry, Grover, & Highfield, 2012).

One key strength of GIS is that it offers links between research and practice. GIS provides significant tools for planning, mitigation, and response by translating complex research ideas into visualized formats. In a recent study, Kyne (2015) examined the estimated and predicted plume path of nuclear fallout in relation to major population concentrations (see Fig. 15.1). Kyne's work links research and empirical

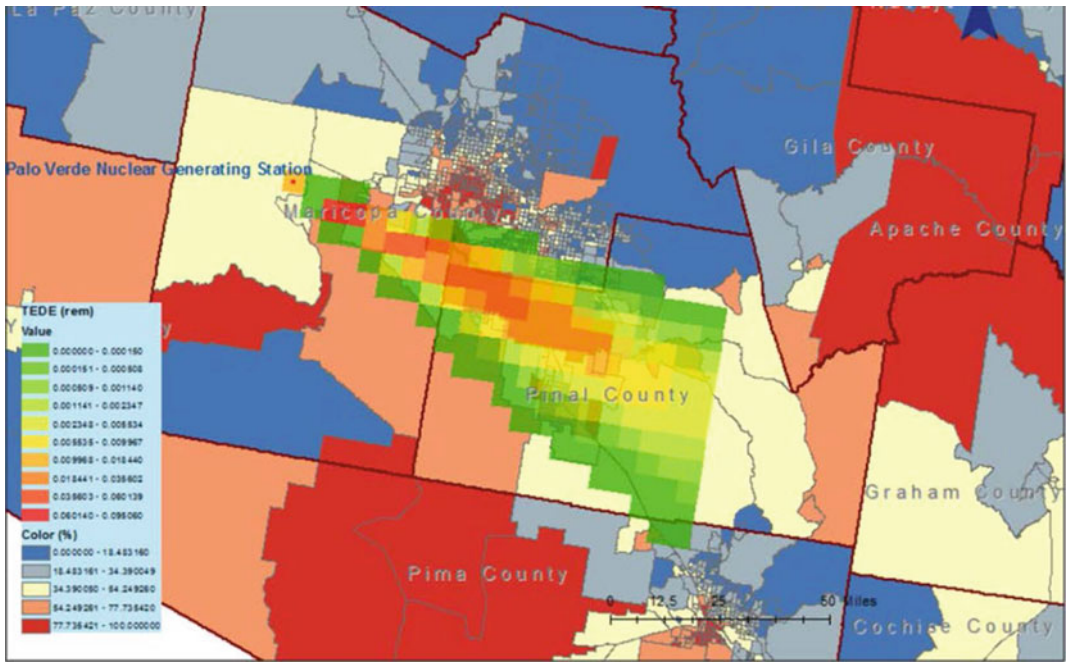

Fig. 15.1 Projected plume path from core-damage accident. Here the predicted concentration and direction of radioactive smoke plumes are overlaid on county maps with demographic information

observations and condenses them into an easily digestible format for those charged with planning and preparing for disaster. GIS may also be used to build data sets, as well. Donner (2007) used GIS to geolocate tornado touchdowns via latitudinal and longitudinal coordinates in order to examine the relationships between sociodemographic characteristics, tornado intensity, and mortality outcomes.

GIS research may also be used to make long- or short-term strategic decisions across all stages of the disaster process - identification and planning, mitigation, preparedness, response, and recovery (Greene, 2002). A promising new trend in the use of data in the management and response to disaster using GIS has been in the area of "crowdsourcing" whereby individuals provide real-time information on disaster events (Laituri & Kodrich, 2008). And while there are concerns with this approach, scholars argue that the benefits of rapid, nearly real time information outweighs the costs (Goodchild & Glennon, 2010).

While GIS is becoming a more and more prevalent tool, scholars urge a cautious approach in the application of GIS methods. Fekete (2012) in particular draws attention to several issues, for instance, in the mapping of spatial vulnerability. An overreliance on GIS risks the "aggregation fallacy," which describes the false assumption that "every object within every square metre covered by a colour for high vulnerability is indeed highly vulnerable. The vulnerability depicted by the index map is a 'relative' vulnerability, or even more a 'potential', 'hypothetical', 'estimated' or 'assumed' vulnerability, as opposed to a 'revealed' vulnerability after a disastrous flood event" (Fekete, 2012, p. 1174; also see Fekete, 2010).

15.7 Conclusion and Future Directions

The field of disaster studies faces several challenges both common to the social sciences in general, as well as unique to the field itself. Issues of rapid deployment, data that are often nested institutionally and organizationally, and ethical challenges in the field are but a few of the numerous problems that today remain unresolved. New methodological and analytic approaches, however, have led to progress in addressing longstanding issues within the field. As illustrated, GIS offers the promise of addressing the inherent interdisciplinary nature of disaster, providing both a conceptual framework and set of tools for addressing the physical, social, and geographic dimensions of environmental and technological hazards. Though still somewhat underused in the field, new analytic approaches such as multilevel modeling afford the development of models less susceptible to estimate biases and more faithful to the social behaviors they attempt to capture and predict. Computer simulation, though still highly nascent, present opportunities for the collection of data and prediction of behavior impossible through previous methods. The future will continue to see evolutions in the field, both theoretically and empirically, that surmount past limitations and provide more accurate models and understandings of behavior before, during, and after, a disaster event.

Although there is a need for a general focus on methodological development in the field, there are several key ideas discussed in this chapter that are of central relevance to the theory and methodology of disaster studies as a scholarly enterprise. Perhaps none more paramount and persistent remains the short timeframes by which researchers are bound in the design of quick-response fieldwork. This yields several problems that directly and indirectly shape the quality of collected data. The rapid need to revise qualitative sampling and data collection protocols, for instance, due to emergent phenomena in the field may clash with IRB standards and risks affecting the quality of samples and measurements. To overcome this, researchers need to have a clear understanding and agreement with IRB boards at their universities as to when and how quickly protocols may be modified in the field.

Also of note are new developments in technology and mathematics that have served to

overcome the challenges that have traditionally attended research design in research studies. In particular, the use of multilevel modeling could, if used more consistently in quantitative designs, provide more valid conclusions regarding the causes of mortality, economic losses, recovery markers, and a host of other outcomes with which disasters scholars have been traditionally concerned. In order to do this, however, an effort among scholars to address problems with secondary data is required. As discussed earlier, such data not infrequently lack full and transparent disclosure in regards to collection protocols and therefore currently hold limited value for quantitative researchers.

In addition to statistical modeling, causal inference also remains a significant barrier to building systematic empirical knowledge in the field. As noted, this is largely because no two disasters and no two populations are alike and, as a result, experimental and control groups often differ in ways that potentially confound results. Solutions here are limited, although readers who wish to pursue the use of quasi-experimental approaches would be encouraged to explore further new developments in propensity score matching, which has been demonstrated to normalize differences between experiments and controls absent randomization procedures (although the procedure is still somewhat controversial; see King & Nielson, 2016).

Advances in the field of computational sociology, computational modeling, and agent-based approaches to understanding disaster behavior offer promising potential. To date, computer simulation has been heavily used to model evacuation behavior in the case of fire evacuations (Feinberg & Johnson, 2010). While computer simulations offer a very promising approach to predicting disaster behavior, there are some reservations among scholars as to its use. Most notable, scholars caution that many simulation models are methodologically flawed as they loosely piece together a collection of "behavioral facts" from past research, anecdotal testimonies, and reports, lacking an overall and comprehensive conceptual model of human behavior (Kuligowski & Gwynne, 2008).

Finally, a strong case was made for the use of interdisciplinary approaches in the field. As with the ERC-CASA case, collaboration between social and natural scientists has been demonstrated to produce knowledge and policy of more benefit to end users. There are several future questions that must be answered with respect to interdisciplinary collaboration. First, there is a growing though still ambiguous culture of collaboration in the field and, as a result, collaboration between different disciplines tends to follow an unplanned course. As a result, there is routinely limited structure governing collaborative inquiry within a given project, resulting in more of a "reactive" rather than more ideal planned and "proactive" approach to collaborative work. From the beginning, what kinds of data are to be collected, modeling techniques, policy questions, and, most importantly, what kinds of questions are to be answered through collaborative must be established if cooperation is to be successful.

While this chapter addressed a broad range of issues, we believe there are several overarching issues and concerns that should be addressed as the field moves forward. Disaster studies is a discipline quite unlike other disciplines in the field, a fact that creates both opportunities and challenges for researchers within the field. As the field continues to advance and develop from a methodological standpoint, great care should be taken to ensure that such developments acknowledge the uniqueness of the discipline.

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The Role of Geographic Information Science & Technology in Disaster Management

16

Deborah S.K. Thomas

Contents

Place-based capabilities have permeated a multitude of mobile applications and have transformed the ways in which technology supports place-based knowledge generation and decision-making. Data-enabled cell phones, smartphones and tablets commonly have location-based services (LBS) embedded throughout various applications, which use real-time geographic data (geo-data) to collect data and/or provide information (even basic cell phones have locational capabilities). While their use spans a wide variety of topics and frequently utilized functions, such as generating directions or finding resources, they are also commonly used in the context of hazards and disasters. For example, one mobile device can now perform a variety of place-based disaster management decision-support functions, from assisting a person's routing for evacuation based on traffic flows to conveying place-specific weather warnings.

Mobile technologies have revolutionized awareness of, and access to, place-based mapping technologies and approaches through relative ease and high level of exposure/usage. By extension, they have dramatically expanded geographic information science & technology (GIS&T) applications to hazards and disasters. This chapter will focus on the potential of using GIS&T, emphasizing geographic information systems (GIS), for spatial (geographic) decision support systems (SDSS), highlighting the ways these technologies can integrate physical and social science approaches to support disaster risk reduction. A disaster management spatial decision support system (DM-SDSS) must be firmly based in research, as well as meet the needs of decision-makers across a diverse set of users who utilize the system. The first

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part of the chapter provides a brief background of GIS&T and the basics of a DM-SDSS. This is followed by examples of current GIS applications in disaster management, a discussion of challenges and opportunities, and suggested directions for future research.

16.1 GIS&T & DM-SDSS Background

GIS&T is a comprehensive interdisciplinary field grounded in geography that incorporates a range of geographic technologies, including geographic information systems (GIS), remote sensing, and even global positioning systems (GPS). As a field of study, GIS&T is comprised of "three interrelated sub-domains" (DiBiase et al., 2006), including geographic information science (knowledge generation based in geography, but multidisciplinary), geospatial technology (management and manipulation of georeferenced data), and applications (uses in wide-ranging discipline/practice areas). Certainly, the integrative capabilities of GIS&T are powerful, bringing together geographic data from a wide variety of environmental, social, and engineering sources for evaluation and analysis. GIS&T enables the systematic exploration of the nexus of geography and the knowledge base of numerous other disciplines so that place can be centrally examined. For disaster management, this translates to robust disaster/hazards place-based research across the social/physical sciences and engineering that is tied to practice with processes for integrating ever-increasing amounts of spatial data in meaningful and efficient ways.

Even though geographic questions have long been of concern to both disaster researchers and practitioners alike, the proliferation of GIS&T has fundamentally increased the capacity of those in the disaster community to incorporate place-based approaches. Geospatial technologies are recognized as key support tools for disaster management (Abdalla & Li, 2010; Goodchild, 2006; Mileti, 1999). The visualization capabilities (map output) alone have almost become expected by policy makers, disaster managers, and even the public, particularly with the advent of mobile technologies and increased access to data through the Internet for easier access. In the most basic way, the mapping of hazard events and the impacts on people has a long and rich history with roots in basic geographic approaches (Hodgson & Cutter, 2001; Monmonier, 1997). For example, daily weather maps were produced first in Europe and then the U.S. in the 1800s and the Sanborn Company compiled systematic maps of urban hazards for fire insurance in major U.S. cities starting in the 1870s. The systematic mapping of hazard zones in relation to human settlement patterns for understanding human response can be linked to Gilbert White in the 1960s and 1970s (White, 1974; Burton, Kates, & White, 1993). The acceleration of the application of GIS to disasters began with the advent of the computer, especially affordable desktop computers and software in the late 1980s and 1990s, and then mobile platforms in the 2000s. Along with increased software and hardware availability and accessibility, spatial/geographic data for hazards, including hazard monitoring and risk information, has increased dramatically through monitoring, assessment and modeling efforts. Simultaneously, the sheer amount of built environment and social data with a location (spatially-enabled) has grown considerably, extending the possibilities for data integration and analysis. Real-time geographic data, now so readily available, can potentially improve the allocation of resources or planning processes.

As GIS&T has evolved, its application in both disaster research and practice as expanded rapidly for supporting risk reduction decision-making; it is fundamental to capturing, understanding, and conveying many dimensions to disaster risk and human adaptation to hazards. Place-based decision support requires broader approaches than GIS alone, drawing on all three GIS&T sub-domains, particularly when considering the complexity of DM-SDSS.

16.1.1 Components of Spatial Decision Support Systems (DM-SDSS)

Although not having a single, strict definition, any DM-SDSS would consist of several essential components, including: (1) data collection, integration, management, (2) analytical solutions, and (3) a user interface that allows the setting of parameters and generation of different solutions. A DM-DSSS is developed to address a specific problem, and must perform sophisticated tasks at the right place and time, involving modeling and analyses that transform spatial data into information for the evaluation of alternatives (Jankowski, 2008). Disaster management requires complex coordination of resources, equipment, skills and human resources from a wide variety of agencies and organizations. As such, a DM-SDSS can foster cooperation and promote disaster loss reduction (Pourvakhshouri & Mansor, 2003; Tomaszewski, Judex, Szarzynski, Radestock, & Wirkus, 2015; Zlatanova, van Oosterom, & Verbree, 2006). Interoperability of emergency services is especially vital during response and relief phases and is frequently supported by DM-SDSS (NAS, 2007). Further, a DM-SDSS also plays a vital role in mitigation and planning (Tate, Burton, Berry, Emrich, & Cutter, 2011). In essence, DM-SDSSs are tools that support individual (disaster managers, policy makers, first responders, or the public) and organizational decision-making in short, medium, and long-term scenarios (Andrienko, Andrienko, & Jankowski, 2003; Jankowski & Nyerges, 2002; Nyerges & Jankowski, 2009).

Technical concerns surrounding the implementation of DM-SDSS include such issues as spatial data acquisition and integration, interoperability, distributed computing, dynamic representation of physical and human processes, spatial analysis and uncertainty, and system design (Cutter, 2003; Radke et al., 2000). A DM-SDSS must allow the efficient and effective interchange of data between modules and modeling techniques. Interoperability ensures that data, algorithms, and models can be shared between various systems that are housed in diverse agencies, departments, or organizations contributing to disaster management.

Data collection comprises a multitude of activities utilizing a variety of primary and secondary sources that have a locational element. Since a DM-SDSS is data dependent, integration and management is no small feat, and requires incorporation of different data types, making the appropriate data available to the correct people at the right time. Data may be compiled directly from the field using mobile devices, GPS, or cell phones and is captured by experts or even through volunteered data from the public. Data can also be generated from people's decisions, perceptions, and behavior via geo-tagged social media, or locations of Internet searches. Remote sensing (satellite imagery, aerial photography, or other detection and monitoring devices, such as unmanned aerial vehicles) are also common inputs (Nayak & Zlatanova, 2008). Many datasets already exist and are maintained by various entities, though they are not always readily available and/or interoperable. Increasingly, data are accessed through web-services whereby a connection to the data is made through the Internet to the location where it is maintained and stored. Ideally, data should be current and timely. Quality control of the data should occur as part of the DM-SDSS, along with data security and management of user access.

Analytic tools and models process data into useful information that can be utilized for decision-making. Data must be converted to information that is meaningful and useful to those involved in disaster decision-making processes. For example, efficient and reliable hazard forecasting and monitoring leads to early warning and/or mitigation activities. Vulnerability analyses, risk assessments and modeling drive scenario generation (varying inputs based on priorities from stakeholders). Further, a DM-SDSS must be expandable and flexible in order to integrate new sensors, accommodate new users, and integrate new software applications into the future. The level of coordination and sophistication necessary for scenario-building essential for DM-SDSS may seem

somewhat unattainable given the wide range of hazard types and the complexity of social, built, and physical environments. However, the increasing availability of geographic technologies and advancements in GIS&T make it more possible than ever to consider an integrated system that supports disaster management to reduce loss (Keenan, 2006).

The development of a DM-SDSS requires that most of the functionality is not technically difficult for the end user. Keenan (1998) points out that the decision-maker should not have to go through long sequences of commands. In other words, the system itself should be user friendly and should meet informational needs accessing appropriate data and running analytical process in the background (not actually seen by the user), representing physical and human processes in an understandable format. In other words, ease of use is a foundational goal for design and development, making the upfront technical development quite challenging. As spatial data, maps, and models become embedded into DM-SDSS, geographic concepts must be addressed and incorporated into the system so that the end-user can set parameters and examine various options to support decision-making, but does not necessarily need proficiency in the spatial data or analysis models. Still, disaster managers, and others involved in response and mitigation to disasters, are usually from disciplines outside of geography or geographic technologies, and thus require some GIS&T education or training, even if just the basics of unique spatial data characteristics and the operation of a DM-SDSS. Training and education are too often neglected in formal processes, reducing the likelihood for adoption.

16.1.2 Geographic Information Systems (GIS) and DM-SDSS

Geographic information systems (GIS), a subset of GIS&T, allows for the mapping and analysis of hazard-related data transforming it into visual information and could be considered a DM-SDSS in and of itself (Keenan, 2006), particularly with the wider availability of Internet-based GIS. GIS is an interface for handling, collecting, sharing, recording, analyzing, updating, organizing and integrating spatial (geographic) data, derived from maps, remote sensing, and/or GPS. Within a GIS, a database is directly connected to the graphically mapped information and so data can be manipulated and mapped, or a user can interact with the map to retrieve data. In addition to simply compiling inventories of hazard risk, the built environment, infrastructure, and vulnerable populations, GIS can relate these to one another and analytically evaluate and explore spatial relationships. For instance, by viewing floodplains along with hospitals and roads, a user could select all hospitals in the floodplain or delineate which roads accessing a hospital might flood. Or, GIS can estimate population characteristics of those at risk, assessing the race/ethnicity, age, or housing characteristics. As another illustration, GIS could be used to evaluate which schools are near fault zones or in floodplains for prioritizing mitigation strategies or for evacuation planning.

A DM-SDSS integrates GIS into a broader framework that also incorporates specialized analytical modeling capabilities, database management systems, graphical display capabilities, tabular reporting capabilities and decision-maker's expert knowledge (see Fig. 16.1). A GIS alone cannot often provide problem-specific model support to a less technical user, frequently requiring the involvement of a GIS expert. Further, a GIS can only partly model, test, and compare among alternatives to evaluate a specific problem (Pourvakhshouri & Mansor, 2003) without extensive processing or often interfacing with other software. A DM-SDSS enables a less technical user to run scenarios, set model parameters, and produce results to inform decision-making since much of the technical functionality are embedded within the DM-SDSS. Although designs vary, a DM-SDSS includes elements beyond a GIS, including analytical tools (to enable data exploration), decision models (to run various scenarios with different parameters), a geographic/spatial

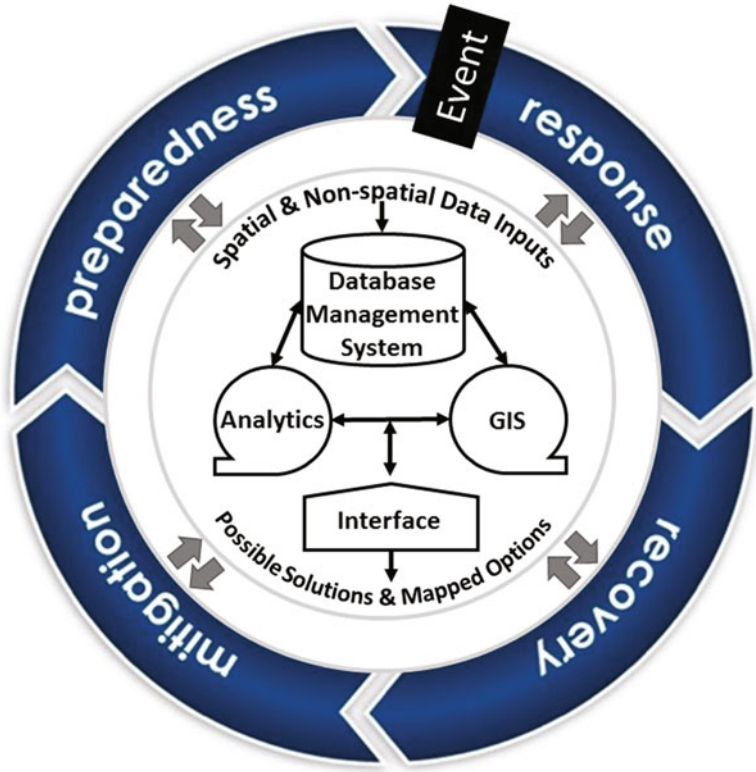

Fig. 16.1 DM-SDSS Conceptual Model

database (whereby data management for the end user is minimized), a user interface, and expert knowledge that informs all aspects of the DM-SDSS (Densham, 1991; Jankowski, 2008; Zerger & Smith, 2003). A DM-SDSS must be flexible and adaptable for dealing with evolving and dynamic scenarios in disaster management (Bui & Sankaran, 2001). Most importantly, its success rests on how well it supports the needs of the decision-maker, not how advanced the technology is (Keenan, 2006).

16.2 Examples of GIS Applications to Disaster Management

While GIS is only one subcomponent that contributes to GIS &T and DM-SDSS, focusing on this technology provides insights into complex place-based solutions for the study of disasters/hazards. Examples range from relatively simple local scale hazard mapping to fully interactive GIS interface. Many GIS applications span preparedness, response, recovery and mitigation, although some are specific to one or two of the phases. For instance, hazard mapping is necessary for supporting decision-making in all disaster management phases while evacuation planning is much more specific to preparedness and response. GIS has wide-ranging potential in disaster management, including, but not limited to, damage assessment, risk prediction and situational analyses, vulnerability and resilience assessments, or prioritization of mitigation alternatives.

Disaster/hazards GIS-based research generates place-based knowledge production that can/should inform the development of any DM-SDSS tool. However, the translation of research results into practice and decision-making varies. So, while GIS is now

pervasive in disaster management, research is not necessarily infused as consistently. This is especially true in a rapidly evolving technological arena where advances in practice often outpace research. As such, the following section highlights exciting GIS applications in practice along with GIS-based disaster/hazards research.

16.2.1 Monitoring and Detection

Hazard event monitoring and detection requires extensive data collection efforts and lays the groundwork for risk assessments as well as early warning systems. A thorough discussion of the use of geographic technologies for monitoring and detection, detailing extensive efforts in all areas, is beyond the scope of this chapter. Still, this important area must be mentioned because of the foundation these data collection processes provide for any type of DM-SDSS, which are inherently data-driven and require high quality data.

Many examples exist of organizations that collect and disseminate hazards event data. The National Aeronautics and Space Administration (NASA, 2016a) shares global remote sensing images of historical and recent hazard events for the public and scientific community to better understand worldwide hazards. The U.S. Geological Survey's Earthquake Global Seismic Network (USGS, 2016a) is one of several monitoring and detection systems for earthquakes and collects, maintains, and disseminates data globally. The USGS (2016b) also maintains the stream gauge network for the U.S., providing real-time and historical data on streamflow conditions. The National Oceanic & Atmospheric Administration's (NOAA) Satellite and Information Service (2016a) integrates a variety of satellite and data products for tsunamis, wildfires, drought, and all weather and climate hazards. Parallel organizations in many other countries also maintain a stream-gauge network for flood monitoring and detection (for example, the European Centre for Medium Range Weather Forecasting or the European Severe Weather Database), though many parts of the globe do not have hazard-related organizations collecting high quality data.

In all of these instances, data collection is important, but the post-processing to ascertain risk is the vital next step. Monitoring and detection is particularly powerful when married with a mechanism for dissemination of warnings. For example, the Bangladesh Flood Forecasting and Warning Centre (BWDB, 2016) captures data from a variety of sources (such as satellite imagery, meteorological data, water levels) to create real-time maps and information products, along with flood forecast models. These products, including current warnings, daily inundation reports/maps, and river level forecasts, are released to many outlets from government authorities to the media. As another illustration, NOAA collects and disseminates severe storm and weather data through the National Weather Service (NOAA, 2016b). In support of the *Weather-Ready Nation* initiative focused on the U.S., current watches and warnings for all weather-related events are posted with corresponding maps. These data are one element of a broader early warning system, as well as the basis for fostering awareness, assessing risk, and enhancing communication efforts. While the monitoring and detection of hazard data has expanded and evolved, capabilities for monitoring social, economic, and political trends is not nearly as robust.

16.2.2 Risk Assessment

Risk assessments encompass a wide variety of activities, from evaluating groundwater pollution from historical hazardous waste dumps to deriving air pollution levels across an area, and involve calculating the potential for negative outcomes on human, built, and/or physical systems for any natural and/or technological event (s). Data from monitoring and detection are evaluated in attempt to understand the potential for harm. The systematic mapping of hazard zones in order to assess who is at risk has a long

history for a variety of hazards, including floods, earthquakes, and tropical and severe storms. Risk mapping underpins basic decision-support by transforming data into information that is then made available to end-users (decision-makers).

Floodplain and earthquake mapping applications, in particular, demonstrate the potential for a DM-SDSS. In the U.S., the Federal Emergency Management Agency's (FEMA) Flood Hazard Mapping Program began in 1968 as part of the National Flood Insurance Program in order to make a determination about properties located in high risk flood areas (FEMA, 2016a). Although a complex scientific (highly technical modeling of floodplains) and political (conveying to communities for incorporation into systematic planning) endeavor, the intent of these efforts is to support mitigation decision-making for flood loss reduction. In fact, numerous inundation mapping efforts are underway in U.S. states and countries throughout the world to calculate flood risk, utilizing Digital Elevation Models (DEM) and Airborne Light Detection and Ranging (LIDAR) remote sensing, combined with metrological, coastal and hydrologic data. As another example, the USGS has long provided systematic earthquake risk mapping for the U.S. and the world (USGS, 2016c). At the state level, California's Seismic Hazards Mapping Program was mandated in 1990 to reduce threats from earthquake-related events, which must also be conveyed during real estate purchases (CGS, 2016). These few examples illustrate how geographic technologies contribute to evaluating hazard risk as a foundational component to a DM-SDSS.

16.2.3 Vulnerability & Resilience Assessments

Although without a single definition for either and not interchangeable or inversely related, vulnerability and resilience both explicitly emphasize the interaction of human systems with hazards in the creation of risk (Fordham, Lovekamp, Thomas, & Phillips, 2013). Vulnerability has evolved from stressing the hazard event and physical realm as the primary source of destruction to recognizing the significance of human systems (Fordham et al., 2013; Tobin & Montz, 1997). Resilience has recently emerged in research and practice as a term that embodies withstanding and adapting to disturbances of all types (Folke, 2006; Resilience Alliance, 2016). While distinct in many respects, conducting a place-based assessment that incorporates social considerations with hazard risk is fundamental to both.

Vulnerability and resilience continue to require attention with few explicit guidelines for how to conduct a comprehensive, multi-hazard assessment at the local level (Cutter, Mitchell, & Scott, 2000; Cutter et al., 2008). Cutter's Vulnerability of Place Model (1996) perseveres as a place-based, GIS assessment framework, which takes an all-hazards approach integrating social variables into a summary appraisal. However, solutions for incorporating multiple hazards with different recurrence intervals, varying geographic scales, and multiple approaches for conducting hazard risk models into a single, multi-hazard risk layer remains immensely challenging. While progress on quantitatively evaluating social vulnerability has occurred (Cutter & Fitch, 2008), mechanisms for meaningfully combining and interpreting social and built data with composite multi-hazard output remain unresolved. In fact, many aspects of social vulnerability are not easily incorporated onto a map (Morrow, 1999), but still GIS also offers many opportunities that should be further investigated and developed.

As one initiative, in an effort to integrate social data with hazard risk modeling, FEMA's Hazus-MH (Hazards U.S. Multihazards) estimates potential losses from earthquakes, floods, and hurricane winds (independently) and approximates loss to the built environment, populations and critical infrastructure from these models (FEMA, 2016b). The program includes U.S. national datasets and models for the hazard events along with socio-economic and building stock data. However, it is not truly multi-hazard in the sense that the models cannot be run in a single session. In other words, a user must examine floods independently from earthquakes

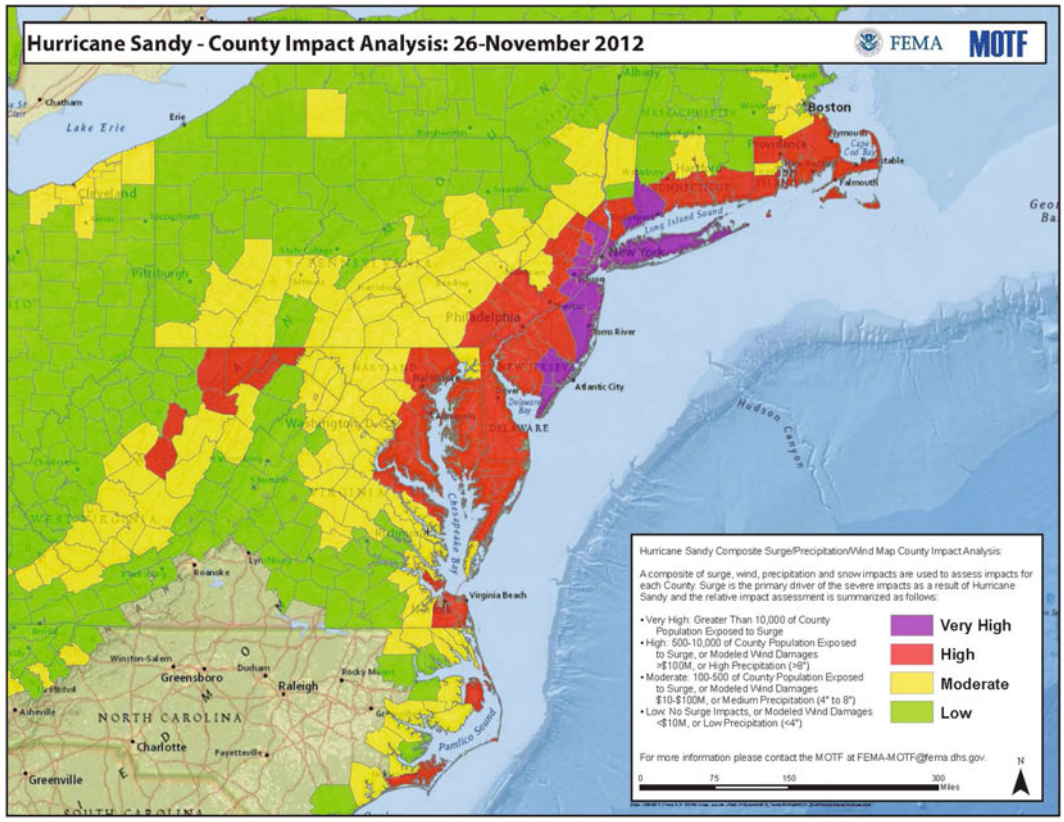

Fig. 16.2 Hurricane Sandy Impact Analysis. Courtesy of: Jesse Rozelle, Sean McNabb, Herbert "Gene" Longenecker, Nicol Robles-Kyle, and Austen Cutrell/FEMA. With permission

without the ability to generate composite risk from both or to quantify the impacts on people, buildings, or infrastructure together. Further, with the emphasis on loss estimation, the role of social vulnerability is rather minimal. The FEMA GIS platform seeks to increase situational awareness (see Fig. 16.2 as an example). The efforts represent an attempt incorporate multiple facets of vulnerability in a platform that allows refining data, setting parameters, and generating scenarios explicitly for decision-support.

16.2.4 Evacuation Planning

Evacuation planning highlights the use of a DM-SDSS for a specific purpose within disaster management with a long history of refinement (Cova, 2014). So, while this is a hazard-specific application, SDSS elements are clearly demonstrated. These systems link transportation models with GIS and decision systems in a manner that offers a more improved output than any of the systems could produce individually, a key contribution of a SDSS.

A few examples for evacuation from potential radiological disasters illustrate the integration of datasets, modeling, and decision-making approaches. Lindell et al. (1985) created a system that calculated the radius of the area for the evacuation, the delay time between warning and start of evacuation, and the speed of evacuation. In addition, changing meteorological conditions, alternative transport routes, modes for evacuation, and the identification of critical facilities (such as schools, hospitals and vulnerable population) were also incorporated. De Silva et al. (1993) developed an interface for simulating and

modeling evacuation routes. In this instance, simulation models were included directly into the SDSS to predict traffic flow for several scenarios (vehicle break down or road closure). De Silva (2001) expanded the use of a DM-SDSS to a true interactive planning tool to examine simple scenarios and to assess the evacuation process and progress. The system had four main components, including a traffic simulation module, a GIS module, an integration module, and a user interface. Importantly, the system incorporated expert users' input directly into the model. Although this was directed at a specific stakeholder group, it illustrates the full functionality that is anticipated from DM-SDSS by allowing the incorporation of user priories and parameter-setting capabilities. Other evacuation scenario models are applied to wildfires (e.g. Cova, Theobald, Norman, & Siebeneck, 2013), hurricanes (e.g. Lindell & Prater, 2007; Wilmot & Mei, 2004), or floods (e.g. Simonovic & Ahmad, 2005). All are problem specific (evacuation planning) and exclusive to a single hazard type.

16.2.5 Technological Hazards

The potential for incorporating technological hazards into a comprehensive DM-SDSS is immense, both because of SDSS development in this realm and due to the fact that natural and technological hazards are frequently closely intertwined. Natural hazards commonly trigger technological events, such as gas leaks after earthquakes or dispersion of hazardous materials during flooding, among numerous other examples. Other hazards emerge directly from the interaction of natural and human systems and so can be difficult to classify infectious disease outbreaks or climate change, for instance.

Technological hazards are commonly modeled in support of emergency management for assessing and minimizing the impacts on health. Chemical accidents, for example, require an emergency response and the Computer-Aided Management of Emergency Operations (CAMEO) was developed by the U.S. Environmental Protection Agency (USEPA) and NOAA to assist emergency managers and first-responders (USEPA, 2016). The software incorporates necessary information about chemicals, a dispersion model, along with response recommendations, using mapped output to convey results.

GIS-based SDSS is also used for support in managing oil spill incidents (Ivanov & Zatyagolva, 2008). The Environmental Response Management Application (ERMA) offers an online mapping tool aimed at providing a resource for oil and chemical spill preparedness, planning, and response (NOAA, 2016c). A multi-criteria SDSS can detect coastal area sensitivity in support of decision-makers providing alternatives for spill control and clean-up (Pourvakhshouri & Mansor, 2003; Vafai, Hadipour, & Hadipour, 2013). The *BP Deepwater Horizon Oil Spill* was one of the largest disasters of any type in the 2000s, needing complex physical, technological, and socio-economic analysis for short- and long-term management. Leifer et al. (2012) describe the use of remote sensing specifically for this extensive event and NOAA scientists modeled oil spill trajectories (Fig. 16.3), making these maps available to inform response efforts (NOAA, 2016d). Similar to the evacuation planning SDSS, those in the realm of technological hazards are well developed, but specific to a particular problem.

16.2.6 Information Sharing for Decision-Support and Risk Communication

The Internet disseminates hazards data, static maps, and interactive disaster mapping. Currently, online mapping incorporates little analytical capabilities or possibilities for adjusting parameters, either by an individual end-user or to capture input from stakeholders for prioritizing local, regional, and/or national approaches. Further, the number of Internet sites related to mapping are so numerous, disparate, and disconnected, they likely do not adequately reach the necessary audiences and can be confusing. Still, it is not hard to imagine

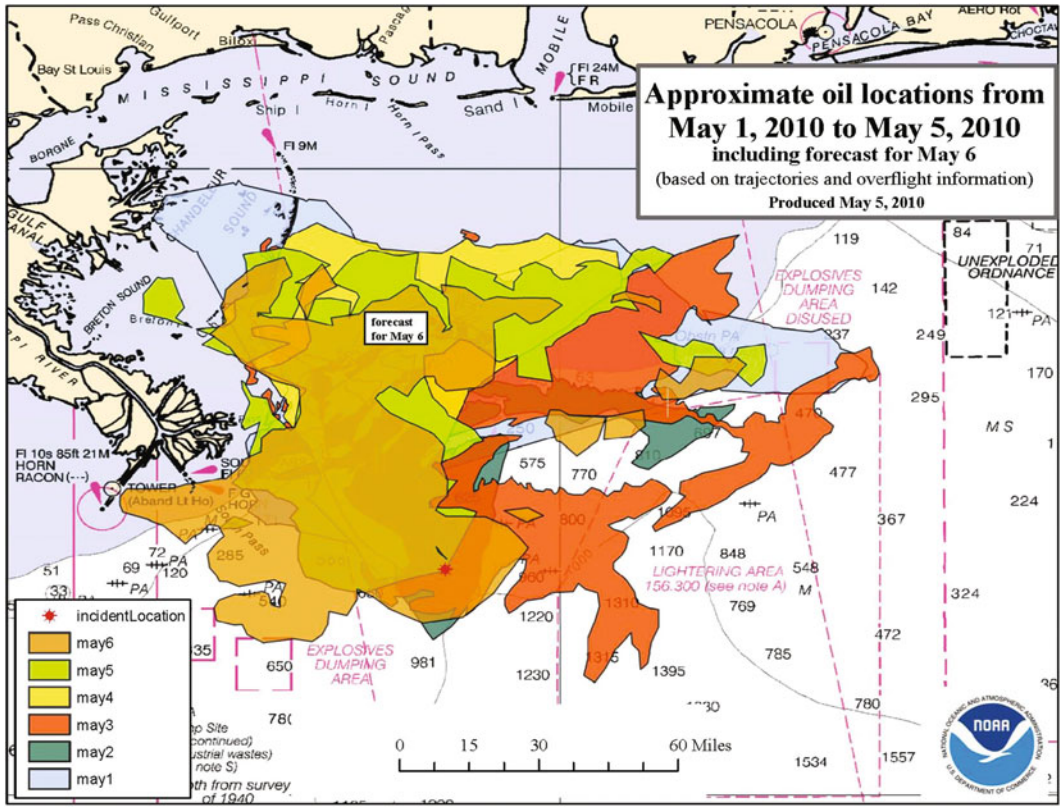

Fig. 16.3 The approximate oil locations from May 1, 2010 to May 5, 2010 based on trajectories and overflight information, including forecast for May 6. Produced by NOAA's Office of Response and Restoration (OR&R). With permission

the expansion of the capabilities embedded in existing web-based systems to include some of this functionality. Several regional, national, and international efforts serve as information sharing tools for both spatial and non-spatial hazards and disaster management resources.

Many data distribution endeavors supply spatial (geographic) hazards-related data through a data portal or clearinghouse, often including static maps. Increasingly, these data are made available through a web service (live data feed), which means the data are maintained by a particular agency/organization and other groups can access the data with an online connection, pulling them directly into a GIS or web-based interface (even non-mapping programs). These data support hazard, vulnerability and resilience assessments, though usually requiring technical GIS expertise. As one example, the USGS maintains and supplies a multitude of hazards event databases, including earthquakes, volcanic eruptions, landslides, floods, tsunami, and geomagnetic storms spatial data, along with educational materials (USGS, 2016d). The Global Disaster Alert and Coordination System (GDACS, 2016), although focusing on major sudden-onset disasters and not mitigation, acts as a repository for event-based data and acts as a cooperation framework between the United Nations, the European Commission and disaster managers worldwide to improve alerts, information exchange and coordination in the first phase after major sudden-onset disasters. The World Health Organization has published an online atlas with data sources in support of public health preparedness across the eastern portion of Europe

(WHO, 2016). The Center for Research on the Epidemiology of Disasters maintains an international database on natural and technological disasters by country and region, including deaths, injuries, damages, and impacted people that is an important data repository for understanding hazard impacts at the global scale (CRED, 2016). Though the data are seemingly extensive, navigating and compiling them from a vast number of sources is overwhelming and can be extremely time intensive.

In addition to the web data portals and static mapping, many mapping efforts have interactive interfaces whereby a user would not need to have extensive GIS skills to consider the data and/or the risk maps, though often capability is limited to visualization. Online availability increases access to the most current information and is useful for viewing complex hazard datasets and risk. Data are incorporated from a variety of sources to drive the system, which displays information selected by the user. Perhaps one of the most elaborate examples, the Pacific Disaster Center (PDC) provides disaster management information integration and sharing throughout the Asia Pacific Region and has developed an integrated mapping decision-support system for disaster management and humanitarian assistance (PDC, 2016). *DisasterAWARE* supplies access to many disaster-related databases, including emergency services, public facilities, utilities, transportation communications, political boundaries, demographics, hazard, image data, elevation, hydrograph, climate, weather, landforms and land use. Importantly, the user chooses what and how to display the data (PDC, 2016). *SERVIR*, another example that utilizes online data products, provides integrated geospatial data and tools to support environmental decision-making in Africa, the Himalayas, and the Mekong region (NASA, 2016b). California's interactive *MyHazards* (CalOES, 2016) mapping tool aims to enhance hazard risk awareness by the public. These Internet-based projects illustrate the possibilities for integrating new and emerging information technologies, observation systems, and communications for disaster management.

16.2.7 Community-Based Efforts and Volunteered Geographic Information

Through the extensive availability of mobile technology, place-based applications, and the evolution of social media, individuals and local communities can now participate in disaster management in innovative ways that challenge top-down approaches traditionally taken by formal disaster management organizations. Public participation GIS (PPGIS), which engages all stakeholders and emphasizes the role of local community members, is not new (Elwood & Leitner, 1998; Talen, 1999), nor is citizen data collection (citizen science) (Elwood, Goodchild, & Sui, 2012). Community-based disaster management, frequently incorporating mapping, also has a long history with numerous applications globally for promoting disaster risk reduction (Maskrey, 2011; Pearce, 2003; PreventionWeb, 2016). When used in a participatory or community-based fashion, data development and interpretation involve an exchange of information and integrates information about hazards, capabilities, assets, vulnerability, and resilience from the public (Khan, Enriquez, & MacClune, 2015; Pearce, 2003). Multiple segments of society should have access to disaster decision-making information along with experts. Further, the community-derived information has value alongside expert data sources. Still, in many ways the more "scientific," expert-driven approaches still dominate.

Rapidly evolving technologies now provide a platform to engage in community-based disaster management, with information sharing commonly occurring outside of formal disaster management structures. Increasing access to place-based applications through mobile platforms allows for the creation of Volunteered Geographic Information (VGI), data with a location generated outside of traditional structures by the public and uploaded to a mapping interface via a data connection. The emergence of this form of rapid data collection has challenged the top-down control of data creation and dissemination, and allows for increased

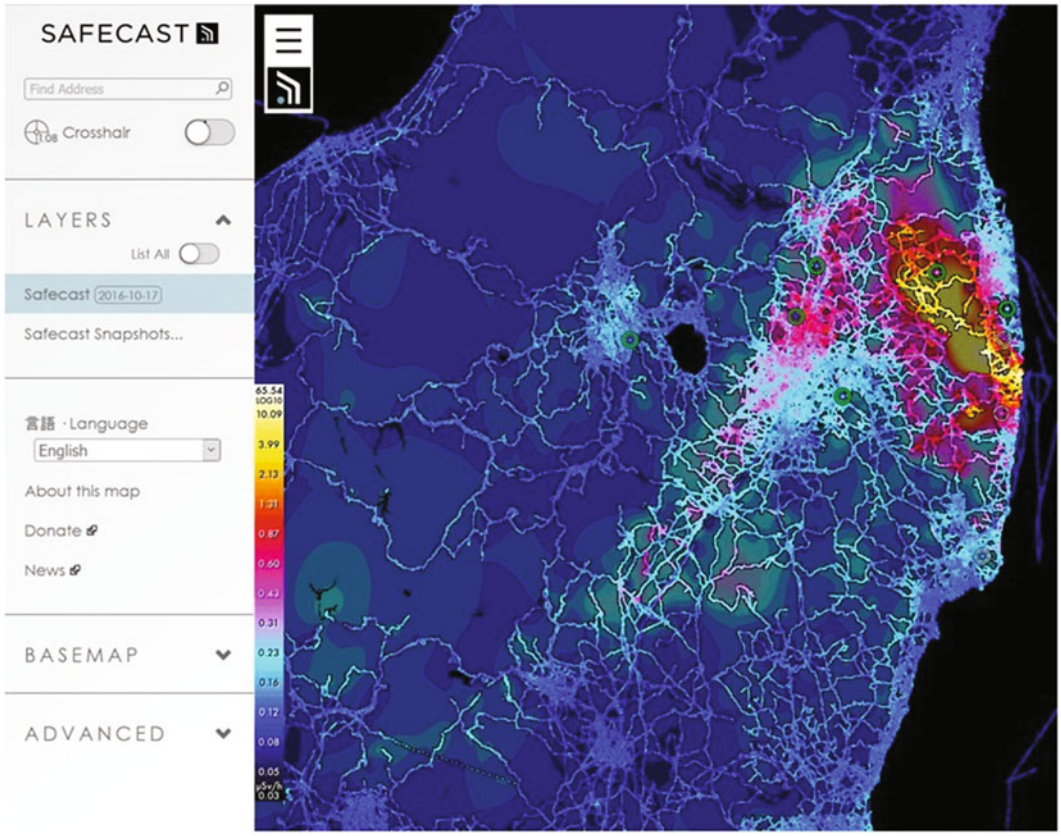

Fig. 16.4 Crowd-sourced radiation data collected after the Fukushima Daiichi Nuclear Disaster. Safecast distributed inexpensive Geiger counters to volunteers starting one week after the event. These data were then uploaded and mapped on an interactive site. Safecast Interactive map availabe at: http://www.safecast.org/tilemap/ With permission

community-based sharing of information and empowerment of citizen engagement (Haworth, 2016). In addition, social media, such as *Facebook* or *Twitter*, have also promoted the organic exchange of data and information and have augmented possibilities, though with challenges, for the integration of social media with geographic technologies (Sui & Goodchild, 2011).

VGI is now employed for nearly every recent disaster, and crisis mapping has become commonplace in less than a decade. The 2010 Haiti Earthquake launched a transformational shift in crowd-sourced information and VGI (Zook, Graham, Shelton, & Gorman, 2010). As another example, within a week after the Fukushima Daiichi Nuclear Disaster, Safecast distributed inexpensive Geiger counters to volunteers. These data were uploaded to an interactive mapping site, producing a crowd-sourced high resolution depiction of radiation levels (Fig. 16.4) at a moment when risk communication from formal sources was not terribly forthcoming. Various groups (e.g., Harvard Humanitarian Initiative, The Humanitarian OpenStreetMap Team, CrisisMappers) contribute to these endeavors, as do numerous platforms (e.g., Google Crisis Resources, Ushahidi), many of which are free and/or open source (Leidig & Teeuw, 2015a). Even near real-time maps exist of conflict areas (for instance, the Syria Crisis, Liveuamap, 2016).

16.3 Trends and Future Directions

Taken together, the rapid expansion of mobile technologies, the ever-increasing volume of generated spatial data, and the numerous topic-specific examples of support-systems suggest immense possibilities for DM-SDSS, supporting a wide range of user constituents. While the potential is exciting, this all points to challenges and future needs. The technological and data needs are immense and the required physical and social models vast. This section focuses on trends and considerations for the development of DM-SDSS, suggesting future directions for research.

16.3.1 Data Considerations

Data issues are mentioned by nearly everyone who writes on GIS, GIS&T, or DM-SDSSs, and is one of the greatest challenges facing the development of effective DM-SDSSs (NAS, 2007; NRC, 1999). Since these technologies are fundamentally data-driven, the lack of documentation about the information, data standardization, up-to-date information, or access to existing data all limit usefulness. High quality, relevant, timely, accessible, and integrated data are foundational to a DM-SDSS.

The nuanced data behind the maps and the models used to define risk data have variable quality with uncertainty embedded throughout the display. Describing and conveying uncertainty in an interactive mapping environment is just as, if not more, difficult than paper versions, a challenge that is not yet solved. Geographic data have many unique characteristics, such as scale, resolution, and projection. For instance, the scale at which data are collected directly impacts the level of detail included, which in turn affects the types of questions that may be answered or the analytical approach required. Evaluating whether a property is in a floodplain illustrates this point. Ideally, one would want very detailed tax maps along with engineering maps of the floodplain to make a determination. Using a statewide roadmap with streams and rivers (smaller scale maps) would not be an adequate option. Scale is but one geographic data consideration. Some others include how often and how recently the data were collected and by whom, the type of sensor for remotely sensed data, the original source, format, and procedures for collecting and processing. Not surprisingly, the quality of data and the geographic characteristics directly influence uncertainty and error embedded in results and visualization.

Studies surveying emergency managers revealed that real-time decision support require *temporal* detail in combination with the mapped information (Aubrecht, Fuchs, & Neuhold, 2013; Zerger & Smith, 2003), which adds a level of complexity if data are even collected, or collected in a way that is applicable. For example, data on many vulnerable and special needs population, such as tourists, homeless people, or undocumented workers are still not even collected or maintained in a consistent fashion (Cutter, 2003; Morrow, 1999); thus, these groups remain entirely under-represented in disaster GIS. Understanding day-time and night-time populations (for example, work or school versus residence), as well as movement between various activities persist as data gaps, nor is socio-economic composition captured for temporal shifts around a community. Importantly, disaster management requires both geographical and non-geographical data, all of which must be incorporated into any DM-SDSS, but are not always of the same high quality.

Even after decades of planning, debates, and consideration for disaster management data needs, there still is not a centralized data clearinghouse, portal, or repository for hazards or social science data that are already collected. Further, common data standards do not exist for collection, storage, or dissemination (NAS, 2007), which would facilitate efficient integration without significant manipulation. So, while vast quantities of data do exist, they are in disparate locations with variable access and quality. Even when high quality datasets do exist, they may be held by a private company (e.g. critical infrastructure related to utilities) or not available due to security (e.g. dams) or privacy (e.g. health

records) concerns; all of these are stored in disparate systems and organizations. Data sharing agreements are often necessary when data are not publicly available, though often not in place prior to an event. Cloud computing now offers immense possibilities in terms of sharing data and processing. However, reliance on the Internet poses a potential pitfall since it may not always be available (Johnston, Banerjee, Cothren, & Parkerson, 2014). So, while taking advantage of web-based solutions offers tremendous possibility, ensuring viable alternatives requires careful consideration and research.

At the same time, global positioning systems, remote sensing imagery, and geographic information systems are all accessible in ways not even possible five or ten years ago, generating ever-increasing amounts of geographic data. Other emerging technologies, including unmanned aerial vehicles (UAVs), 3D mapping applications (Breunig & Zlatanova, 2011), and video (Mills, Curtis, Kennedy, Kennedy, & Edwards, 2010) are all already generating immense quantities of data that will increase into the future. Individually and in combination, these increase data processing, storage, and management needs.

Although coming with exciting possibilities, the emergence of VGI data poses some unique data quality and dissemination challenges as compared to data collected through formal processes because of the lack of data collection/dissemination protocols and controls. The very strength of VGI through distributed and rapid collection also gives rise to substantial uncertainty in both the spatial and non-spatial data (Camponovo & Freundschuh, 2014). Issues of data quality, management, liability and security all need significant attention (Elwood et al., 2012; Haworth & Bruce, 2015; Sui & Goodchild, 2013). The decentralization of power poses unique need and opportunities for evaluation of VGI data quality and credibility (Flanagin & Metzger, 2008; Sui & Goodchild, 2013). VGI, as new paradigm for the generation and exchange of geographic information, has far-reaching implications, possibilities, and challenges for both practice and research (Elwood et al., 2012; Goodchild & Glennon, 2010; Sui & Goodchild, 2013).

The emergence of vast amounts of spatial data and interactive mapping have not necessarily facilitated access and use. The key for DM-SDSS is making information available to decision-makers in a meaningful and efficient manner. In fact, the massive quantities of spatial data now generated require big data analytics (BDA) to convert data into useable information (NIST, 2015), and much research is needed in this realm. Currently, there is a mismatch between what end users/decision-makers need from these data and the data science that produces meaningful results (NSTAC, 2016?). Research is necessary to ascertain whether and how this vast amount of data enhances disaster mitigation, preparedness, response, and recovery. Further, as spatial data is disseminated in various forms, effective map and risk communication principles must be explored.

While the Internet provides significant opportunity for dissemination, most online mapping efforts fall short of an integrated, robust DM-SDSS in several ways. Many predominantly focus only on the display and visualization of hazards data. Perhaps not surprisingly given the agency/organizational-oriented nature of data collection, online mapping interfaces tend to focus on a single hazard or set of related hazards, limiting the potential for all-hazard approaches and creating disjointed platforms that inhibit cohesive decision-making. Further, they are often oriented towards finding a specific location and then displaying the risk for a particular hazard without the inclusion of other social, physical, or built environmental data. The ability to change parameters and examine various scenarios is rarely an option. As an extension, they do not commonly include user priorities and perspectives, instead usually delivering information in one direction, often with limited analytic capabilities.

16.3.2 Social & Organizational Needs

Because a DM-SDSS is used by people within a particular context, social and organizational success is not simply based on technical concerns. In other words, a DM-SDSS may be developed and run efficiently, but may never be utilized to the fullest capacity without taking social and organizational issues into account. As important as the technology, the realization of risk reduction guided by DM-SDSS is dependent on coordination between and within organizations, user needs, data/technology access, and ethical considerations, incorporating and applying the technologies in ways that change behavior.

A system must meet the needs of an organization, as well as the end user/disaster manager. A DM-SDSS' compatibility with existing workflows augments decision-making, rather than requiring users to learn a different process. At the individual level, the design of the system should incorporate user need assessments, which reveal how technology can support the decision-making process. An end user can represent a range of stakeholders, from the expert to the lay person; design requires careful identification and consideration of who this is. At the organizational level, interoperability requires the cooperation of organizations for the transfer of data and models. Agreements must be in place prior to events, and a plan for the flow of information and models should exist. The International Charter, "Space and Major Disasters," is an example of this type of data sharing agreement and gives organizations in countries affected by major disasters access to necessary remote sensing data if they are an authorized user.

Even as community-based approaches and VGI disrupt traditional communication flows and access to data fosters unrestricted communication, the digital divide between subgroups of people and parts of the world not all having access to these technologies exacerbates inequities (Leidig & Teeuw, 2015b). In some ways, the most vulnerable become even more peripheral to information exchanges since they are least likely to have access to technology that can facilitate access to vital information. In fact, this is also true of many rural areas or low-income urban communities in high income countries, as not all places have high-speed Internet access, nor can all people afford it. In turn, they do not have the same access to risk information as people or organizations that are "connected." Although there are exciting and interesting examples of GIS use in lower and middle income countries, particularly with the availability of geospatial open source software (Teeuw, Leidig, Saunders, & Morris, 2013), computing infrastructure and data beyond Internet access are not as readily available.

A DM-SDSS should ensure equitable data access balanced with privacy and security considerations. These systems should contribute to documenting disaster loss reduction balanced with minimizing infringement on individual or community rights. Further, some data are secure (proprietary or legally restricted, such as dams in the U.S.). In an era of digital geographic data, the very data that are utilized to support improved hazard mitigation and preparedness may, in fact, reveal too much detail about communities and/or individuals. For instance, knowing where undocumented workers or people with disabilities live is necessary for vulnerability reduction. However, these data could be employed in a vastly different way by groups, such as law enforcement, with an alternate motivation. Further, the ways in which places are reconceptualized by GIS must be examined (Curry, 1997), since the way a community may want to be portrayed can differ from expert depictions.

16.3.3 Sustainability and Dissemination

Even though numerous DM-SDSS examples exist, their adoption and dissemination is currently not well understood. Why does a particular DM-SDSS persist, while others are rarely used and/or disappear entirely after a short time? What might be considered a success in terms of

adoption, VGI is now nearly ubiquitous during major events response, but it has not been widely applied in other disaster management phases. The rapid dissemination of VGI likely reflects a relative advantage over more traditional GIS for the public in response scenarios, so understanding how this may, or may not, translate to recovery, mitigation, or preparedness is relevant. Further, many DM-SDSS initiatives have come and gone, possibly suggesting limited financial, technical and human resource support; or, just as probable of an explanation, the tool was not widely adopted and so support became inappropriate. In reality, many DM-SDSSs remain siloed mapping tools for a particular hazard or management issue with fairly specific purposes with little integration between applications. In fact, on a portal for interactive tools NOAA (2016e), no less than 59 options, most with mapping capabilities, are listed related to various aspects of coastal and disaster decision-making, which could be overwhelming for many users who might benefit from their use. Further, tools are frequently developed without user needs assessments, thereby not identifying the requirements for decision-support at the onset of development. Once available, limited support for analysis and evaluation may constrain use (Uran & Janssen, 2003). Significantly, little is known about the actual use of DM-SDSS and whether, and how, any of these tools influence decision-making or organizational/individual behavior.

Research is needed on the cognition of geographic information for disaster management and risk communication. In other words, knowing how people process and understand spatial data aids in the creation of appropriate and effective maps and other corresponding output from the DM-SDSS. The ways in which people understand and interpret maps varies. Thus, not only does the data impact the output, but people's perceptions and map reading skills should also be considered. For example, red is generally interpreted as 'danger' and so using a yellow to depict wildfire-prone areas would not be as effective. Cartographic (map-making) principles should always be incorporated into the design and implementation of any DM-SDSS interface and visualization capabilities (for example, MacEachren, 2004 or Robinson, Morrison, Muehrcke, Kimerling, & Guptill, 1995). Related to this, developing theory-based mechanisms for conveying uncertainty that exists in all physical and social models, as well as in the data itself, is necessary. However, in the face of information that is not one-hundred percent correct, disaster managers still must make costly decisions about evacuation or prioritizing mitigation measures. Individuals and communities are faced with the same dilemma.

In the end, if elaborate decision-support tools do not change individual and organizational behavior and ultimately reduce risk, investment in them is ill-placed. Little research currently exists on how maps (or a DM-SDSS) influence risk perception or decision-making. Ultimately, changing behavior is cornerstone for reducing loss, not the generation of vast amounts of unusable data or decision-support tools that are not adopted, used or applied. Research is necessary that directly explores how (and whether) research embedded within DM-SDSSs translates to risk reduction.

16.4 Conclusion

The proliferation of GIS&T throughout disaster/hazard research and practice enables and facilitates placed-based approaches for disaster risk reduction. GIS&T guides all elements of a DM-SDSS, which incorporates database management systems, specialized analytical modeling capabilities, graphical display capabilities, and reporting capabilities with the ability to consider scenarios by an end user. GIS, one type of geo-technology in GIS&T, has wide-ranging potential in disaster management, including, but not limited to, damage assessment, risk prediction and situational analyses, vulnerability and resilience assessments, or prioritization of mitigation alternatives. Rapidly evolving

technologies now provide a platform to engage in community-based disaster management, and geo-enabled mobile technologies have rapidly expanded the potential for widespread geographic problem-solving and decision-making. With proper design considerations, DM-SDSS should reduce information overload and assist all types of stakeholders in the assessment of risk reduction activities.

As DM-SDSS utilization increases, critical evaluation of the technology should be undertaken. Little is known about the way DM-SDSS tools are adopted and disseminated. By extension, limited research explores how GIS and maps directly affect decision-making or how people process and utilize geographic information, including uncertainty, for risk reduction actions. Research is still needed that explores tensions between access, security and privacy, continually promoting equitable and inclusive solutions. For example, the digital divide and consistent access to the Internet still present significant barriers to the utilization of spatial data and mapping, the basis of a DM-SDSS. The rapid emergence of VGI, and associated social media, has transformed the potential for broad citizen participation in GIS&T, offering expansive opportunities for needed research in data credibility, social decision-making, and user motivation. With the availability of ever-increasing amounts of data from numerous inputs, including remote sensing, GPS, VGI and new sensors, the mismatch between vast data availability and the ability to process into meaningful results warrants significant attention. Not only is there a need for centralized data repositories & clearinghouses (social and physical sciences and engineering), research in big data analytics (BDA) specific to spatial data is necessary to convert data into useable information.

DM-SDSS has not reached its fullest potential and significant gaps in research exist across numerous DM-SDSS dimensions. Although immense promise exists, the proliferation of GIS&T applications throughout disaster/hazards research and practice does not always translate to decision-support or behavior change. The proliferation of technology for the sake of technology is not particularly useful; it is cutting-edge approaches that support disaster decision-making that will ultimately reduce loss, which requires commitment to interdisciplinary research that transcends boundaries between the physical and social science, as well as engineering.

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Computer Simulation and Optimization

17

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Contents

17.1 Introduction

Computer simulation and optimization are among the most commonly used mathematical modeling methods in the related fields of operations research, systems engineering, and industrial engineering. Both use a set of mathematical relationships to represent real-life systems with the aim of improving understanding of the systems' behavior, and supporting decisions related to their design, operation, and management. The methods can be used separately or together, bringing the power of mathematics to many real-life questions. Simulation and optimization are both increasingly applied in the field of disaster studies due to their ability to provide system-level analyses, to explicitly represent the uncertainty that is core to the disaster problem, and to support real-life decisions that disaster studies ultimately often serve.

Despite being thought of as primarily engineering methods, simulation and optimization modeling (and in fact, most mathematical modeling) applications in disaster studies can benefit greatly from collaborations with social scientists,

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in particular in formulating the models and interpreting their results. The goal of this chapter is to facilitate improved integration of the engineering mathematical modeling and social science lines of research that address similar real-world disaster-related questions. Too many engineering disaster studies occur without incorporating relevant social science findings, and too many social science studies proceed without awareness of the benefits that engineering math modeling methods could provide. Specifically, for the social science reader, we aim to introduce the methods of computer simulation and optimization—what each does, how it works, the value it can add, and the vocabulary to describe it—so that they might consider collaborating on projects that use them in the future. Providing some insight into the mindset of math modelers may also help the social scientist interested in working with them. For the engineering reader, we hope to encourage them to consider how they might integrate social science perspectives into future simulation and optimization modeling efforts.

In Sect. 17.2, we provide an overview of engineering mathematical models in general—what they are, how they can be used, the process by which they are developed, the different types, and their strengths and limitations. In Sects. 17.3 and 17.4 we describe optimization and simulation, respectively, including in each case a brief history, the basics of how it works, the types, the strengths and limitations, and sources of additional information. Following those general discussions, in Sect. 17.5 we present example applications of these methods in disaster research in particular, offering an overview of the types of questions in disaster studies that have been addressed using these methods and an understanding of why the methods are well-suited to those questions. Finally, we conclude in Sect. 17.6 with a discussion of the opportunities and potential challenges of increased collaboration between social scientists and engineers around the use of computer simulation and optimization.

17.2 Mathematical Modeling

17.2.1 Definitions

A *system*, a general term that can refer to everything from a road network or a building to a community or set of laws, can be defined as a combination of entities (e.g., objects, people, processes) forming a complex whole. In engineering, definitions typically include a requirement that the entities interact, often toward the accomplishment of some logical end (Law and Kelton, 2000). A *model* is a simplified representation of a system that helps us understand it, and there are many types. A *physical model* is a three-dimensional, often scaled-down, physical representation of a system, such as a miniature building used in an experimental set-up in a wind tunnel. A *conceptual model*, common in the social sciences, is a set of ideas about the system, often depicted as a flowchart-type figure that includes assumptions, variables, and directions of influence between elements of the system. Examples include the Pressure and Release model (Blaikie, Cannon, Davis, and Wisner, 2014) and Protective Action Decision Model (Lindell and Perry, 2012). In this chapter, we focus on models that use the language of mathematics to represent a system. Bender (2000, p. 2) defines a *mathematical model* as an "abstract, simplified, mathematical construct related to a part of reality and created for a particular purpose." Including the same components, Velten (2009, p. 12) defines it as a "triplet (S, Q, M) where S is a system, Q is a question relating to S, and M is a set of mathematical statements $M = \{\Sigma_1, \Sigma_2, \ldots, \Sigma_n\}$ which can be used to answer Q." While we often focus on the set of equations or mathematical relationships when we think of a mathematical model, the other two components of the triplet are important as well. To be considered a mathematical model, the equations must describe a particular part of reality or system S, and they must be developed for the purpose of addressing a particular question or purpose Q. Considering the example of a building, one can

imagine there are numerous possible mathematical models of a building, and the appropriate one depends on the purpose. If the aim is to estimate building damage in an earthquake the relevant building features and resulting set of equations will differ from those if the aim is to estimate space in the building available for rental.

In the context of disaster studies, an example of a mathematical model would be the equations that define a set of fragility curves (M), which are used to represent a building (S) for the purpose of estimating damage associated with experiencing ground motion (Q) (Fig. 17.1). Figure 17.1 shows an example in which the model is a set of three equations written in mathematical form (right) and also graphed (left). The equations allow the analyst to compute the probability a building will be in at least a slight, extensive, or complete damage state if a specified level of ground shaking intensity, S_d, occurs. Another would be a logistic regression equation (M) that represents the percentage of people living on the coast (S) who will evacuate under threat of hurricane (Q). Figure 17.2 shows an example of such a logistic regression model from Wilmot and Mei (2004). (Note that this is the same regression modeling social scientists commonly use, but while they focus on hypothesis testing and the relative significance of different variables, engineers often use them for prediction.)

17.2.2 Goals and Uses of Mathematical Modeling

Recognizing that mathematical models are simplifications of a system, it is clear that it is possible to develop multiple models for a given situation depending on the choices made about which aspects of the system to focus on. The goal therefore, is not a single correct mathematical model, but the one that best achieves the stated objectives. A balance must be found between model accuracy, flexibility, and cost. The best model is the simplest, most flexible one that still serves its stated purpose (Velten, 2009). This highlights the importance of clearly stating the purpose a priori.

In general, mathematical models have multiple possible uses, including: (1) improved system understanding, (2) decision support, (3) design of a new process/system, and (4) training. The process of developing a mathematical model, the

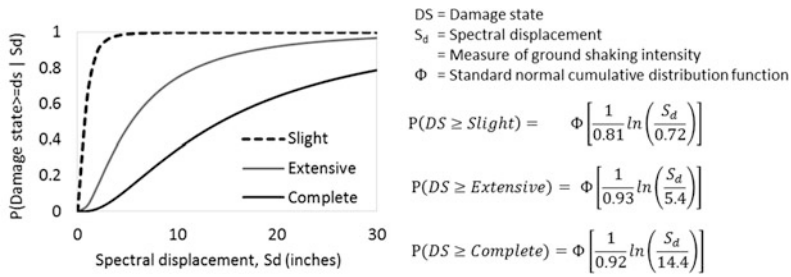

Fig. 17.1 Example fragility curves, a mathematical model of earthquake building damage

$$ln\left[\frac{p}{1-p}\right] = 1.80 + 2.32 * x_{mobile} - 1.05 * x_{SFD} + 1.44 * x_{order} - 0.04 * x_{age} + 0.80 * x_{dist} - 1.26 * x_{single} - 0.80 * x_{married}$$

p = P(Evacuates)
x_{mobile} = Mobile home (Y/N)
x_{SFD} = Single-family home (Y/N)
x_{order} = Evacuation order given (Y/N)
x_{dist} = Distance to water< 1 mi. (Y/N)
x_{single} = Single, never married (Y/N)
$x_{married}$ = Married (Y/N)
x_{age} = Age (years)
{Y=1; N=0}

Fig. 17.2 Example logistic regression model for hurricane evacuation (Wilmot and Mei, 2004)

form of the model itself, and solving the equations that make up the model can all offer insights into how the system behaves, why, and which factors are most important in determining the behavior. If the results of a mathematical model agree with expectations, it can confirm the existing conceptual understanding; if not, it can highlight deficiencies, suggest ways to improve understanding, or at least identify areas where more study is needed. The process of modeling itself can often help organize thinking about a system and facilitate communication among many participants. Models are often used for decision support as well. Once a model is thought to accurately reflect a system's behavior, it allows the user to test the effect of changes in the system and predict behavior under new circumstances (e.g., if a new earthquake occurs, if a policy change is implemented, or if evacuation orders are given at a different time). This can be useful when resource constraints or ethical standards prevent testing the effects in the real world (e.g., Aguirre, El-Tawil, Best, Gill, and Federov, 2011). Mathematical models can be used to design new systems or processes as well by identifying the combination of design parameters that is optimal for achieving some stated objectives (e.g., determining the amount and location of pre-positioned relief supplies that best facilitates emergency response). Finally, some mathematical models are used for training. Since disasters in a particular location are by definition infrequent, people have limited direct experience with them. A model that can simulate the behavior of a system in the event of a disaster can allow emergency managers and others to experiment with different actions in a risk-free, virtual environment to see what is most effective.

17.2.3 Mathematical Modeling Process

Mathematical modeling, i.e., the process of building, solving, and using a mathematical model, is part science and part art, involving intuition, judgment, and experience, as well as technical knowledge. It cuts across the real world and the formal, idealized world of mathematics (Fig. 17.3). In a general sense, the process involves three main steps (based on Murthy, Page, and Rodin, 1990; Shier and Wallenius, 2000): (1) formulation, (2) analysis, and (3) interpretation.

The process begins in the real world with a question to be answered or a problem to be addressed (bottom left corner of Fig. 17.3). The first step then is to formulate the mathematical model. This crucial step involves two main stages: (1) problem framing and conceptual formulation, and (2) mathematical model formulation. In the real world, problems are typically messy and ill-defined. Work is needed initially to develop a clear problem statement that focuses on the true questions of interest, not the symptoms. The problem must be framed to determine where to draw the boundaries of the problem—what will be addressed and what will not. The goal is to include all critical elements, but omit all else, keeping the model as simple as possible, but no simpler. A conceptual formulation can be useful in this first stage to organize thoughts about the main elements of the problem and the relationships between them, determine the degree of detail to include, and establish the main assumptions. This might include a description in writing or figures or schematic diagrams. For example, to help decide if an electric power substation should be retrofitted (i.e.,

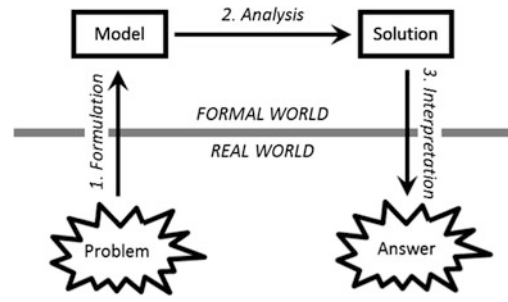

Fig. 17.3 Mathematical modeling process

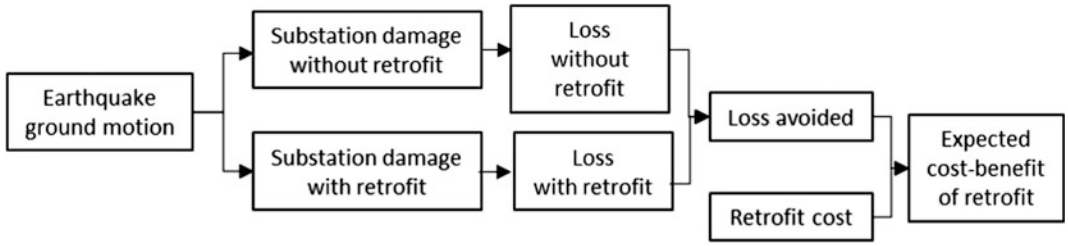

Fig. 17.4 Example of a conceptual model that could be translated into a mathematical model

strengthened) to resist earthquake damage, one might have a conceptual model in which the damage and loss with and without the retrofit are estimated, the losses are compared to determine the loss avoided by doing the retrofit, and that is then compared to the cost of the retrofit (Fig. 17.4). Once the problem statement and main concepts have been defined, in the second stage, a mathematical formulation is developed to translate the conceptual system characterization into a mathematical one. This requires identifying the appropriate type of model (e.g., optimization, simulation), then specifying the particular form of it for the given problem (i.e., the specific equations). For the substation retrofit model (Fig. 17.4), for example, one might use a simulation of the process, and within that simulation, the equations representing two sets of fragility curves like those in Fig. 17.1 might be used to estimate the damage with and without the retrofit. In reality, these two stages of formulation must happen together, iteratively. As the modeler aims for a mathematical model that represents the system as well as possible, but is also solvable using the laws of mathematics and computational resources, he has to balance accuracy and tractability. This delicate balancing act requires experience and understanding of both the real world problem and the possible mathematical formulations. The engineering strategy is typically to begin with a relatively simple model that includes some assumptions and simplifications, but that the modeler knows how to solve, then gradually to relax the assumptions and add complexity as needed until the model can serve the stated purpose.

Models are often considered in terms of the inputs they require and the outputs they provide. In formulating the model, one must ensure that the required inputs are available and that the outputs will serve the intended use of the model. In many cases, the modeler is not starting from scratch. There may be available models for subsystems that can be linked together, for a similar system that can be modified, or for a general situation that can be specified for the case of interest. This first formulation step is arguably the most difficult and the most important. If the problem is misspecified or framed inappropriately, or the model is defined in a way that does not capture the system correctly, then no matter how elegant the mathematical solution developed in Step 2, the model's usefulness will be compromised. Imagine, for example, one is interested in developing a tsunami response plan. One could develop a sophisticated optimization model to determine the best routes to get people away from the coast as fast as possible, but if the problem is framed so that it considers only horizontal and not vertical evacuation, then no matter how elegant the math is, the model may not provide the full solution.

Step 2, the analysis, takes place entirely in the formal world of mathematics. During this stage, it almost does not matter what the real world application is. The laws and methods of math are applied and computations performed to find a solution to the mathematical statements that define the model. This analysis is typically done using computers now, and in fact, often involves a great deal of computation. Depending on the model formulation, this step may be

straightforward or quite difficult. Much engineering education focuses on this part of the process (Shier and Wallenius, 2000), as reflected in the many papers that emphasize the solution method with relatively little discussion of Steps 1 or 3.

In the interpretation (Step 3), the solution to the mathematical model is translated from a mathematical form into real world conclusions. This step involves drawing valid conclusions that were not known ahead of time and communicating them accurately and clearly. The model must be checked to confirm that the conclusions are reasonable and that the mathematical model represents what it purports to represent. Sensitivity analysis may determine the range of values for which the model is reasonable. If the validation is not satisfactorily achieved, the process loops back and changes are made in the formulation or analysis steps until it is. In the substation retrofit example, after validating the model, one might examine the results to better understand if the retrofit is likely to be cost-effective, and the relative importance of the different factors—magnitude of earthquake ground motion, how much the retrofit reduces loss, and retrofit cost.

Although some might assume that mathematical modeling is a purely technical endeavor, as this discussion hopefully suggests, social science can provide valuable input to the process, particularly in the Formulation and Interpretation steps that involve the intersection of the math with the real world (Fig. 17.3). Those opportunities are discussed further in Sect. 17.6.1.

17.2.4 Classification of Mathematical Models

The myriad types of mathematical models can be categorized in many ways, based on the types of systems they represent, questions they address, and mathematical formulations they use (Velten, 2009). A few classifications of interest in the context of disaster studies are (Fig. 17.5): deterministic/stochastic, static/dynamic, normative/descriptive, and theoretical/empirical.

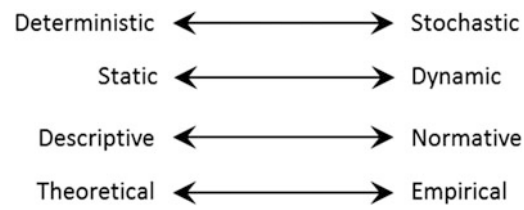

Fig. 17.5 Some classifications of mathematical models

Deterministic models ignore random variation, so the same input always produces the same output with certainty. By contrast, *stochastic or probabilistic* models explicitly represent uncertainty in the system, including variable values that are treated as random, i.e., described by probability distributions rather than single values. For example, a common hurricane wind field model relates the wind speed at each location in a region to the radial distance from the storm center, pressure at the storm center, and other parameters (Holland, 1980). Given a set of input values, this deterministic model always gives the same single wind speed value at each location. On the other hand, a ground motion prediction equation model typically relates the ground motion intensity at each location in a region to the distance from the earthquake fault and other attributes of the fault, fault-to-site distance, and site, but with an error term added. This means that for a specified set of attributes of the fault and site, these probabilistic models produce a probability distribution describing the ground motion at the site.

In *static or stationary* models, the variables and relationships in the model are time-independent. In *dynamic or non-stationary* models, time plays an important role with the variables and/or relationships changing with time. Hurricane formation could be described with a stationary model if one assumes the rate of occurrence remains constant, or as dynamic model if one assumes it is changing over time due to climate change. *Descriptive* models try to represent a system as it is, whereas *normative* models describe how it should ideally be so as to achieve some objective, where the objective is defined by the policymaker or other user of the model. A normative model might represent when people *should* evacuate an area so as to minimize

the risk associated with wildfire; a descriptive model might capture when people *actually do* evacuate from a wildfire threat. Finally, *theoretical or mechanistic* models are based on theoretical information about the system behavior. *Empirical* models are based on data that describe the system behavior. Although some are more common, any combination of these categories can exist together (e.g., a deterministic model can be static or dynamic). Especially the last two of these classifications actually can be considered scales, with models often are best defined in the middle, not at one end or the other.

17.2.5 Strengths and Limitations of Mathematical Modeling

Mathematical modeling has a number of strengths that make it a powerful tool in disaster studies and innumerable other disciplines. For any problem amenable to representation by quantitative data, mathematics provides a natural way to express concepts and relationships. Further, mathematical models bring the immense power of mathematical methods to real world problems. Once a real life system is described in terms of mathematical equations, the laws and methods of mathematics can answer questions that are impossible to address any other way. For example, in situations with very large numbers of possible solutions, such as how to allocate funds among possible retrofit projects, optimization can systematically search and find the solution that optimizes some stated objective, such as minimizing future loss. That task could not reasonably be completed by other means. Similarly, there are so many ways that a flood might unfold and impact a community, a simulation can help represent those many possibilities in a way one could not without such a model. Finally, while mathematical models often complement real-life experiments, and physical and conceptual models, in many cases, the alternatives are too expensive, too slow, or not possible, and thus mathematical models provide the only feasible approach.

Like anything, however, mathematical modeling also has some substantial limitations and common pitfalls. First, garbage in, garbage out. Mathematical modeling is not magic. It cannot produce a useful, high quality result without a clear understanding of the system and the problem to be solved, and quality data to serve as input. The modeling process must reflect reality and the needs of the model users. Since many models are quite complex, the process often requires collaboration among multiple participants—experts in the real world systems as well as the model formulations. Mathematical model results can sometimes appear more accurate than merited because the solution to the equations can be stated with a high degree of precision. All results should be taken with a grain of salt until assumptions have been checked and results have been properly validated. Second, even when expertly developed, mathematical models are simplifications of reality—partial representations of a complete, real-life system—and must be interpreted accordingly. When using them for decision support, for example, the results should not be followed blindly but considered as input to the decision process, which will include other sources of information as well. The modeling is not an end in itself but a means to solve real world problems. Third, once a model exists it can take on a life of its own, and can easily be misused. A model is built for a specific purpose, so it is important to be careful when attempting to use it for another. Developing the model involves making assumptions about what aspects of the real-life system to include and what to omit, for example, and those assumptions must be appropriate for the new proposed purpose. Similarly, models are often formulated using input data and thus the results are only valid within the range of that input, and great care should be taken when extrapolating beyond. An awareness of and healthy respect for these pitfalls can help ensure mathematical modelers avoid them while taking advantage of the power and insight the models have to offer. Collaboration with social scientists attuned to the complexity of real systems and needs of policymakers and other model users can support that effort.

17.3 Optimization

In this section, we provide an introduction to one of the most common types of mathematical modeling methods used—optimization. We include a brief history, the basics of how it works, the types, the strengths and limitations, and sources of additional information. In Sect. 17.4, we present a similar introduction for computer simulation. The aim is help the reader understand what each method does, how it works, the value it can add, and the vocabulary to describe it—so that they might consider collaborating on projects that use them in the future.

17.3.1 History

Although evidence of the use of optimization techniques dates back to the early 1900s, the real beginning of optimization is typically considered to be World War II, when it was developed by the British and Americans to help maximize their use of limited resources in supporting the war effort (Sarker and Newton, 2008). Following the war, the method expanded rapidly into non-military fields with the development of new techniques and facilitated by the rise of computing power (Hillier and Lieberman, 2001). Applications now span a huge range of fields including manufacturing, transportation, finance, and health care.

17.3.2 Basic Structure

Optimization models are used in situations in which a best, or optimal, solution is sought for the problem under consideration, that is, in which the objective is to maximize or minimize some quantity. The basic structure of the problem includes a few key elements (Fig. 17.6). *Decision variables* are variables (say, $x_1, x_2, \ldots, x_n$) that represent the quantities whose values are to be determined by solving the model. The *objective function* defines the measure of performance that is to be maximized or minimized. It is a function of the decision variables. Changing the values of the decision variables changes the objective function value. The aim of the model is to find the values of the decision variables, $x_1^*, x_2^*, \ldots, x_n^*$, that maximize (or minimize) the objective function. In most cases, there are also restrictions on the values that the decision variables are allowed to take. Those restrictions are specified as equations or inequalities called *constraints*. The example in Fig. 17.6 shows one inequality and one equality, but it is possible to include as many as necessary. The constants in the objective functions and constraints are the model *parameters*.

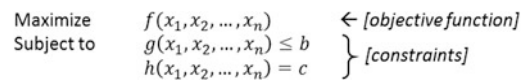

Fig. 17.6 Basic structure of an optimization model

The primary outputs of an optimization include both the objective function value (i.e., the maximum or minimum performance measure value that can be obtained) and the associated decision variable values. One, the other, or both might be of interest in a particular situation.

For example, suppose an emergency management agency can choose between two types of mitigation projects to support (Type 1 and Type 2). Figure 17.7 shows a simple example of an optimization model formulated to help decide how many of each to do, where x and y are decision variables representing the number of projects of Type 1 and 2, respectively. Each type of project has a different cost ($5M and $10M for Types 1 and 2, respectively), has different staff requirements (20 and 10 for Types 1 and 2, respectively), and will protect a different number of people (100 and 200 for Types 1 and 2, respectively). The budget and staff available are both limited ($50M and 100 staff, respectively). When solved, the optimization will determine the values of x and y, representing the number of projects of Type 1 and 2 that will maximize the number of people protected without violating the budget and staffing constraints.

There are at least two ways social scientists can contribute to the optimization modeling

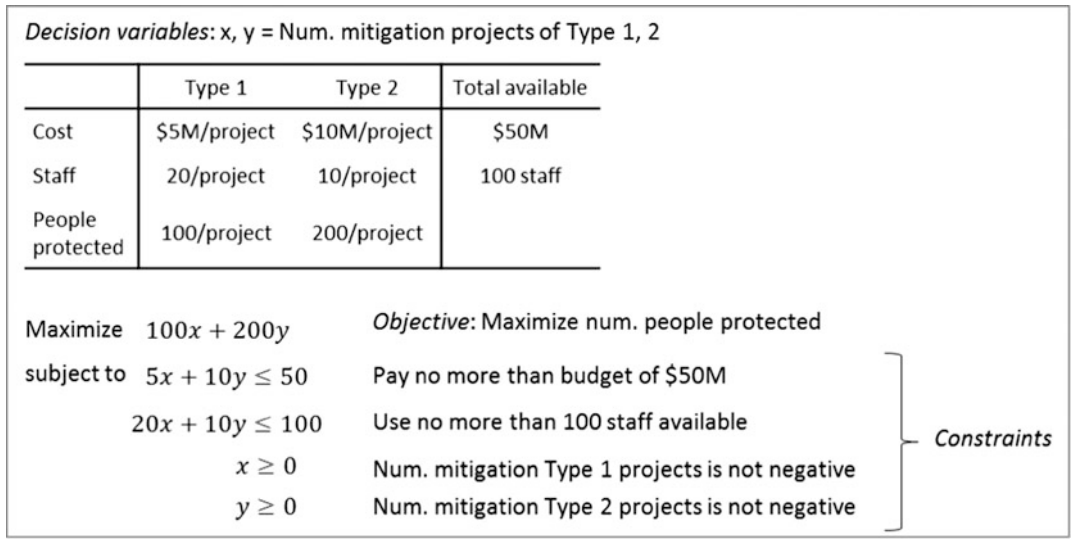

Fig. 17.7 Example optimization model

process. First, they can help frame the problem and formulate the model. That is, their understanding of a system can provide insight to help determine what the objective(s), decision variables, and constraints in an optimization should be to best represent the real-life system being modeled. In the mitigation project example, for instance, they may suggest that there is an important regulatory constraint that should be represented in the formulation as well. Second, more generally, optimization is used to inform decisions, and social scientists have a long history of empirical research about how people actually make decisions. Economists have identified many cognitive biases that affect decision-making, such as, underestimation of the probability of disaster events (McClelland, Schulze, and Coursey, 1993), aversion to upfront costs (Kunreuther, 2006), and use of a short time horizon in evaluating consequences (Kunreuther, Onculer, and Slovic, 1998). Sociologists and others have identified additional factors, such as, risk perception, hazard experience, and social influences (e.g., Lindell and Perry, 2000; Peacock, 2003). To the extent that modelers understand how people make decisions, they can better design optimization models to be part of and support that process.

17.3.3 Types of Optimization Models and Solution Methods

There are many types of optimization (also known as programming) models depending on the form of each of the main elements (Fig. 17.8) (Sarker and Newton, 2008). A model may have a single objective function or multiple objectives. The decision variables may be constrained or not. The variables may be continuous, integer, or mixed (some of each). They may be deterministic or random variables. The objective function and constraints may be linear or nonlinear. The most common, simplest type of model is the linear programming model, or linear program (LP), which includes a single objective, constraints, continuous deterministic variables, and only linear functions (e.g., Fig. 17.7). All examples in Sect. 17.5 are constrained. The adjectives on the left side of Fig. 17.8 are the simpler and default versions of an optimization, and so a model typically is described using the adjectives that distinguish it from those. For example, if a model described only as a *stochastic integer program*, it can be assumed to be single objective and linear.

Many situations encountered in real-life exhibit the same structure as a well-known problem that has been carefully studied and for

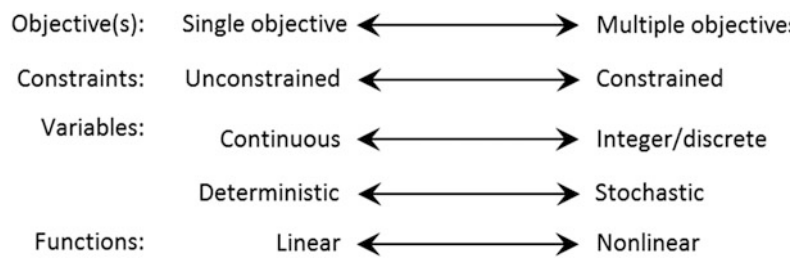

Fig. 17.8 Selected optimization problem classifications

which solution algorithms are readily available. These include, for example, the *shortest path* problem, in which one seeks the path through a network from an origin to a destination that offers the minimum cost (or length); the *maximum flow* problem, in which one seeks the maximum amount of flow that can occur through a network from an origin to a destination node assuming limited flow capacity on each link; the *knapsack* problem, in which one aims to determine which items should be put in a knapsack given a total weight limitation (same as the capital budgeting problem in which one decides which projects to fund given strict limit on total budget); the *facility location* problem, in which one aims to locate facilities so as to serve clients economically; and the *traveling salesperson* problem, in which one seeks a path by which a traveling salesperson can visit each of several locations exactly once ensuring minimum total traveling distance (or cost). All of these problems, though formulated for particular, seemingly limited situations, have a structure that turns out to be quite generally useful. For example, a model to identify which of a set of possible water supply system retrofit projects to fund given a specified budget could be considered a knapsack problem, and thus solutions for that problem type could be applied. Similarly, a model to determine where to pre-position supply warehouses to best provide disaster relief could be considered a facility location problem.

Depending on the form of the optimization problem, various solution algorithms are possible, including graphical, simplex, and branch-and-bound, methods that are guaranteed to converge on the true optimal solution. For some complex models, those algorithms do not apply and heuristic methods are required instead. Heuristic methods are intuitively designed procedures that may not guarantee convergence and optimality, but produce solutions of acceptable quality for the intended practical purpose. These include simulated annealing, tabu search, genetic algorithms, and ant colony optimization (Sarker and Newton, 2008).

17.3.4 Strengths and Limitations of Optimization Models

Optimization models are powerful for situations when they apply. Their strengths include:

- *Provides optimal solution*. For problems that can be formulated as a minimization or maximization question, they can identify the solution (i.e., set of decision variable values) that optimizes the objective(s). (Simulation, by contrast, does not identify an optimal solution.)
- *Compares many alternatives*. Unlike methods that require a priori specification of a limited number of alternative solutions, optimization can evaluate a huge number of alternatives and identify the best.
- *Exact*. The solution can often be proven to be exact (unlike simulation, which is approximate).
- *Flexible*. Many versions of optimization models exist, making them widely applicable in many situations.
- *Standard problems*. Many real-life problems can fit into standard, well-studied types of problems (e.g., the knapsack problem) facilitating their solution.

Limitations include:

- *Applicability*. Optimization is not applicable to all problems.
- *Solvability*. The more complex problems become the more difficult it is to formulate and solve them as an optimization.

17.3.5 Further Information

Solving optimization models requires many computations, and thus it is almost always done using computers. Many software packages are available to solve optimization models, including LINGO/LINDO, CPLEX, and Gurobi (Sarker and Newton, 2008). Since heuristic methods are designed specifically for each problem, computer code must be written for each problem separately. This chapter is intended to provide a conceptual, high-level understanding of what optimization models are and what they can do. To study the topic in more depth requires some background in linear algebra. The following are good sources for the interested reader: Bertsimas and Tsitsiklis (1997), Hillier and Lieberman (2001), Jensen and Bard (2003), Sarker and Newton (2008), The Institute for Operations Research and the Management Sciences (INFORMS) (www.informs.org), and International Council on Systems Engineering (INCOSE) (www.incose.org).

17.4 Computer Simulation

Computer simulation refers to the technique by which a computer is used to mimic (or simulate) the behavior of a system or process. The analyst builds a mathematical model of the system, implements it as a computer program, and then uses the computer to imitate the system's behavior for the purpose of observing it under different conditions. Computer simulation is closely related to the Monte Carlo method or Monte Carlo simulation, which can be described as "any technique that approximates solution of quantitative problems through statistical sampling" (Saxena, 2014) or "a numerical method of solving mathematical problems by random sampling" (Sobol, 1994). Disagreement exists about how to define the relationship between the two terms (e.g., Kalos and Whitlock, 2008; McHaney, 1991; Ripley, 1987). In this chapter, we use the terms stochastic simulation and Monte Carlo simulation interchangeably as in, for example, Sokolowski and Banks (2010).

17.4.1 History

Although its roots can be traced back earlier (Kalos and Whitlock, 2008), the origin of the Monte Carlo method is usually considered to be the 1940s, when it was used as part of the Manhattan Project and appeared in Metropolis and Ulam (1949). The name Monte Carlo refers to the casinos in Monaco to reflect the role of randomness in the technique. After the war, the use of computer simulation exploded with the rise of computational power, to the point that it is now one of the most commonly used operations research techniques. It has been applied in countless fields, including manufacturing, transportation, health care, and finance.

17.4.2 Classification and Types of Simulation

Simulations can be categorized in a few key ways (Law and Kelton, 2000; Pidd, 1998): (1) deterministic or stochastic, (2) static or dynamic, and (3) continuous or discrete in time. The distinction between deterministic and stochastic is the same as in Sect. 17.2.4—*deterministic* does not contain random elements; *stochastic* does. In the case of simulations, deterministic models are typically a complicated system of equations (e.g., differential equations) that cannot be solved analytically, i.e., by directly using mathematical rules. Stochastic simulations have some random inputs, as in queuing systems or earthquake occurrence. As described in Sect. 17.2.4, *static* simulation models represent a system at a particular time or in a

steady state; whereas, *dynamic* simulation models represent a system as it evolves over time. A simulation of earthquake damage to components of a building could be static, for example. A simulation of the spread of wildfire could be dynamic. Finally, for dynamic models, time may be treated as *continuous*, which typically involve differential equations providing relationships for the rates of change of variables with time, or *discrete*, in which variables change only at discrete points in time. For those that are discrete, time can be discretized at equal increments or only when events occur.

Some special types of stochastic simulation are *discrete event simulation*, *agent-based simulation*, and *system dynamics*. In discrete event simulation (DES), the model steps through time tracking the behavior of the system as it evolves by allowing state variables that describe the system to change instantaneously at specified points in time (Law and Kelton, 2000). A model of the process by which ice storm damage to an electric power distribution system is repaired and service is restored might be a DES, mimicking how the activities unfold over time. Agent-based models (ABMs), a newer type of simulation, are comprised of a large number of autonomous agents that follow a series of pre-defined rules to achieve their objectives while interacting with other agents and the environment (Macal and North, 2010; Siegfried, 2014). It is useful when the analyst has some insight into the individual behavior of agents or objects, but not the behavior of the system as a whole. Thus, the model is built from the bottom up, representing the behavior of the individual agents and then observing what system behavior emerges. An ABM could be used for building evacuation if one understood the behavior of individual occupants and wanted to use that to determine the behavior of all the interacting occupants as a group. Systems dynamics is used to study the behavior of complex systems over time when interactions and feedback loops are fundamental to the problem, as with the economy (Sterman, 2000). The system is represented using stocks (entities that accumulate over time) and flows (rates of change of stocks), feedback loops, and time delays. The focus is on flows through networks rather than the behavior of individual entities as in DES and ABM. Gillespie, Robards, and Cho (2004) describes use of system dynamics in disaster studies.

17.4.3 Basic Steps of Stochastic Simulation

A system being modeled with stochastic simulation by definition exhibits randomness in some of the inputs. There is uncertainty, therefore, in how the system will behave. The basic idea of stochastic simulation is to use statistical sampling to generate many possible realizations or replicates of the system behavior, each of which is realistic given the nature of the randomness in the inputs, and that together represent the overall uncertainty in the system behavior. The basic approach includes the following steps (Fig. 17.9):

1. **Develop model**. Define a mathematical model of the system, including some inputs that are uncertain and therefore are represented by random variables.[1] The probability distributions that represent the input random variables may be fitted to sample data, or based on an understanding of the processes that generated them or expert opinion.
2. **Sample inputs**. Draw a sample value for each random input variable from the probability distribution that represents it. The sample value is generated in such a way that if you repeat the process many times, the distribution of the sampled values will match the probability distribution that describes the random variable. (Methods are available to do so.) Each set of sampled inputs represents one possible realization of the system.
3. **Evaluate model**. Using the sampled input values, evaluate the model to compute the

[1] A random variable is a variable that can take on different possible values each with an associated probability. It is represented by a probability distribution—a probability mass function (pmf) if discrete, or a probability density function (pdf) if continuous.

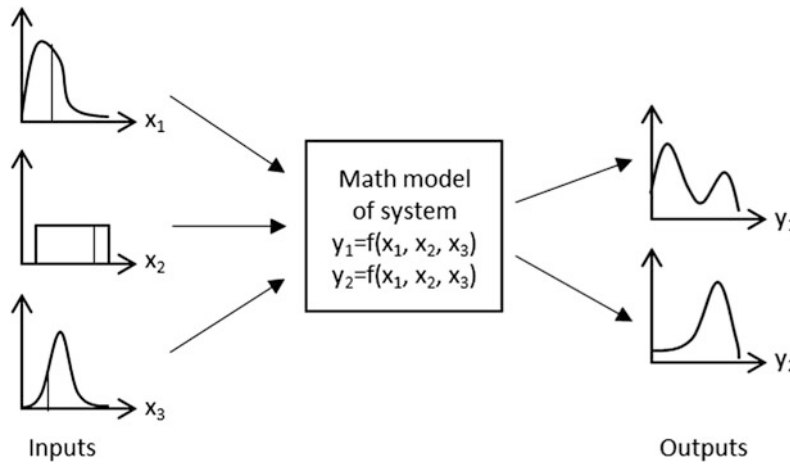

Fig. 17.9 Schematic of the computer simulation process

outputs of interest. That is, pretend that the sampled input values are the actual values of those variables and use them to compute the outputs.

4. **Repeat**. Repeat Steps 2 and 3 a large number N times (say, 1000s), producing N sets of separate, independent outputs which can be assembled into probability distributions of the outputs.
5. **Analyze results**. Analyze the probability distributions of the outputs.

For example, to simulate damage to a bridge, in Step 1, one might define a simple model that relates the load on each component of the bridge (e.g., deck, column, abutment) to the overall bridge damage state (e.g., if the load on a component exceeds the component's capacity, the component fails, and if at least one component fails, the bridge fails). Suppose the load on each component can be represented by a different random variable. The probability distribution representing the load on each component could be assumed using expert opinion, or developed by fitting a distribution to sample data from the field or from lab experiments. For example, one might assume a lognormal distribution so that the load is never negative and estimate the parameters of that distribution using a sample of field data. In Step 2, we would sample a value of each component load from its probability distribution. In Step 3, assuming those component loads, we would use the model to determine if the bridge fails or not. By repeating the process $N = 1000$ times (Step 4), we develop a dataset of 1000 simulated observations of bridge failure. If the bridge failed in 15 of those iterations, we would estimate that the probability of bridge failure is 0.015. As N approaches infinity, this estimate should approach the true probability of failure.

As with optimization, social science can improve simulation modeling. Social scientists' knowledge of the real-life systems being modeled can be invaluable in formulating a simulation model—defining the model's goals, identifying the key components and how they are related, and determining what the outputs should be. As a more specific example of a role they can play, social scientists often develop survey, experimental, or observational data that can be used to fit the probability distributions that represent the random variables in a simulation.

17.4.4 Strengths and Limitations of Simulation Models

Simulation has proven to be one of the most useful mathematical modeling methods available. It has many strengths and limitations, and

understanding them is important to determining when its use is appropriate (Law and Kelton, 2000; McHaney, 1991). Strengths include:

- *Applicability*. It is possible to use simulation in many cases in which no other methods are viable. It is often impossible, too expensive, or too time consuming to experiment on the real system or a physical model of it. Further, many complex, real-world systems cannot be accurately described by a mathematical model that can be solved analytically (i.e., exactly, using mathematical operations and techniques). One must tradeoff between a simpler analytical model with an exact solution or more complex simulation with approximate solution.
- *Uncertainty*. Simulation easily represents systems that exhibit substantial uncertainty.
- *Dynamics*. Simulation allows study of a system over a long time frame in a compressed time.
- *Visualization*. Simulation results can often be presented using visualization techniques that greatly facilitate the communication of results.
- *Flexibility*. The method is extremely flexible, and thus has been used across many diverse disciplines and application areas.
- *Intuitiveness*. The basic idea of the method is relatively straightforward since it involves mimicking system behavior quite literally.

Limitations include:

- *Approximate*. Simulation is an approximate method. It does not provide an exact answer, but rather provides a statistical estimate that approaches the true answer as the number of replications N is increased. While it is sometimes thought of as the "method of last resort" for that reason, to be used only if physical or analytical models are not available, as Law and Kelton (2000) note, it is the method that is required in a great many cases.
- *Does not optimize*. Simulation can compare pre-defined alternative designs or situations, but does not identify an optimal one in the way that optimization does.
- *Computationally intensive*. As computational power increases and computations can more easily be made efficient through parallelization and other techniques, the time required to run simulation models becomes less of an issue. Nevertheless, the increasing complexity of models means it is still often a consideration.
- *Validation*. Simulation models can be difficult to validate since it often is not possible to prove a result is correct.

17.4.5 Further Information

Many software packages are available to build and use simulation models, including Arena and ExtendSim (Swain, 2015). They vary based on applicability and ease of use. Modelers also often code their own simulation models using programming languages like C, R, Java, or Matlab. Simple models can even be built in Excel. This chapter is intended to provide a conceptual, high-level understanding of what simulation models are and what they can do. To study the topic in more depth requires some background in probability and statistics. The following are additional sources for the interested reader: Law and Kelton (2000), Hillier and Lieberman (2001), Pidd (1998), and Saxena (2014), the journal *Simulation: Transactions of The Society for Modeling and Simulation International*, The Society for Modeling and Simulation (http://www.scs.org/), The Institute for Operations Research and the Management Sciences (INFORMS) (www.informs.org), and International Council on Systems Engineering (INCOSE) (www.incose.org).

17.5 Applications of Optimization and Computer Simulation in Disaster Research

Optimization and computer simulation have become increasingly common within disaster research, finding application in numerous aspects of the field. They have proven to be very useful in disaster studies because the field has three features that these methods are particularly well-suited to addressing: (1) it requires a systems approach, (2) it includes great uncertainty, and (3) it aims at least in part to support decision-making. First, disasters are a phenomenon that cut across natural, human, and built systems and require a broad systems approach. Like other operations research methods, optimization and simulation are designed to address such systems-level problems (Jensen and Bard, 2003). They are intended specifically to help understand system behavior. Second, uncertainty is a fundamental issue within disaster studies—both because the events at the center are by definition uncommon and randomly occurring (aleatory uncertainty), and because as a result, there is often a challenge associated with lack of data (epistemic uncertainty). Simulation in particular is focused on understanding stochastic systems and making decisions under uncertainty. Third, disaster research is an applied field that ultimately aims not just to understand disasters but to support decisions that improve how we manage risk. Both methods—optimization in particular—are focused on supporting decision-making in complex situations often involving uncertainty.

In this section, we present example applications of optimization and simulation used in disaster studies. The collection is not meant to be comprehensive; rather, the aim is simply to illustrate how these methods can be applied in the disaster context and the value they can bring to the field. The examples were selected to show the range of possible applications, focusing on the built environment and the last 15 years. They cut across different types of questions, models, hazards, and infrastructure. For convenience of presentation, we divide the examples into three groupings and discuss each in turn: (1) risk assessment, (2) risk reduction decision support, and (3) evacuation. Tables 17.1 and 17.2, summarize the risk assessment, and risk reduction decision support, respectively, with the main method illustrated, and hazard and infrastructure addressed. For additional, engineering-focused literature reviews related to the use of optimization and/or simulation in disaster applications, we refer the interested reader to Altay and Green (2006), Caunhye, Nie, and Pokharel (2012), Galindo and Batta (2013), Hoyos, Morales, and Akhavan-Tabatabaei (2015), Liberatore, Pizarro, de Blas, Ortuño, and Vitoriano (2013), Manopiniwes and Irohara (2014), Peres, Brito Jr, Leiras, and Yoshizaki (2012), and Yusta, Correa, and Lacal-Arántegui (2011). We chose not to explicitly categorize the examples in the evacuation application area because there are some technical subtleties that are beyond the scope of this chapter.

17.5.1 Risk Assessment

The goal of these risk assessment papers is to characterize the risk to some type of infrastructure system (e.g., transportation, water supply, or electric power network) or portfolio of buildings. Risk is defined as the potential for unwanted adverse consequences. A description of risk includes both consequences and their probabilities of occurrence. In this context, it can also be thought of as the product of hazard, exposure, and vulnerability, where hazard refers to the earthquake ground motion or hurricane winds, for example; exposure describes the people, property, and environmental systems that experience the hazard; and vulnerability is a characteristic of the exposed entities that captures how easily they can be adversely impacted by the hazard. These papers are efforts to describe the nature, likelihood, and magnitude of damage and other negative effects associated with the built environment. (Note that this "model-estimated risk," is what some refer to as "objective" risk as opposed to "perceived" risk.) These papers tend to use simulation in particular because the

Table 17.1 Example risk assessment applications with method, hazard, and infrastructure

Cat.[a]	Paper	Method[b]	Hazard[c]	Infrastructure
S	Arboleda et al. (2007)	System dynamics	General [earthquake]	Health care facility
S	Bristow and Brumbelow (2013)	DES	Fire	Water supply
S	Crowley and Bommer (2006)	MCS	Earthquake	General
S	FEMA (2012)	MCS	Hurricane	Multiple
S	Hamid et al. (2010)	MCS	Hurricane	Buildings
S	Jain et al. (2005)	MCS	Hurricane	Buildings
S	Lee and Davidson (2010)	DES	Fire	Buildings
S	Luna et al. (2011)	DES	Earthquake	Water supply
S	Mensah and Dueñas-Osorio (2016)	MCS	Hurricane	Electric power
S	Park et al. (2014)	MCS	Hurricane	Electric power
S	Pita et al. (2015)	MCS	Hurricane	Buildings
S	Porter et al. (2001)	MCS	Earthquake	Buildings
S	Tabucchi et al. (2010)	DES	Earthquake	Water supply
S	Vickery et al. (2000)	MCS	Hurricane	–
S	Vickery et al. (2006)	MCS	Hurricane	Buildings
S, O	Loggins and Wallace (2015)	Integer program, MCS	Hurricane	Multiple lifelines
S, O	Manzour et al. (2016)	MCS, Mixed-integer linear program	Earthquake	–
S, O	Shiraki et al. (2007)	MCS, nonlinear optimization	Earthquake	Transportation

[a]S = Simulation; O = optimization; S, O = Both simulation and optimization
[b]DES = Discrete event simulation; MCS = Monte Carlo simulation
[c]General [XXX] means presented as general method, with example application for XXX

phenomena are so complex and involve so much randomness that it is difficult, if not impossible, to describe them analytically, using closed-form equations.

17.5.1.1 Hazard Assessment

Some papers focus on the assessment of the hazard component alone, aiming to describe the geologic or meteorological phenomenon itself, not its effect on the built environment or people. Crowley and Bommer (2006), for example, use simulation to assess earthquake hazard in the form of an annual frequency of exceedance vs. ground motion intensity curve for each location in the study region. By knowing the rate at which earthquakes of different magnitudes occur on each earthquake source (e.g., fault), a catalogue of earthquakes is simulated for a long period (say, 100,000 years). Then for each earthquake, the map of ground motion it causes in the region is simulated as well by sampling from the distribution of ground motion associated with a specified earthquake. The maps are combined to produce the hazard assessment. Similarly, for hurricanes, Vickery, Skerlj, and Twisdale (2000) simulates the occurrence of hurricanes and their effects by quite literally mimicking the process by which they form, move, strengthen or weaken, and produce strong winds in the surrounding region during a 20,000 year period. This is done by sampling from probability distributions describing, for example, the frequency of hurricane formation and the direction and speed of forward motion. Bristow and Brumbelow (2013) and Lee and Davidson (2010) provide examples simulating fire spread through an

Table 17.2 Example risk reduction applications with method, hazard, and infrastructure

Cat.[a]	Paper	Method[b]	Hazard[c]	Infrastructure
O	Bocchini and Frangopol (2012)	Multiobjective optimization	General	Transportation
O	Bogárdi and Balogh (2014)	Nonlinear optimization	Flood	Floodways, rivers
O	Chandrasekaran and Banerjee (2016)	Multiobjective optimization	Earthquake and flood	Bridge
O	Chu and Chen (2016)	Stochastic program	General, [earthquake]	Transportation
O	Dodo et al. (2005)	Linear program	Earthquake	Buildings
O	El-Anwar et al. (2009)	Multiobjective, integer optimization	General, [earthquake]	Housing
O	El-Anwar et al. (2016)	Mixed integer linear program	General	Transportation
O	Fan et al. (2010)	Stochastic program	Earthquake	Transportation
O	Horner and Downs (2010)	Mixed integer linear program	Hurricane	Transportation
O	Huang and Pang (2014)	Multiobjective, stochastic, mixed-integer program	General, [earthquake]	Biofuel infrastructure
O	Jia et al. (2007)	Integer program	General [terror attack]	Facility
O	Legg et al. (2013)	Linear program	Hurricane	Buildings
O	Miller-Hooks et al. (2012)	Stochastic, integer program	General	Transportation
O	Rawls and Turnquist (2010)	Stochastic, mixed integer program	General [hurricane]	Transportation
O	Romero et al. (2013)	Nonlinear, mixed integer, stochastic program	Earthquake	Electric power
O	Tzeng et al. (2007)	Multiobjective optimization	Earthquake	Transportation
O	Xu et al. (2007)	Stochastic, integer program	Earthquake	Electric power
S	Hwang et al. (2016)	System dynamics and DES	General, [earthquake]	Facility
S	Karamouz and Araghinejad (2008)	Stochastic program	Drought	Reservoirs
S, O	Cai et al. (2015)	Simulation-stochastic optimization	Drought	Watershed, irrigation
S, O	Chang et al. (2012)	MCS, integer program	Earthquake	Transportation
S, O	Leon et al. (2014)	Multiobjective optimization, MCS	Flood	Reservoirs

[a]S = Simulation; O = optimization; S, O = Both simulation and optimization
[b]DES = Discrete event simulation; MCS = Monte Carlo simulation
[c]General [XXX] means presented as general method, with example application for XXX

urban area. One downside of simulation is that it can become so computationally intensive (i.e., require so much computer time) that even with the powerful computers of today, it can be impossible for complex models. Manzour, Davidson, Horspool, and Nozick (2016) combines simulation with optimization to make the process more efficient and overcome that challenge.

17.5.1.2 Vulnerability

Some papers focus on the vulnerability component. Simulation is sometimes used to estimate building vulnerability (Pita, Pinelli, Gurley, and

Mitrani-Reiser, 2015), including in the HAZUS-MH Hurricane Model (Vickery et al., 2006). Model buildings are defined and damage to them is simulated to produce fragility curves that define their vulnerability (probability of at least a specified damage state vs. wind speed). The model recognizes randomness in the resistances of each building component (e.g., window, roof sheathing), for example, and thus in each iteration of the simulation, a value of each component resistance is sampled from the input probability distribution that describes it. Treating those sampled resistances as if they are the true resistances, they are then compared to the wind pressures on the components to identify which will fail, and the corresponding damage state of the building is determined. In each of the many iterations, a new set of resistances are sampled, and the process is repeated, resulting in a probability distribution of damage states. Porter, Kiremidjian, and LeGrue (2001) similarly considers a building to be an assembly of its components and uses simulation to assess vulnerability to earthquake damage. Randomness in ground motion time history, damage given structural response, and repair cost and time are each represented by probability distributions, so that in each iteration of the simulation, a value is sampled from each to represent one realization of the overall building repair cost and time that could occur. Repeating many times provides a distribution of repair costs and times that comprise the vulnerability assessment. Moving beyond building damage, Arboleda, Abraham, and Lubitz (2007) uses system dynamics simulation to represent the flow of patients through a health care facility so as to understand how disaster event-caused disruption of the utilities, for example, might affect them.

Much research has focused on assessing the damage and/or disruption to infrastructure systems (lifelines) as well. Tabucchi, Davidson, and Brink (2010) and Luna, Balakrishnan, and Dagli (2011) use discrete event simulations to explicitly mimic the process by which water supply is restored after an earthquake—crews are assigned to tasks and complete them. These provide estimates of the restoration times under different conditions. Park, Glagola, Gurley, and Son (2014) uses simulation together with statistical models to describe the hurricane risk of electric power distribution systems. In Loggins and Wallace (2015), simulation is used to predict hurricane-caused damage to multiple interdependent infrastructure systems, and an integer-programming optimization model is employed to determine the cascading effects of that damage throughout the interdependent networks, specifically which nodes experience outages. Ouyang (2014) reviews the literature on modeling the interdependencies among infrastructure systems, including agent-based simulation, system dynamics, and optimization methods.

17.5.1.3 Complete Risk Assessment

There are multiple examples in which simulation is used for the entire risk assessment process from hazard event occurrence through loss. These include HAZUS-MH (FEMA 2012) and the Florida Public Hurricane Loss Model (Hamid et al., 2010), both of which provide comprehensive assessments of risk to buildings for a region. Jain, Davidson, and Rosowsky (2005) extends those types of regional risk assessments to simulate how the risk changes over time due to changes in the built environment. Mensah and Dueñas-Osorio (2016) provides a comprehensive hurricane risk assessment for electric power systems, and Shiraki et al. (2007) does the same for earthquake risk to highway networks.

17.5.2 Risk Reduction Decision Support

Another common type of engineering analysis in disaster studies aims to support disaster risk reduction decisions. This includes prioritizing and allocating resources among possible pre-event mitigation and/or post-event repair and reconstruction efforts; and planning efficient preparedness, response, and relief operations. These problems are complex and difficult because they involve multiple stakeholders; multiple, competing objectives; many possible

risk reduction strategies, each with different cost, effect on the risk, and other benefits; different types of spatially correlated impacts (e.g., deaths, economics loss); great uncertainty; and components that change over time (Davidson, 2015; Vaziri, Davidson, Nozick, and Hosseini, 2010). As a result, it is often impossible to weigh all the aspects of the problem and develop optimal decisions intuitively or in an ad hoc way. Decision support models like optimization can help systematically compare many alternative decisions and find the optimal ones. In the optimization models mentioned, note that each specifies an objective(s) and some decision variables whose values are determined so as to optimize that objective (Sect. 17.3.2).

Many studies focus on the decisions of how to prioritize and allocate resources among pre-event mitigation strategies. For lifelines, for example, Chandrasekaran and Banerjee (2016) uses multiobjective optimization to identify retrofit design configurations for a single bridge (e.g., column jacket material and thickness to use) that maximize resilience and minimize retrofit cost. Considering a whole highway network, Chang, Peng, Ouyang, Elnashai, and Spencer Jr (2012), Chu and Chen (2016), and Fan, Liu, Lee, and Kiremidjian (2010) all use optimization models (integer program for the former and two-stage stochastic program for the latter two) to choose which network links (road segments) or bridges to retrofit so as to achieve some optimal performance in terms of for example, maximum post-disaster capacity or minimum repair cost. In Romero, Nozick, Dobson, Xu, and Jones (2013), a two-stage stochastic program optimizes selection of capacity enhancement strategies to maximize earthquake resilience of electric power systems. Focused on buildings for earthquakes and hurricanes, respectively, Dodo, Xu, Davidson, and Nozick (2005) and Legg, Davidson, and Nozick (2013) use linear program optimization models to determine which buildings in a city—by type and location—should be upgraded so as to minimize total pre- and post-event expenditures.

Optimization and simulation are regularly applied to support emergency response operations as well. Rawls and Turnquist (2010) use a two-stage stochastic mixed integer program to determine the location and quantities of various types of emergency supplies to pre-position in preparation for a disaster event. Jia, Ordóñez, and Dessouky (2007) addresses models that can be used to optimally locate medical facilities to provide coverage for emergency response in large-scale emergencies. During the emergency response phase of a disaster, relief arrives at the region and is distributed to victims. Tzeng, Cheng, and Huang (2007) uses multiobjective optimization to design a system of relief distribution that minimizes total cost and travel time while maximizing satisfaction. Horner and Downs (2010) similarly uses an optimization model to make the distribution of disaster relief goods as efficient and effective as possible. In El-Anwar, El-Rayes, and Elnashai (2009), an optimization is used to determine how to assign families to temporary housing so as to minimize (1) post-disaster social and economic disruptions suffered by displaced families; (2) temporary housing vulnerabilities to post-disaster hazards; (3) adverse environmental impacts on host communities; and (4) public expenditures. In Leon, Kanashiro, Valverde, and Sridhar (2014), a simulation model of river system routing is combined with a multiobjective optimization that determines how much to open reservoir flood gates to minimize flood damage. Bogárdi and Balogh (2014) similarly uses a nonlinear optimization to determine daily floodway discharges so as to minimize flood losses. Karamouz and Araghinejad (2008) also addresses reservoir operations, but using simulation with a longer-term focus and an aim of mitigating drought. Focusing on emergency response activities related to lifelines, Xu et al. (2007) optimizes scheduling of post-earthquake electric power restoration tasks using a stochastic integer program.

Optimization models are also used to support decisions about the repair and reconstruction of damaged facilities. Bocchini and Frangopol (2012) use a multiobjective optimization to schedule repair of bridges post-event. El-Anwar, El-Rayes, and Elnashai (2016) similarly

optimizes the prioritization of and construction resource use associated with transportation reconstruction projects so as to minimize cost and maximize traffic performance. In Hwang, Park, Lee, and Lee (2016), a combination of system dynamics and discrete event simulation are used to understand the dynamic and interacting processes of post-disaster restoration of a facility and improve planning of such restorations.

Some models optimize across both pre- and post-event decisions. Miller-Hooks, Zhang, and Faturechi (2012) uses a two-stage stochastic program to allocate a limited budget between preparedness and recovery activities so as to optimize network resilience. Cai, Zeng, Kang, Song, and Valocchi (2015) uses a coupled simulation and stochastic optimization to determine how to mitigate drought risk using both short-term tactical measures (e.g., facility operation) and pre-event strategic measures requiring capital investment. Similarly, in considering the resilience of biofuel infrastructure systems to natural hazard impacts, Huang and Pang (2014) use a multiobjective stochastic mixed-integer program to optimize both planning decisions, such as locations and sizes of refineries, and operational decisions, such as ethanol production and distribution.

17.5.3 Evacuation

Evacuation is a more specific type of problem than the risk assessment or decision support, but there is a great deal of research on it, and it is a good example of a problem that can combine social science insights with simulation and optimization. Evacuation of people from a building is one version of the problem. Liu et al. (2016), Lo, Huang, Wang, and Yuen (2006), and Shen (2005) use system dynamics simulation, agent-based simulation, and discrete event simulation with game theory (which uses optimization), respectively, to understand the process. Xiaoping, Tingkuan, and Mengting (2009) summarizes different modeling approaches to the problem, including a few simulation-based ones.

The other version of the evacuation problem involves vehicle evacuation from a region to escape hurricane, wildfire, or other threat. The many models developed to support regional evacuation planning include all kinds of optimization, as well as macroscopic, mesoscopic, and microscopic simulation. Microscopic simulation tracks the movement of each individual vehicle; macroscopic simulation models flows on each section; and mesoscopic is a hybrid of the two.

Every model assumes each aspect of an evacuation (e.g., who leaves, when, where they go) is either uncontrollable input or something that can be controlled to improve the evacuation. Many early simulation models, e.g., NETVAC (NETwork emergency eVACuation) (Sheffi, Mahmassani, and Powell, 1982), MASSVAC (MASS eVACuation) (Hobeika and Kim, 1998), and OREMS (Oak Ridge Evacuation Modeling System) (Rathi and Solanki, 1993), are purely *descriptive*, assuming everything is predetermined by the existing transportation system or evacuee behavior, and simply trying to describe it accurately. Others are *normative* or *prescriptive*, assuming factors are controllable and then trying to determine how best to control them. For example, a model might take evacuee departure times as given (Theodoulou and Wolshon, 2004), or it might be designed to determine the best departure times (Sbayti and Mahmassani, 2006). The types of decisions supported by evacuation models include determining optimal evacuation routing and/or destination assignment (e.g., Ng, Park, and Waller, 2010; Yuan, Han, Chin, and Hwang, 2006); phased (staged) evacuation (e.g., Chiu, Zheng, Villalobos, Peacock, and Henk, 2008; Sbayti and Mahmassani, 2006); and contraflow or other network control strategies (e.g., Chiu et al., 2008; Meng and Khoo, 2008; Xie and Turnquist, 2011). Most optimization-based hurricane evacuation models define the objective as minimizing network clearance or total travel time (e.g., Ng et al., 2010; Sheffi et al., 1982; Tufekci and Kisko, 1991), although Apivatanagul, Davidson, and Nozick (2012) minimizes both travel time and risk.

17.5.4 Discussion

Together these examples of applications of computer simulation and optimization in disaster studies show the value the methods can bring. They can help describe and make better decisions about complex infrastructure, environmental, and human systems that include great uncertainty. For example, it is a complicated process by which earthquake faults rupture and generate ground motion throughout a region, the ground motion then damages buildings or infrastructure network components, and the damage then disrupts the services those facilities and entities provide. Each step is marked by substantial randomness, so that it is difficult to describe the resulting risk without mathematical models. The systematic description offered by the mathematical models can provide insights into which factors are more influential in the final outputs of interest. Throughout the disaster cycle—mitigation, preparedness, response, recovery—decisions are required that require too many pieces of information, choices, and objectives for a person to fully synthesize unaided. These models can help provide a systematic comparison of the options and the factors that drive the decisions, particularly related to the aspects of the natural and built environment that lend themselves to quantitative description and therefore, analysis using the language of mathematics.

It is worth noting that many of the models in the cited papers, and indeed in the field, are presented as not being specific to a particular type of infrastructure system or hazard. They are presented as generic models, equally applicable to water supply and electric power, to earthquake and terrorist attack. This reveals the focus among many engineers on Step 2 of the math modeling process (Fig. 17.3). In creating the mathematical models, the systems have been abstracted so that both a transportation network and a water supply network are treated as a set of links and nodes, and both an earthquake and terrorist attack are considered to be simply an interruption to the operation of a link or node. This is common in mathematical modeling because the aim is to identify only the most salient features of the system and those might be generally applicable even if the specifics vary by infrastructure system and hazard. It also reflects the engineering disciplinary norm that sometimes values development of a new mathematical formulation or a more elegant or efficient solution algorithm more than use of an existing model to address an application-specific question.

In a related point, the models in the example applications also illustrate the tension that always exists in math modeling between the desire to represent all the important details and complexity of a real-world problem and the desire to simplify the real-world problem so as to produce a model that can actually be solved. A well-designed, simplified model highlights the most salient features of a system, clarifying its behavior by removing some of the complicating, distracting details, and offering substantial, generalizable insights. A poorly-formulated model, however, simplifies the real world in a way that makes its results no longer meaningful for the application area—disaster studies in this case, although they may be elegant from a mathematical point-of-view.

17.6 Opportunities and Potential Challenges for Social Science Collaboration

17.6.1 Opportunities

Although engineers' use of computer simulation and optimization in disaster studies has occurred largely as a separate line of research, parallel to the social science study of disasters, both efforts could be enhanced through integration.

Social scientists could provide valuable input to the mathematical modeling process, especially in the Formulation and Interpretation steps (Steps 1 and 3, respectively, in Fig. 17.3). Perhaps most critical is the insight that social scientists can provide in the process of formulating a mathematical model for disaster studies. This includes defining the problems that are most pressing and will bring the largest return in terms of improved resilience. It includes defining the bounds on the problem—identifying which aspects of a

situation must be considered and which can be omitted. For optimization models, it includes defining the objectives, constraints, and decision variables that best reflect the real-world problem and its possible solutions. Is minimizing clearance time the right objective for regional evacuation models, or is minimizing risk (e.g., Apivatanagul et al., 2012)? It includes defining the outputs of interest and the form they should take. For example, should damage to a health care facility be described in structural terms, or in terms of loss of function?

Involving social scientists in the early problem formulation stage can also provide a reality check on a model's assumptions about the behavior of people and organizations (e.g., residents, infrastructure system operators, investors). Aguirre et al. (2011) discuss social science insights relevant to the behavioral assumptions used in agent-based simulations of building evacuation. Lindell and Prater (2007) and Trainor, Murray-Tuite, Edara, Fallah-Fini, and Triantis (2013) similarly discusses how social science findings can be incorporated into regional evacuation models. Kesete et al. (2014) assumes residents make insurance purchasing decisions by maximizing their expected utility using perfect information. The social science understanding of protective action decision-making could improve that unrealistic assumption (in fact, on-going efforts are attempting to incorporate that understanding).

It is important to remember, however, that the problem formulation step of mathematical modeling is iterative, seeking to balance the often competing desires to (1) include all the necessary detail about the system behavior and to address exactly the questions of interest, and (2) create a mathematical model that can be solved. It is also important to remember that models can still be quite useful even if they lack some of the complexity of the real-world system they represent. In fact, the ideal we seek is the simplest model we can find that is still meaningful. Sometimes including too much detail can muddy the main features of the system behavior.

A second aspect of computer simulation and optimization modeling that could benefit from close collaboration with social scientists is the Interpretation (Step 3 in Fig. 17.3). Once the models have been formulated and solved, the mathematical results must be interpreted into findings in the real world context and validated to confirm the results are reasonable. Models that are intended for use in decision support also have to be integrated into the natural decision-making process of the intended users. The context of the decisions a simulation or optimization model are intended to support should actually be an integral part of the initial model development to ensure that the model provides the type of information needed, in the form in which it is required, and when it can be useful. Wu, Lindell, and Prater (2015), for example, examines the decision-making context for emergency managers using model results to support their choices.

17.6.2 Challenges

Despite the potential gain of better integrating social science research with the engineering methods of computer simulation and optimization modeling, many barriers exist. There are institutional barriers that impede interdisciplinary research in general, including hiring and tenure processes that do not always know how tovproperly value interdisciplinary research (Davidson, 2015). In addition, there are challenges to working across such different disciplines as social science and engineering. The disciplines have different terminologies, different perspectives on what constitutes an interesting research question, different ideas about what is considered a scholarly contribution, and different traditions and norms about authorship and other mechanics of the research enterprise (Davidson, 2015). All of these dissimilarities must be overcome. The value of the enhanced benefits of the integration can make the required effort worthwhile.

17.7 Conclusions

In this chapter, we describe computer simulation and optimization, two mathematical modeling methods that are widely used across a variety of applications, including increasingly disaster studies. Designed specifically to provide analysis and decision support for systems-level problems, particularly those involving great uncertainty, these methods are well-suited to disaster applications. Proper implementation of the methods can benefit greatly from collaboration with social scientists, particularly in the formulation and interpretation phases of the modeling process. This chapter offers a high-level introduction that aims to equip interested readers with a basic vocabulary and understanding of simulation and optimization so as to encourage and enable them to participate effectively on disaster projects involving these methods in the future.

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Morbidity and Mortality Associated with Disasters

18

Michele M. Wood and Linda B. Bourque

Contents

Disasters disrupt the natural, built, and social environment, affecting communities and the people within them. They can be triggered by climatic or geophysical events, technological events, human-initiated events, or a combination of these. Their impact on the health of a community can be immediate or delayed, and changes in health status may be attributable to the original event or result from events subsequent to the disaster. Deaths, injuries, and other health outcomes of a disaster are usually caused by the destruction of the built infrastructure. In the absence of people living in built communities, disasters do not occur.

The frequency and severity of disasters have increased over the last twenty years (Guha-Sapir, Below, & Hoyois, 2017). Part of this increase is due to changes in climate patterns and extreme weather events. Although the frequency of geophysical disasters has remained relatively stable, there has been a sustained increase in climate and weather related events during this same time period (Glasser & Guha-Sapir, 2016). Of even greater relevance, however, is the fact that population density in cities and in geophysically vulnerable areas has increased dramatically since 1950. Most of the world's population lives in urban areas (in increasing proportion), and the most populous cities in the world are at risk of major disasters (Maurice, 2013). The large majority of deaths caused by disasters over the past two decades—90%—has occurred in developing countries (Maurice, 2013). Disaster-related health problems in developing countries are exacerbated by lower immunization rates, poor nutritional status, and the greater vulnerability of facilities that provide water and handle sewage.

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The study of disaster-related morbidity and mortality applies the science of epidemiology to examine the health consequences of disasters. A public health discipline, epidemiology is the study of the distribution and determinants of health and the control of negative health outcomes within populations. Applied to disasters, it is the study of exposure to a hazard and the resulting adverse health outcomes, including morbidity (injury) and mortality (death). Findings can provide insight concerning the patterns of morbidity and mortality associated with different types of hazards, which can help improve efforts to prevent or reduce harm. Such information also can help inform policy decisions and the allocation of public education and financial resources.

Prevention to avoid or reduce the impact of hazard exposure is conceptualized in three levels (Last, 2001). *Primary* prevention refers to activities that prevent the hazard exposure from occurring. In the context of disasters, these include preparedness measures, hazard mitigation, and strong building codes that reduce the likelihood of building collapse. *Secondary* prevention consists of efforts to prevent illness or injury after exposure occurs so that measures can be taken to minimize or reduce impact. This includes search and rescue, evacuation, and sheltering. *Tertiary* prevention involves efforts that take place after a health problem has occurred to prevent death and disability and to improve quality of life. Examples include health care services and health surveillance following a hazard event. The three levels of prevention can be integrated with disaster cycle stages (Kano, Wood, Siegel, & Bourque, 2016).

Prevention is further conceptualized as occurring via multiple levels of influence. Activities designed to improve health outcomes typically vary depending on the intended level: individual, group, or community, for example. Finally, public health conceptualizes prevention as having three levels of intervention: education, marketing, and policy. The lowest level of intervention, education, is appropriate when the benefits of the recommended action are clear and people are prone to act as desired. In the absence of a present hazard, education alone may be insufficient to prompt adherence. Social marketing is appropriate when the population is unconvinced of the benefits and may be persuaded to adopt the recommended action. Policy interventions are appropriate when the benefits of the recommended action are uncertain or difficult to convey and there are undesirable actions "competing" with the recommended action. These three intervention approaches can be abbreviated as "tell", "sell", and "compel."

Disaster health impacts vary by: (1) the physical characteristic of the hazard; (2) the physical, social, and political environment, and (3) the characteristics of the affected population. For example, death by drowning rarely occurs during heatwaves, but is a major cause of death during hurricanes and floods. Although the 2010 earthquake in Haiti resulted in 223,000 deaths, earthquakes of similar magnitude the same year resulted in many fewer casualties in Chile, and no deaths in New Zealand (Glasser & Guha-Sapir, 2016). In general, increases in infectious disease rates following disasters are more common in low and middle income countries than in wealthier countries. The extent to which infectious diseases occur is determined by the health of the affected community before the disaster and the ability of the infrastructure to recover sufficiently to prevent, or at least control the spread of, infectious diseases. Data collection methods also contribute to differences in patterns of disaster related death and injury.

Definitions of what constitutes a death or injury caused by a disaster vary within a type of disaster, as well as across disasters. The Centers for Disease Control and Prevention (CDC) has attempted to develop a system that differentiates the time (relative to the disaster) when the death or injury occurs, and whether the event is directly or indirectly related to the disaster, but the

protocol is difficult to apply. Health effects of disasters can be categorized in many ways; for this review we adopt the typology defined by Combs, Quenemoen, Parrish, and Davis (1999) and used by the Centers for Disease Control and Prevention: "… disaster-attributed deaths [are] those caused by either the direct or indirect exposure to the disaster. Directly related deaths are those caused by the physical forces of the disaster. Indirectly related deaths are those caused by unsafe or unhealthy conditions that occur because of the anticipation, or actual occurrence, of the disaster" (p. 1125).

The purpose of this chapter is to provide an overview of morbidity and mortality trends associated with a wide range of disasters, including physical as well as mental health effects, that have been documented within and beyond the U.S. The concept of social vulnerability to disasters, that is, vulnerability related to social factors, provides a useful lens for understanding and interpreting morbidity and mortality patterns. Methodological issues such as differences in data collection methods used across locations are also important to consider when examining observed differences in disaster-related health outcomes. The chapter will use hazard type as an organizing scheme for discussing morbidity and mortality. The chapter begins with an overview of social vulnerability to disaster morbidity and mortality, and then explores how different natural hazards worldwide and terrorist events that have occurred in the United States have affected the health of populations. These events are neither more important nor more lethal than events not described, but they are the centerpiece of this chapter because a greater quantity of methodologically rigorous research has focused on these disasters. The chapter next considers the case of psychological injury and other mental health effects of disasters, followed by a brief discussion of methodological concerns. Concluding remarks summarize overall trends and patterns in disaster related death and injury, and outline future research needs.

18.1 Social Vulnerability to Disasters: Trends and Issues

Historically, vulnerability to disasters has been conceptualized as a function of physical exposure to hazards. However, biophysical vulnerability does not always correspond to the most vulnerable populations (Cutter, Mitchell, & Scott, 2000). In the mid-1970s, a broader perspective emerged that incorporated the social factors that contribute to disaster vulnerability (O'Keefe, Westgate, & Wisner, 1976). Specifically, social vulnerability refers to demographic and socioeconomic factors that amplify or diminish the impacts of disasters on local populations (Tierney, Lindell, & Perry, 2001), affecting the abilities of individuals and places to prepare for, respond to, recover from, mitigate, and adapt to hazards (Cutter & Emrich, 2006). The factors driving social vulnerability vary across contexts, i.e., factors increasing social vulnerability in one setting may decrease it in another (Cutter, Mitchell, & Scott, 2008; Rufat, Tate, Burton, & Maroof, 2015). Mapping areas in a community with elevated social vulnerability and incorporating such information in the development of comprehensive mitigation plans is an important aspect of disaster planning (Morrow, 1999). Children, elderly persons, women, racial minorities, low income individuals, persons with physical or mental disabilities, and immigrants have been identified as particularly vulnerable to disasters (Cutter, Boruff, & Shirley, 2003). These groups may lack access to economic and social resources, independence, and power (Morrow, 1999) and tend to live in the lowest quality housing (Wisner, Blaikie, Cannon, & Davis, 2004).

Age is the characteristic that has been reported most consistently to be associated with disaster-related morbidity and mortality. Following the Northridge earthquake, studies of hospital admissions and emergency room logs found that older persons were more likely to be hospitalized because of injuries suffered (Seligson & Shoaf, 2003) and were somewhat

more likely to seek treatment at emergency rooms (Mahue-Giangreco, Mack, Seligson, & Bourque, 2001), but when residents were asked about injuries in community-based samples following three California earthquakes, women and younger persons were more likely to report being injured (Shoaf, Nguyen, Sareen, & Bourque, 1998). Elderly people were also more likely to be killed in the Hanshin-Awaji earthquake in Kobe, Japan, but here the higher death rates for elders are confounded by the fact that they tended to sleep on the first floor of "bunka jutaku," two-story wooden houses with heavy tiled roofs and thin walls that were built after World War II (Kunii, Akagi, & Kita, 1995).

Likewise, *recovery* from disasters favors those with knowledge and money. In a series of analyses conducted at UCLA, we have demonstrated that persons with higher education and income are more likely to engage in preparedness and hazard mitigation activities before earthquakes, are more likely to take first aid courses, and know more about where to obtain assistance after disasters. Conversely, immigrants and persons who are linguistically isolated are less likely to have invested in preparedness and hazard mitigation, or to know where to go for assistance (Goltz, 2006; Kano, Siegel, & Bourque, 2005; Nguyen, Shen, Ershoff, Afifi, & Bourque, 2006; Nguyen, Shoaf, Rottman, & Bourque, 1997; Russell, Goltz, & Bourque, 1995). Interestingly, however, during the Northridge earthquake, newer homes inhabited by middle-class whites were more likely to be damaged than older homes that were inhabited by groups more often considered vulnerable (Comerio, 1995; Shoaf & Bourque, 1999), but African-American residents more often perceived themselves to be victims of the earthquake than did other groups with more property damage.

An ongoing challenge for the study of social vulnerability and disaster morbidity and mortality is the generally weak methodology of most studies, which likely contributes to attenuated results. Developing measures to quantify social vulnerability has been another ongoing challenge. To this end, the Social Vulnerability Index, or SoVI, (Cutter et al., 2003) has emerged as one of the most common approaches to measuring social vulnerability. The index has been used broadly and applied in a wide variety of contexts (Cutter, Emrich, Webb, & Morath, 2009; Roncancio & Nardocci, 2016). A final challenge has been the tendency of researchers to focus on individual demographic factors in isolation rather than on the complex interactions between vulnerability categories (Phillips & Morrow, 2007).

18.2 Hurricanes

Different terms are used to describe tropical storm systems based on location: "hurricane" in the Atlantic and Northeast Pacific; "typhoon" in the Northwest Pacific, and "cyclone" in the South Pacific and Indian Ocean. Together, these storms are estimated to have caused about 1.33 million deaths since the beginning of the 20**th** century (Doocy, Dick, Daniels, & Kirsch, 2013e; Nicholls, Mimura, & Topping, 1995; Rappaport & Fernandez-Partagas, 1997; Shultz, Russell, & Espinel, 2005). In the past two centuries, most deaths occurred in developing nations, with 42% in Bangladesh and 27% in India. Between 1980 and 2009, 1,080 events were recorded (32 per year on average) worldwide, with a total of 412,644 deceased and 290,654 injured. Although the frequency of these storms increased over time, associated mortality did not; rather, peaks in mortality were associated with infrequent, but deadly high-impact events. Only 1.9% (N = 20) of the tropical storm systems resulted in more than 1,000 deaths, and these 20 storms accounted for 83.9% of all attributed mortality (Doocy et al., 2013e). The two deadliest storms in this period, Gorky (Bangladesh, 1991; 138,866 deaths) and Nargis (Myanmar, 2008; 138,366 deaths), accounted for two-thirds of the total storm-related deaths. Inconsistent reporting is believed to have resulted in underestimated cyclone impacts, particularly for injuries. Age (children and older adults), residence type, not reaching shelter, geographic location, race, flood level, and deforestation were all associated with increased mortality. In more developed countries,

being male, and in less developed countries, being female, was associated with increased mortality risk (Doocy et al., 2013e).

Half (54%) of U.S. hurricane deaths between 1980 and 2008 were "direct" deaths, and of these, the majority (59%) were due to drowning, with another 39% caused by trauma. Cause was less frequently reported for indirect deaths; of those including cause, trauma, followed by motor vehicle accidents, carbon monoxide poisoning, fires or burns, and electrocution, were most frequent. Prior to the development of effective warning, evacuation, and shelter systems, most deaths were caused by drowning in storm surges (Shultz et al., 2005). Since 1990, improved early warning systems and evacuation capacity in developed countries has resulted in a growing proportion of deaths and injuries occurring in the aftermath of storms (CDC, 2005a).

The 2004 hurricane season was among the most destructive to the state of Florida in recent history. Four hurricanes hit Florida, with Hurricane Charley resulting in 35 deaths, Hurricane Frances, 40; Hurricane Ivan, 29; and Hurricane Jeanne, 19 (Dahlburg, 2005). In Hurricane Charley, 17 of the 35 deaths were due to trauma caused by falling trees, flying debris, and destroyed physical structures. Only one death was caused by drowning. Other causes of death, all after impact, included carbon monoxide poisoning, electrocution, suicide, exacerbation of a medical condition, and lack of respiratory equipment (CDC, 2004c).

Surveys after four Florida hurricanes in 2004 found the most prevalent risk factor for indirect morbidity and mortality was improper use of portable gas-powered generators. "A total of 167 persons had nonfatal CO poisoning diagnosed during the study period, representing a total of 51 exposure incidents. The number of cases and incidents peaked within three days after landfall of each hurricane" (CDC, 2005b, p. 699). Environmental concerns considered most important by respondents included water quality (50.9%), sewage disposal (13.2%), and food protection (11.8%). Only 51.3% of respondents reported having had an evacuation plan.

The following year, 2005, was the most active U.S. hurricane season to date and the most deadly since 1998 (Beven et al., 2008). Of the 28 storms that year (27 tropical and 1 subtropical), there were 15 hurricanes, 7 major hurricanes, and 4 category 5 hurricanes, with winds greater than 155 miles per h. On August 29, Hurricane Katrina struck the Gulf Coast. It was the deadliest U.S. hurricane since 1928 and likely the most costly to date. Damage was caused by storm surges along the coast of Mississippi, Louisiana, and Alabama, reaching as far as the Florida panhandle. Roughly 80% of New Orleans experienced catastrophic flooding due to storm-related levee failure. State and local officials reported a total of 1,833 related deaths, with 1,577 in Louisiana, 238 in Mississippi, 14 in Florida, 2 in Georgia, and 2 in Alabama. Of these, the number of deaths directly caused by the forces of the storm has been estimated at 1,500 altogether, with roughly 1,300 in Louisiana, 200 in Mississippi, 6 in Florida, and 1 in Georgia. The exact number of direct fatalities is uncertain. A study of Louisiana residents calculated a total of 986 deaths, 971 that occurred in Louisiana, and 15 that occurred among Louisiana evacuees in other states. Of the 971 deceased in Louisiana, 387 died from drowning, 246 from injury and trauma, and 338 from illnesses. Those 75 years of age and older were most affected by the storm (Brunkard, Namulanda, & Ratard, 2008). Less than a month later, Hurricane Rita also struck the Gulf Coast. More than 20,000 people were displaced by these two hurricanes.

Multiple reports of morbidity following Hurricane Katrina have been published. Chronic illness was the most common type of morbidity in Arkansas, Louisiana, Mississippi, and Texas evacuation centers from September 1–22, 2005, accounting for 4,786 of the 14,531 visits. Gastrointestinal illness accounted for 3,892, and respiratory illness accounted for another 2,896. From September 5-22, injury was the most common morbidity category in health-care facilities, accounting for 5,716 of the 9,772 visits, while respiratory illness accounted for 1,550. Among evacuees and rescue workers, there were 30 cases of Methicillin-resistant *Staphylococcus* aureus, 24 cases of *Vibrio* (with 6 deaths), 17 cases of Tinea corporis, 97 cases of arthropod bites (likely

mites), approximately 1,000 cases of diarrheal disease (including a norovirus outbreak among evacuees in temporary shelter facilities in Houston, Texas), 4 cases of respiratory disease, and approximately 200 cases of presumed viral conjunctivitis (CDC, 2005c, 2005d, 2005e, 2006b, 2006c). Carbon monoxide poisoning was a problem following Hurricane Katrina and also Hurricane Rita, with 37 nonfatal cases in Alabama and 41 nonfatal cases in Texas; 10 fatal cases occurred in Texas (CDC, 2006a).

18.3 Tornadoes

Although tornadoes occur in other parts of the world, information about morbidity and mortality associated with tornadoes comes exclusively from North America, primarily the United States. Reports generally provide information on Fujita scores or wind speed.[1] Data on deaths and injuries are available from the following tornadoes: Topeka, 1966; Omaha, 1975; Wichita Falls, Texas, F4, 1979; the Carolinas, 1984; Pennsylvania, 1985; Southern Ontario, 1985; Saragosa, Texas, F4, 1987; Illinois, F5, 1990; Kansas, F5, 1991; Alabama, F4, 1994; Arkansas, F4, 1997; Texas, 3 tornadoes at F3, F4, and F5, 1997; Oklahoma, F5, 1999; and Joplin, Missouri, EF5, 2011 (Bell, Kara, & Batterson, 1978; Carter, Millson, & Allen, 1989; CDC, 1984c, 1986b, 1988, 1991, 1992, 1994c, 1997b, 1997c; Daley et al., 2005; Erickson, Drabek, Key, & Crowe, 1976; Glass et al., 1980; Paul & Stimers, 2012; Pereau, 1991). A total of 623 deaths and 8,882 injuries were attributed to these tornados.

Deaths were overwhelmingly instantaneous, occurring at the time of tornado impact, and resulting from head, chest and body traumas: 89% (43/48) in Wichita Falls; 100% (12/12) in Ontario; 82% (23/28) in Illinois; 84.5% (22/26) in Arkansas; 89.7% (26/29) in Texas in 1997; and 98% (159/162) in Joplin. Victims died from becoming airborne and being slammed into structures and objects, or from being crushed by structures. Some reports attributed deaths to brief, non-existent or insufficient warnings. In Joplin, conflicting and uncertain information was prevalent and public response was delayed or incomplete (Kuligowski, Lombardo, Phan, Levitan, & Jorgensen, 2014).

Although most deaths occurred in buildings, persons in mobile homes, motor vehicles, and outdoors were at high risk of death. In Wichita Falls in 1979, 60% (26/43) of the deaths from multiple traumas occurred in motor vehicles; 77% (20/26) had entered their vehicles expressly to outrun the tornado. Studies of Oklahoma victims, however, found that risk of death in motor vehicles was not elevated, but that persons in mobile homes and persons outdoors were at high risk (Daley et al., 2005). This difference in findings was attributed to improved warnings about expected tornado paths. In Joplin, lack of basements or underground spaces was identified as a possible contributor to the high fatality rate. There were no deaths in single family homes demolished by the tornado among those who sheltered in basements, nor was there evidence that any deaths occurred underground (Kuligowski et al., 2014).

The most common injuries from tornadoes are contusions, lacerations, abrasions, strains/sprains/muscle spasms, fractures, penetrating wounds, and closed head injuries (Bohonos & Hogan, 1999; CDC, 1984c, 1997b). What differentiates those hospitalized from those treated and released is the severity and combination of injuries suffered, not the type of injury. Carter et al. (1989) report that most nonfatal injuries are due to being struck by moving objects. There is no evidence that malnutrition increases as a result of tornadoes and little evidence that disease increases. Following the Joplin tornado, however, there was a significant increase in the number of pneumonia cases compared with prior years (Forshee-Hakala, 2015). Additionally, there was a cluster of 13 confirmed cases of cutaneous mucormycosis, a rare necrotizing

[1]The Fujita Scale was introduced in 1971 to rate tornado damage in the U.S., and is used as a proxy for wind speed (Fujita, 1987). It ranges from F-0 to F-5; anything above F-5, or 319 mph, rarely occurs. In February 2007, the U.S. began using a revised version, the Enhanced Fujita scale, which was designed to increase standardization and reduce subjectivity.

soft-tissue fungal infection that enters the body through cuts and wounds. All these patients had skin trauma, with an average of four wounds each; ultimately, five died (38%) (CDC, 2011; Fanfair et al., 2012; Green & Karras, 2012; Lewis, 2011). Factors that increase the risk of death and injury from tornadoes include event magnitude (proximity to EF4 or EF5 tornado), sheltering in mobile homes, being outside, being an older adult (65 years or older), lacking safe room access, inadequate warning, and evening impact (Ashley, 2007; Bohonos & Hogan, 1999; Brown, Archer, Kruger, & Mallonee, 2002; Daley et al., 2005).

18.4 Floods

Floods are the most common disaster in the world and the leading cause of mortality in natural disasters, accounting for 6.8 million deaths in the 20th century (Doocy, Daniels, Murray, & Kirsch, 2013c). The origin of a given flood is not always clearly delineated, however (Pielke & Klein, 2005). Floods may be caused by tropical cyclones and hurricanes, excess rain, tsunamis, dam breaks, and so forth. Deaths usually are caused by drowning or trauma from being hit by objects in fast-flowing water (Ahern, Kovats, Wilkinson, Few, & Matthies, 2005; Doocy et al., 2013c). Flash flooding is the leading cause of weather-related mortality in the United States, accounting for approximately 200 deaths per year (CDC, 1993, pp. 653–656; French & Holt, 1989). Riverine flooding is associated with fewer deaths, largely because with the gradual accumulation of rainfall, there is more time to warn the population at risk. Floods also affect the geology of an area, with landslides being another source of death and injury. During floods in Puerto Rico, 48% of 95 deaths occurred in landslides and 50% (23/40) were due to traumatic asphyxia (Dietz, Rigau-Perez, Sanderson, Diaz, & Gunn, 1990).

In developed countries, being in a motor vehicle and being male has been associated with increased flood-related mortality; in low-income countries, increased mortality appears to be associated with being female (Doocy et al., 2013c). In the developing nation of Nepal, being female has been associated with increased flood mortality across all age groups (Pradhan et al., 2007). Certain geographic regions (e.g., coastal areas, river basins, lakeshores) are at elevated risk of storms and cyclones that can generate storm surge and, thus, influence flooding. From 1980 to 2009, flood deaths were overwhelmingly concentrated (69% of global flood mortality) in South East Asia (Doocy et al., 2013c). Other risk factors include population growth and proximity to coastlines, increasing development of coastal areas, degradation of the environment, and climate change. In the United States, most deaths in floods occur in motor vehicles that are driven into high water.

Ahern and colleagues (2005) note that there is a potential for increased fecal-oral transmission of disease, vector-borne disease (e.g., malaria), and rodent-borne disease (e.g., Hantavirus), especially in areas with poor sanitation and endemic levels of diarrheal disease. Generally, such outbreaks do not occur in the United States, suggesting that mass immunization for diseases such as typhoid is not needed (CDC, 1983). Other research has found that mortality due to infectious disease may increase following floods over the course of time (Alajo, Nakavuma, & Erume, 2006; Jonkman & Kelman, 2005; Li et al., 2004).

18.5 Earthquakes

Compared to other types of natural hazards, it is easy to determine when earthquakes start and end. Casualties that occur while the ground shakes, or immediately afterwards are impact-phase events; those that occur after the shaking has stopped are post-impact events. There are no pre-impact events. Distinguishing between direct and indirect earthquake casualties, however, is difficult. Injuries that occur during the earthquake, such as falls, are direct effects of the physical force of the earthquake. But an injury that occurs because of structural collapse can be either direct or indirect. If it happens during an earthquake, it is direct; if it happens at

least 24 h later, it usually is considered indirect. Thus, the cause of injury and the outcome may be the same; the timing relative to when the earthquake occurred often determines the difference. In the 1989 Loma Prieta earthquake, 57 of the 60 deaths were considered direct and resulted from injuries sustained within 2 min of the earthquake (CDC, 1989b); three deaths considered indirect resulted from injuries sustained up to 24 h after the earthquake.

The casualty reports for U.S. earthquakes (i.e., 1987 Whittier Narrows, 1989 Loma Prieta, 1994 Northridge, 2001 Seattle/Nisqually, 2003 San Simeon), note that the major causes of deaths include structural collapse of buildings and infrastructure (i.e., freeways) and debris falling from damaged buildings (Durkin, 1995; Eberhart-Phillips, Saunders, Robinson, Hatch, & Parrish, 1994; EERI, 2005b; Peek-Asa, Kraus, Bourque, Vimalachandra, Yu, & Abrams, 1998; Weber, 1987). Injuries that result in death are mainly crush injuries and other traumatic injuries.

The overwhelming majority of earthquake-related health problems are injuries, with soft tissue and orthopedic injuries caused by falls and being struck by non-structural elements (e.g., furniture, light fixtures) accounting for most (Kano, 2005; Mahue-Giangreco, Mack, Seligson, & Bourque, 2001; Peek-Asa, Ramirez, Shoaf, Seligson, & Kraus, 2000; Shoaf, Nguyen, Sareen, & Bourque, 1998). The majority of these injuries are minor and do not require hospitalization. Earthquakes can also cause environmental pollution that affects health. Following the 1994 Northridge earthquake, active surveillance in Ventura County documented increased cases of coccidioidomycosis, an infectious disease known as "Valley Fever."

Studies conducted after the 1994 Northridge earthquake (Bourque et al., 1997a; Seligson & Shoaf, 2003) allow us to examine the extent to which estimates of disaster-related deaths and injuries differ between sources, and the extent to which injuries are incorrectly reported. Where Durkin (1995) reported 72 earthquake deaths and the official count by the State of California was 57 (EQE International, Inc., 1997), Peek-Asa and colleagues (2000), after a careful review of coroners' records, reported 33 deaths caused by the earthquake. The discrepancies are explained by a tendency to include in the "official mortality count" any case that showed up in the coroner's office during or immediately after an earthquake or, in the case of state estimates, all deaths for which burial expenses were approved.

Most troubling is the inclusion of deaths that occur from cardiac events. Normally, people who die from heart attacks do not become "coroner's cases;" rather, death certificates are signed by attending physicians and bodies are released to next of kin. Following the Northridge earthquake, Kloner, Leor, Poole, and Perritt (1997) reviewed all death certificate data for January 1994 and compared it with similar data collected in January 1992 and January 1993 to identify deaths from ischemic heart disease (IHD) and atherosclerotic cardiovascular (ACD) disease. The numbers of deaths attributed to IHD and ACD on January 17 were higher (N = 125) than the daily average for the preceding 16 days (N = 73), but average rates dropped to 57 deaths for the rest of the month. Overall rates of death for January 1994 did not differ from those of January 1992 and 1993. We refer to this as a harvest effect. Deaths that are imminent occur a few days early. These results are consistent with research conducted in Athens and in the Hanshin-Awaji earthquake (Kario & Ohashi, 1997; Suzuki, Sakamoto, Miki, & Matsuo, 1995; Trichopoulos, Katsouyanni, Zavilsanos, Tzonou, & Dalla-Vorgia, 1981).

Similar problems exist in counts of injuries. As of September 2005, National Information Service for Earthquake Engineering continues to list 5,000 injuries from the Northridge earthquake on its web site while the Red Cross lists "1500 serious injuries," and FEMA lists "more than 5,000" (American Red Cross, n.d.; Federal Emergency Management Agency, National Earthquake Hazards Reduction Program, 2005; National Information Service for Earthquake Engineering, n.d.). Both the state and Durkin (1995) reported 11,846 injuries; according to Durkin this figure was based on data collected by the Red Cross which has several limitations including lack of uniformity in data collection

methods and in the definition of "earthquake relatedness." None of the numbers match what was found through actual review of hospital and coroner's records or population based surveys.

After review of hospital records, Peek-Asa and colleagues (1998) found that only 138 injuries were serious enough to require hospitalization; five people's injuries were such that they died after hospitalization. Mahue-Giangreco and colleagues (2001), in a review of emergency room logs in four hospitals found that 423 injured persons were treated and released, and Shoaf and colleagues (1998) in a survey of a population-based sample of households found that 8.1% of households reported an injury to at least one member of the household. Ten percent of those injured, or 0.81% of the total sample, sought treatment from some source, with a third (0.267% of the total sample) seeking treatment from a hospital. Thus, extrapolating to Los Angeles County from these studies, the death rate was 0.38/100,000 population; the hospitalization rate was 1.5/100,000 population; there were approximately 240,000 minor injuries, of which 6.6% sought out-of-hospital treatment; and 3.3% went to emergency departments (Seligson & Shoaf, 2003). These numbers are quite different from those that continue to sit on official websites.

Since 1996, earthquakes have caused an estimated 1,497,242 deaths (Glasser & Guha-Sapir, 2016) worldwide, with many more casualties and other devastating health effects occurring in other areas of the world. The 2001 Gujarat, India earthquake resulted in 20,000 or more deaths, the 2003 Bam, Iran earthquake resulted in 30,000, the 2005 Kashmir, Pakistan resulted in 73,338, the 2008 Sichuan China resulted in 87,476, and the 2010 Haiti earthquake resulted in 316,000 (Doocy, Daniels, Packer, Dick, & Kirsch, 2013d; EERI, 2005a; Farfel et al., 2011). As in the U.S., the primary cause of death and serious injury was structural collapse (De Brucycker, Greco, & Lechat, 1985; Glass et al., 1977; Noji, Kelen, Armenian, Oganessian, Jones, & Sivertson, 1990), which occurs more often in areas with weak or nonexistent building codes (Ramirez & Peek-Asa, 2005).

18.6 Volcanoes

Roughly 9% of the world's population lives in the exposure range of a volcano that has been active in recorded history (Small & Naumann, 2001). Between 1980 and 2009, 147 volcanoes erupted, with an estimated 28,365 deaths and 9,284 injuries. The largest proportion of eruptions (35%) occurred in the Americas, accounting for 88% of the estimated deaths (Doocy, Daniels, Dooling, & Gorokhovich, 2013b). Potential hazards associated with volcanic phenomena include: acid rain, ash and tephra (fine pyroclasts and solid fragments), ballistics or ejected rocks or lava lumps, earthquakes associated with volcanic activity, gas and acid particle emissions associated with eruption or degassing activity, global climate change from mass eruptions ground deformation, landslides, lava flows, laze (gas clouds resulting from lava entering sea water), lightening in volcanic clouds, pyroclastic density currents, and tsunami from volcanic debris avalanches or volcanogenic earthquakes (Hansell, Horwell, & Oppenheimer, 2006).

From 1900 to 1999, there were 491 volcano-related events that impacted humans, with 296 (60%) classified as disasters (Witham, 2005). Fatalities were attributable to a relatively few large events. In recent eruptions, the primary cause of death has been ash asphyxiation, thermal injuries from pyroclastic flow, and trauma. Although some research has shown that volcanic gases have accounted for a small proportion of deaths (1-4%), these figures likely underestimate actual volcanic gas related mortality (Hansell et al., 2006).

Morbidity associated with volcanic eruptions consists mainly of short term ocular irritation and respiratory symptoms (Doocy et al., 2013b). Ashfall can affect populations up to hundreds of kilometers away, the effects of which depends on particle size as well as other factors (Horwell & Baxter, 2006). Increased risk for respiratory symptoms has been observed for children under 5 years of age (Naumova et al., 2007), and those with preexisting lung conditions (Bernstein, Baxter, Falk, Ing, Foster, & Frost, 1986; Horwell & Baxter, 2006; Merchant et al., 1982).

There have been eight significant volcano events in the U.S. in the last 40 years, the largest of which was the eruption of Mt. Saint Helens in Washington in 1980 (USDHS, 2016). Thirty-one bodies were recovered from the eruption, and 32 persons were missing and presumed dead. Deaths were from asphyxiation by dense ash exposure (19/31), burns (7/31), falls (1/31), flying rocks (1/31), and falling trees (3/31) (Merchant et al., 1982). Hospital visits and admissions for respiratory illnesses, especially asthma, increased following the eruption. Repeated exposure to volcanic ash increases risk of pneumoconiosis, especially if particles are inhaled (CDC, 1986a), putting persons involved in post-disaster clean-up and those who work outdoors at elevated risk. The presence of free silican increases future lung damage, but results of a longitudinal study of loggers exposed to Mt. St. Helens indicated that risks of chronic bronchitis or pneumoconiosis were negligible. A study of the health effects of volcanic ash found elevated rates of lung cancer and COPD in the area surrounding Mt. Sakurajima, Japan compared to the control area, and concluded that cristobalite was the most likely cause of elevated chronic respiratory mortality rates (Higuchi, Koriyama, & Akiba, 2012).

More insidious is the air pollution caused by sulfur dioxide gas when it combines with other gases emitted by volcanoes and interacts chemically in the atmosphere with oxygen, moisture, dust, and sunlight to create vog. This has been an ongoing problem since 1986 on the island of Hawaii, where the Kilauea volcano produces a nearly constant outflow of lava and gas. Vog, in turn, produces acid rain which damages crops and is thought to increase health problems, particularly asthma among children (Elias, Sutton, Stokes, & Casadevall, 1998; Sutton, Elias, Hendley, & Stauffer, 2000, June; USGS, 2001).

18.7 Tsunami

Between 1900 and 2009, 94 tsunami affecting human populations were recorded, and most (95.5%) were triggered by earthquakes. Relative to other types of natural disasters, the death to injury ratio for tsunami is high. Tsunami recorded during this period resulted in an estimated 255,195 deaths and 48,462 injuries. It is estimated that between 10,900 and 116,950 additional injuries were unreported. Injury estimates were reported first for the 1964 tsunami in Crescent City, California, by Lander and colleagues, with 35 injuries, and the 1996 Chimbote, Peru tsunami, with 55, including one serious injury (Humboldt State University, Geology Department, n.d.; Petroff, Bourgeois, & Yeh, 1996). Most events (92.5%) resulted in one or more deaths; the vast majority of deaths (227,497, 89%) were attributed to the December 26, 2004 tsunami caused by the Sumatra-Andaman Islands earthquake. Drowning was the most common cause of mortality, while wounds and lacerations, fractures, and near drowning/aspiration were the most common causes of injury. Risk of mortality was higher among women, children, and the elderly; risk of injury was higher among men and young adults. Overall, the South East Asian region and poorer countries experienced higher tsunami-related mortality. Indoor location during the event and having a fishery-based livelihood were identified as additional risk factors (Doocy, Daniels, Dick, & Kirsch, 2013a).

The "Indian Ocean" tsunami caused by the Sumatra-Andaman Islands earthquake[2] destroyed miles of coastline in 12 countries with devastation, death and injuries correlated with the number and height of waves, the amount of run-up, and the extent of development. Kremmer (2005) noted that coastline that remained covered with indigenous mangrove forests fared better than areas that had undergone development. The most comprehensive data are available from Thailand, owing to the well-developed national health care system that was in place before the tsunami. There were an estimated 125,000 reported injured, which is

[2]Nineteen countries were affected by the tsunami: Indonesia, Sri Lanka, India, Thailand, Somalia, Maldives, Malaysia, Myanmar, Tanzania, Seychelles, Bangladesh, Kenya, Singapore, Madagascar, Mauritius, South Africa, Mozambique, Australia, and Antarctica (Peek-Asa et al., 2000).

presumed to be a substantial underestimate, given the unreliability of most injury reports following disasters. In Sumatra, Indonesia, reported mortality rates ranged from 13.9% in Meulaboh to 22.2% in Banda Aceh (Doocy, Rofi, Robinson, Burnham, & Shanker, 2005, May); in Sri Lanka, from 4.2% in the Northern Province to 20.0% in the Southern Province (Pomonis, 2005, April); in Thailand, death rates were 25% for residents and 50% for tourists in Phang Nha, and 3-5% in Wilkinson (2005 April); and in India, 3.3% were dead and 13.7% were missing in the Nicobar Islands (Jain et al., 2006, April).

More recently, the 2011 Tōhoku mega-earthquake (9.0 M) was the most powerful earthquake recorded in Japan, and the fourth most powerful worldwide since 1900, when instrumental recording began. It also was the most costly, with damages estimated at US$210 billion (Guha-Sapir, Vos, & Below, 2011). The event triggered a tsunami that reached the coast of Japan roughly 30 min later, with run-up elevation as high as 130 feet in Miyako, and in the Sendai area, traveled as far as 6 miles inland, inundating a total of approximately 217 square miles in Japan (Mimura, Yasuhara, Kawagoe, Yokoki, & Kazama, 2011; Mori & Takahashi, 2012). Records show the tsunami led to approximately 15,893 deaths in Japan, with another 2,556 persons missing (National Police Agency of Japan, 2016). Autopsy results suggested the earthquake alone was not responsible for many of the deaths; the majority (>90%) were caused by drowning. Unlike the Indian Ocean tsunami, epidemiological research found no sex differences in mortality, lower mortality rates among children, and increasing rates with age (Nakahara & Ichikawa, 2013). The timing of the event, which occurred on a Sunday morning, when women and children were more likely to be home, may have influenced mortality patterns. Predictors of survival were younger age, early evacuation starting time, and occupation. Office workers had a lower likelihood of death compared to those in other settings (Yun & Hamada, 2015).

The National Police Agency of Japan estimates the total number of injured persons at 6,152 (2016). Overall, infectious disease had a small impact on health, but risk was elevated in evacuation centers, particularly for influenza and diarrheal illness, due to lack of access to clean water, unsanitary conditions, and crowding (Hatta et al., 2011; Iwata et al., 2012). Japan has a relatively large proportion of elderly persons, and inclement weather exacerbated health impacts, particularly among shelter-seeking elderly. In the Japanese Red Cross Ishinomaki Hospital, a regional disaster base hospital in Miyagi, Japan, admissions for pneumonia and chronic respiratory disease among the elderly during the 60 days following the tsunami increased compared to control periods during the previous two years (Yamanda et al., 2013). In three hospitals in Kesennuma City, northern Miyagi Prefecture, there was a significant increase in pneumonia incidence during the 3 months following the tsunami, during which time pneumonia-related hospitalizations and deaths increased by 5.7 and 8.9 times, respectively (Daito et al., 2013). Incidence of congestive heart failure in Iwate Prefectural Central Hospital during the three weeks following the event also increased compared to control periods (Nozaki et al., 2013). In highly flooded areas, cerebral infarction or ischemic stroke among elderly men ($\geq$ 75 years) more than doubled the month following the tsunami (Omama et al., 2013). The population-based incidence of sudden cardiac and unexpected death in the Iwate prefecture during the 4 weeks following the disaster was roughly twice that observed during the control period and was observed predominantly in women, the elderly, and residents of the tsunami flood area (Niiyama et al., 2014). Other research in the Japanese Red Cross Ishinomake Hospital found the disaster had a strong negative impact on the clinical outcomes of coronary obstructive pulmonary disease patients, with incident cases normalizing 6 weeks following the event (Kobayashi et al., 2013).

The tsunami caused damage to four nuclear power plants along Japan's coast (Lipscy, Kushida, & Incerti, 2013), resulting in an unprecedented compound disaster. As water overtopped sea walls, it destroyed backup power

systems causing explosions and resulting in the release of radioactive materials. Damaged fuel rods led to contamination of the environment with radioactive isotopes of iodine and cesium. Iodine-131 can lead to decreased thyroid function and tumor growth, and Cesium-137 can lead to bone necrosis and cancer. More than 200,000 residents were evacuated to reduce exposure. The event was the first in which radiation contamination of air, water, and soil emerged as a health concern following an earthquake (Ratnapradipa, Conder, Ruffing, & White, 2012). Environmental health impacts include air and water quality, food safety, healthy housing availability, and radiation exposure. Resulting long-term health effects are yet unknown.

18.8 Heat

Deaths directly caused by heat occur from hyperthermia, defined as a core body temperature of 40.6° centigrade (105°F). When a body is found in a hot, unventilated environment with unknown core body temperature at the time of death, the death certificate frequently lists the death as heat-related, with heat listed as a contributing cause (CDC, 1994b).

A heat wave is defined by the U.S. National Weather Service as three or more consecutive days of temperatures 32.2° centigrade (90°F) or higher (CDC, 1995a). Between 1979 and 1999, an average of 371 deaths per year in the United States were attributed to "excessive heat exposure," which translates into a mean annual death rate of 1.5 per 1,000,000 persons (CDC, 2000). Of the 8,015 heat-related deaths in the United States between 1979 and 1999, 3,829 (48%) were due to weather conditions, with an average of 182 heat deaths per year (CDC, 2003a). From 1999 to 2010, 7,415 U.S. deaths were associated with heat; annual deaths ranged from 295 in 2004, to 1,050 in 1999, with an average of 618 per year (CDC, 2012).

The criteria used to determine which deaths are attributable to hot weather and heat-related illness vary by state and among individual medical examiners and coroners. In Dallas, for example, a decedent must meet at least one of three criteria to be listed as heat-related: 1) a core body temperature of 40.6° centigrade (105°F) or higher at the time of or immediately following death; 2) substantial environmental or circumstantial evidence of heat as a contributory cause of death; or 3) being found in a decomposed condition without evidence of other causes of death and last seen alive during a heat wave (CDC, 1997a). Absent consistent criteria defining heat-related deaths, the number of deaths caused by heat may be substantially over or under reported.

Heat-related deaths are higher for persons over 60 years of age and children under 5 (CDC, 1994a). Elderly females are at greater risk of death in part because they live longer than males. African Americans are at greater risk of heat-related death, largely reflecting living conditions associated with lower socio-economic status and residing in densely populated urban centers without air conditioning. For adults under 65, males are at greater risk of heat-related death (CDC, 1984a, 1984b, 1989a, 1995b, 1996, 2000, 2001, 2013). Semenza, McCullough, Flanders, McGeehin, and Lumpkin (1999) examined the hospital admissions in 47 non-VA hospitals in Cook County in 1995 and compared them to admissions during the same period in 1994. Most excess admissions were because of dehydration, heat stroke, and heat exhaustion. Persons older than 65 years of age with the underlying medical conditions of cardiovascular diseases, diabetes, renal diseases, and nervous system disorders were at higher risk of being admitted.

Heat-related health effects are expected to increase over time owing to changes in climate. For example, the number of heat-related deaths in New York City is expected to increase 47%-95% by 2050 (Knowlton et al., 2007), and in California, up to a 7-fold increase in heat

related deaths is anticipated by 2090 (Hayhoe et al., 2004).

18.9 Ice and Snow

The impact of blizzards, ice, and snow on morbidity and mortality has not been widely studied. Exposure to extreme natural cold can lead to hypothermia and may exacerbate preexisting chronic conditions, particularly when the conditions involve medications that inhibit thermoregulation (Berko, 2014). In the 1978 New England Ice Storm total mortality did not increase, but a third (N = 37) of all deaths were classified as storm related (CDC, 1982). Eight persons stranded in cars died, with five dying from carbon monoxide poisoning. Mortality from ischemic heart disease increased significantly in Rhode Island though the number of visits to emergency rooms declined by 64% in Rhode Island and 65% in Eastern Massachusetts during the blizzard. No disease outbreaks occurred and no water or sanitation hazards could be verified, although seven were reported in Eastern Massachusetts.

Ice storms during 1994 in the Washington, D.C., area resulted in 53 National Institute of Health employees having acute musculoskeletal injuries (CDC, 1995c). Of these, 22 (42%) were bruises and contusions, 24 (45%) were strains or sprains, and 7 (13%) were fractures. Thirty-nine of the 53 injuries resulted from falls on ice on the NIH campuses, including all seven fractures, 63% of the strains/sprains, and 77% of the bruises and contusions.

During November 18–21, 2014, Erie County, New York experienced unprecedented snowfall, resulting in 11 deaths. Decedents ranged in age from 30 to 92 years; nine were male (82%). One death was directly storm-related, and 10 were indirectly related, involving shoveling or blowing snow, carbon monoxide intoxication in stranded vehicles, and acute medical emergencies. Another possible storm death occurred after nursing home residents were relocated due to the storm (Burstein, Blank, Chalmers, Mahar, & Mahoney, 2015).

18.10 Wildfires

Historically, wildfires in the United States have occurred in unpopulated areas and have been allowed to burn out. Starting in the 1940s and escalating during the last thirty years, development has occurred in areas traditionally considered wildlands. Areas where residential structures and fire-prone wildlands intermix are referred to as urban-wildland interfaces. One of the first fires to receive widespread attention was the Oakland, California, fire of 1991, with 25 deaths and 150 injuries (East Bay Hills Fire Operations Review Group, 1992). Subsequent fires in Malibu, Laguna Hills, and those that occurred throughout Southern California in October 2003, which resulted in 20 deaths and 121 injuries, have emphasized the increased importance of wildfires as a type of natural disaster (Greenberg, 2003). There have been no systematic studies of the deaths and injuries that occurred in these fires; most available information is contained in press reports and other informal sources. It is clear deaths occur because persons are unable to evacuate the area of fire and either do not consider or are unable to initiate procedures that would allow them to shelter in place. Most deaths appear to be caused by smoke inhalation and burns.

More recently, research has begun to document deaths and injuries. A study of the 2006 Texas wildfires detailed the context surrounding 12 deaths that occurred in five separate incidents (CDC, 2007). Of the 12 attributed deaths, 7 were directly, and 5 were indirectly, related to the fire. Eleven of the decedents were civilians. Smoke inhalation was the immediate cause of death for 8 (67%) decedents, and for half of these, the underlying cause was listed as superheated air from grass wildfires. For the remaining four deaths, the immediate cause of death was blunt-force trauma and complications, with vehicular accident/collision listed as the underlying cause.

Most studies have found an association between wildfire smoke exposure and increased risk of respiratory and cardiovascular diseases, with children, older adults, and individuals with underlying chronic illnesses being more

susceptible (Liu, Pereira, Uhl, Bravo, & Bell, 2015). Specifically, exposure has been found to result in increased emergency department visits for respiration and asthma, acute exacerbation of bronchitis, chest pain, eye irritation, and dyspnea, with minimal impact on the number of hospital admissions (CDC, 1999, 2008; Johnson, Hicks, McClean, & Ginsberg, 2005; Sharip, Kajita, Jones, & Hwang, 2008). Socioeconomic characteristics have been found to modify the effect of wildfire smoke exposure on asthma and congestive heart failure (Rappold et al., 2012). Following the 2003 Southern California wildfires, a school-based questionnaire administered in K-12 and high schools found that among children, increased eye and respiratory symptoms, medication use, and physician visits were associated with exposure to wildfire smoke (Kunzli et al., 2006). Additional research is needed to help develop a better understanding of wildfire health effects (Kochi, Donovan, Champ, & Loomis, 2010).

18.11 Terrorism

Since September 11, 2001, the disaster community has examined the extent to which terrorist incidents do or do not resemble natural disasters, which have been studied over the last 70 years. Bombs, planes, arson, gases (e.g., sarin), pathogenic microbes including *Bacillus anthracis* (anthrax), variola virus (smallpox), *Yersinia pestis* (plague), *Francisella tularensis* (tularemia), *Clostridium botulinum* (botulism), the hemorrhagic-fever viruses (e.g., Ebola), and nuclear devices have been hypothesized to be, or actually have been, selected as the agent of choice by terrorists. Clearly, cause of death and the kinds of morbidity experienced after a terrorist attack differ with the agent used. Devices are frequently delivered by individuals who intentionally commit suicide as part of the delivery process. Between 1989 and 2014, 93% of all terrorist attacks occurred in countries with high levels of state-sponsored terror (e.g., extra-judicial deaths, torture, and imprisonment without trial); 90%, in countries involved in violent conflicts, 50%, in countries experiencing internal conflict; and 41%, in countries in which the government was involved in an international military conflict. Since 2000, about half of all terrorist attacks resulted in no deaths. During this same period, there was a 550% increase in deaths caused by terrorism targeting private citizens. Just over half of these attacks used bombings or explosions, followed by armed assault, which made up about 20% of attacks. Armed assault was more lethal than other forms of attack on civilians, with an average of 5.5 deaths per event compared to 2.6 for bombings and explosions (Institute for Economics & Peace, 2016, p. 383).

In the United States, there were 555 terrorist attacks resulting in 3,322 deaths between 1995 and 2015 (NC START, 2016a, 2016b). Overall, 50% were facility/infrastructure attacks and another 25% were bombings. Primary targets included businesses (25%), abortion activities (18%), government (17%), and private citizens and property (17%). Since 2006, the vast majority (98%) of U.S. terrorism-related deaths were from attacks carried out by individuals who acted alone. In 2015 and 2016, several high fatality attacks were carried out by lone actors, including the San Bernardino attack that resulted in 14 deaths, the attack on attendees of the Emanuel African Methodist Episcopal Church in South Carolina with nine deaths, the attack on the Navy Operational Support Center in Tennessee that killed six, and the Orlando nightclub shooting that killed 50 and injured 53 (Institute for Economics & Peace, 2016).

This section examines the deaths, injuries, and disease potentials associated with the 2001 attacks on the World Trade Center and Pentagon. The majority of deaths in such events are caused by being instantaneously blown up, by being crushed by debris, by burns, and by smoke inhalation. Morbidity is primarily the result of physical injuries, but disease syndromes associated with inhalation or other kinds of exposure to toxic substances are also of concern. In contrast to earthquakes, which result in similar kinds of injuries, the lethality of bombs is increased by the

force with which the blast transforms parts of structures and other materials into projectiles.

As of August 22, 2002, 2,819 persons were estimated to have died in the attack on the World Trade Center, and a total of 2,734 death certificates had been issued (CDC, 2002a). In the Pentagon attack, 125 occupants of the Pentagon and 64 occupants of the plane were killed, and 106 persons were treated for injuries in local hospitals (Jordan, Hollowed, Turner, Wang, & Jeng, 2005; Wang, Sava, Sample, & Jordan, 2005). Fifty-four patients were treated and released; 47 were admitted; and 7 were transferred to other sites. Injuries treated were primarily burns, respiratory problems, and orthopedic injuries.

It is more difficult to determine the number and type of injuries that occurred in New York. CDC reported in January 2002 that 790 survivors with injuries were treated within 48 h at four hospitals and one burn center. Of the 790, 49% had inhalation injuries and 26% had ocular injuries, primarily attributable to smoke, dust, debris, or fumes. Of the 139 hospitalized, the distribution of injuries was as follows: 37% inhalation; 7% ocular, 18% lacerations; 12% sprain or strain; 21% contusions; 19% fractures; 19% burns; 6% closed head injuries; and 4% crush syndrome. Two hundred thirty-nine rescue workers sought care, with the majority suffering from inhalation (42%) and ocular (39%) injuries (CDC, 2002e). Since the original studies reported by the CDC, more detailed reports about patients seen in a number of hospitals have been published (Cushman, Pachter, & Beaton, 2003; Kirschenbaum, Keene, O'Neill, & Astiz, 2005) but no single article has attempted to describe all of the injured seen.

In the years since 9/11, numerous articles have reported attempts to monitor the long-term health effects of the Trade Center attack on the population of New York City. The majority have reported efforts to monitor the impact of environmental contamination on health. Reports of asthma, respiratory symptoms, eye irritations and rashes by persons who lived or worked in the immediate area increased after 9/11, but researchers have not been able to establish a link to the attack itself or to changes in ambient air in the months following the attack (CDC, 2002d, 2002f, 2003b; Trout, Nimgade, Mueller, Hall, & Earnest, 2002). Fifteen months after the attack, firemen and other rescue and recovery workers exhibited lower-airway hyper-responsiveness which may be due to high levels of airborne contaminants from smoldering fires, dust resuspension, and diesel exhaust from heavy equipment. Respiratory medical leaves by firefighters increased five-fold during the 11 months after the attacks (CDC, 2002b, 2002c, 2004b; Prezant et al., 2002).

18.12 A Note on Psychological Morbidity

This chapter has considered the impact of disasters on physical health. Not surprisingly, the type of disaster has a strong influence on the health outcomes that occur. In contrast, the impact of disasters on mental health is less differentiated by disaster type and more strongly affected by the pre-disaster characteristics of the individual and the parameters of the disaster event. The presence of concurrent stressors and the lack of social support also bear on mental health impacts. Post-traumatic stress disorder (PTSD) is by far the most common disorder studied, followed by major depression, anxiety, and panic disorders (Norris, Friedman, Watson, Byrne, Diaz, & Kaniasty, 2002b; Vlahov et al., 2002). This section provides an overview of research on the impact of disasters on mental health. The interested reader is referred to key literature (Galea, Nandi, & Vlahov, 2005; Norris et al., Norris, Friedman, & Watson, 2002a; Norris et al., 2002b; North, 2014; North & Pfefferbaum, 2013) for a more detailed review.

Norris and colleagues synthesized two decades of disaster research published between 1981 and 2001 in a comprehensive literature review (Norris et al., 2002b). Their work noted the widespread belief that human-initiated disasters yield higher rates of mental impairment, with mass violence being the most disturbing of all. Pointing out the need for prospective, longitudinal studies of diverse populations with exposure

sufficient to impact mental health outcomes, they suggested further consideration of this assumption using rigorous and consistent study designs. Subsequent research with a large combined sample (N = 811) examined directly exposed survivors of 10 different disasters with full diagnostic assessment and consistent methods, and found no evidence of differential PTSD prevalence by disaster type, challenging the earlier assumption (North, Oliver, & Pandya, 2012b). Future research with additional disasters is needed to better understand these conflicting findings.

Despite considerable diversity in circumstances, methods, and outcome measures, some commonalities emerge from the research on the mental health impact of disasters, both in regard to characteristics of individuals and parameters of the disaster events (North, 2014). Most persons surviving natural disasters do not meet criteria for psychiatric disorders. In North and colleagues' study of 10 major disasters, on average, 20% of survivors developed a new psychiatric disorder they had not previously experienced (North et al., 2012b). Including pre-existing psychopathology, this figure rose to about a third. Of those exposed to disaster-related trauma (through direct endangerment, eyewitness, or learning that trauma occurred to a close family member or friend), 20% developed PTSD. Major depression was experienced by 14% of survivors. Some research has documented increased alcohol and drug use following disasters, but new substance use disorders typically do not develop. Preexisting conditions may worsen, however (Norris et al., 2002b; North, 2014). Following disasters, unpleasant emotions and other symptoms that do not meet formal diagnostic criteria for psychiatric disorders are far more common than psychiatric disorders, and are referred to as psychological distress.

Disaster-related psychiatric disorders generally begin shortly after disaster occurrence and then dissipate over time; however, there is variability, and a substantial minority experience chronic psychopathology. Several studies reveal a significant drop in symptoms over time (Briere & Elliott, 2000; Norris et al., 2002b). These and other findings have led some researchers (see McMillen et al., 2000) to propose a subthreshold, or partial PTSD diagnostic category that would apply to survivors who are impaired yet do not meet diagnostic criteria. In contrast, a 7-year prospective study following survivors of the 1995 Oklahoma City bomb blast found ongoing chronicity of PTSD and major depression (North & Oliver, 2013; North, Pfefferbaum, Kawasaki, Lee, & Spitznagel, 2011). In some delayed cases, PTSD may not develop until at least 6 months following exposure.

Two studies of survivors of the Oklahoma City bombing reported PTSD rates of 34% (North, Nixon, Shariat, McMillen, Spitnagel, & Smith, 1999) and 8% (Sprang, 1999). The study yielding the higher rate included only survivors who had been *directly* exposed to the blast, whereas the latter sample *excluded* direct victims of the bombing and those who had experienced another traumatic event in the five years preceding data collection. A study of the rescue and recovery workers, including volunteers, from the 2001 attack on the World Trade Center indicated that 13% met criteria for PTSD, a rate about four times what would be expected in the population (CDC, 2004a). Stress-related illness increased 17-fold among FDNY rescue workers in the year following the attack (CDC, 2002c). In the 2011 Tōhoku earthquake and tsunami, a considerable proportion of the exposed population experienced substantial mental health effects, with prevalence ranging from 10% to nearly 50%. Mental health impacts included PTSD, depression, anxiety, and stigma, among others (Matsubara et al., 2014; Niitsu, Watanabe-Galloway, Sayles, Houfek, & Rice, 2014). Consistent with the World Trade Center attacks, indirect exposure was related to stress-related psychological injury (Niitsu et al., 2014).

People with similar exposures to the same disaster may have very different mental health impacts (Norris et al., 2002b). The strongest predictors of PTSD following a disaster are having a prior history of psychopathology and being female, both of which roughly double the

likelihood of developing PTSD (North, 2007). Having a personality structure with high cooperativeness and high self-directedness has been identified as a protective factor for both PTSD and major depression (North, Hong, Suris, & Spitznagel, 2008; North, Abbacchi, & Cloninger, 2012a). Epidemiologic studies consistently show that disaster severity and degree of involvement with the disaster are important predictors of individual response (McDonnell, Troiano, Barker, Noji, Hlady, & Hopkins, 1995). Physical injury, witnessing death or injury, and property loss are robust predictors of mental health sequelae, and are more important in this regard than the type of disaster (Briere & Elliott, 2000). Following the Armenian earthquake, an especially severe natural disaster, two-thirds of survivors met criteria for PTSD (Goenjian et al., 1994). Health and disaster services were inadequate, and death tolls in this earthquake approached 100,000. Among survivors of a severe earthquake in Western India, 59% met criteria for a psychiatric diagnosis, six times the usual rate in rural India (Sharan, Chaudhary, Kavathekar, & Saxena, 1996). Reports from the December 2004 tsunami indicate that rates of disaster-related mental disorder are high relative to other natural disasters. Following the September 11 attack, several studies documented higher prevalence of PTSD among those with greater exposure (Galea et al., 2002; Schlenger et al., 2002). It is worth noting that research on psychological responses to the events of September 11, 2001, shows that one third of those with PTSD had *not* been directly exposed to the World Trade Center or Pentagon attack (Galea et al., 2003). The immediacy and extensive nature of the media coverage, coupled with the profound psychological impact of the event, seem to have expanded the boundaries of disaster impact. Likewise, a review of mass shootings found that degree of exposure and social proximity to the shooting were positively associated with increases in psychological distress, PTSD, depression, and anxiety (Shultz et al., 2014).

Similar to research on other major stressors, the disaster literature shows that vulnerable persons are particularly prone to postdisaster stress, with vulnerability encompassing prior distress, social class, gender, and linguistic or social isolation. Disasters enhance socially structured inequalities already in place and generate new, secondary stressors that further tax coping capacity (Kaniasty & Norris, 1995; Norris et al., 2002b; Tierney, 2000), particularly among community members who experience chronic adversity (Richmond, 1993). Paramount among these secondary stressors is disruption of social networks. After a disaster, demand for support can exceed the network's capacity to provide support (Kaniasty & Norris, 1993; Norris et al., 2002b). In the face of disaster stressors, instrumental, as opposed to emotional, support is especially important (Haines, Hurlbert, & Beggs, 1999). A national survey, fielded five days after the September 11th attacks, confirmed the greater vulnerability of certain groups, but also found significant distress among most of those surveyed (Schuster et al., 2001). In other 9/11 research, women who were already experiencing chronic stress were most likely to respond with anxiety and increased alcohol use (Richman, Wislar, Flaherty, Fendrich, & Rospenda, 2004). Female survivors of the Oklahoma City bombing were twice as likely as men to meet criteria for PTSD, depression and generalized anxiety (North et al., 1999). These findings are compatible with a meta-analysis of psychological impairment following disaster which showed that effect sizes were directly proportional to the number of females in the sample (Rubonis & Bickman, 1991).

18.13 Methodological Concerns

An important concern for the study of morbidity and mortality associated with disasters is the generally weak methodology of most studies. Very few studies allow disaster related prevalence estimates and morbidity and mortality rates to be calculated (Bourque, Shoaf, & Nguyen, 1997b; Dominici, Levy, & Louis, 2005; Ibrahim, 2005). Most studies describe those cases in a

coroner or medical examiner's office, or at a hospital or emergency room, with no effort to describe the denominator population from which the cases are drawn. A study focused only on the dead, injured, and sick who present at a particular location provides no insight into how deaths and injuries are distributed across the population at risk, and whether certain groups are more vulnerable to death and injury. Increased use of cluster samples in rapid needs assessments after floods and hurricanes provides some ability to generalize to a larger population. Unfortunately, such techniques do not work well following earthquakes where structural damage is less predictably distributed (Noji, 2005).

Other useful, but underutilized, methodologies include case-control designs, geographic information systems (GIS), comparative cohorts, and probability proportionate to size (PPS) surveys. All have the potential to provide information about whether morbidity and mortality are differentially distributed across populations. A case control design considering persons who died or were hospitalized as a result of the Northridge earthquake and sets of age-matched and geographically matched controls selected from a post-quake survey of Los Angeles County residents revealed that persons at elevated risk of death or hospitalization were females, elderly, close to the epicenter, in areas of high peak ground acceleration or high Modified Mercalli Intensity, or in buildings that were damaged or constructed after 1970 (Peek-Asa, Ramirez, Seligson, & Shoaf, 2003). Comparative cohorts were used by Semenza et al. (1999) to examine excess hospital admissions during the July 1995 Chicago heat wave, and by Leor, Poole, & Kloner (1996) and Kloner, Leor, Poole, & Perritt (1997) to study deaths on the day of the Northridge earthquake. GIS could, for example, be used to "map" the addresses where the injured and dead lived or were at the time of impact (Peek-Asa et al., 2000). This information could then be compared with census data about the populations who live in those areas, similar to what Klinenberg (2001) did after the 1995 Chicago heat wave. But these methodologies require substantial resources, which are not readily available to researchers. Similarly, ongoing surveillance systems in hospitals and emergency rooms would increase our ability to determine whether the number and pattern of presenting cases change in the aftermath of a disaster. Surveillance has long been advocated by the public health community, but has yet to be instituted widely in the United States.

Further complicating research is the lack of agreement on what constitutes a disaster- related death, injury, or disease. Thirty years ago, the Centers for Disease Control and Prevention (CDC) took the lead in attempting to develop a standardized definition of disaster-related deaths and injuries; more recently, Seligson and Shoaf have attempted to develop standardized procedures for identifying earthquake-related deaths and injuries (2003). Despite these attempts, many researchers continue to develop their own definitions of which injuries and deaths are counted, often with little regard for or even knowledge of past research and discussions. Disaster-related mortality is more accurately described than are injuries, where official numbers are often guesses compiled by a public health employee who contacts the Red Cross and hospitals within an affected area for estimates of the injured and sick seen in emergency rooms. Most of those injured do not utilize emergency rooms and the person representing the hospital usually does not know which patients are injured or sick because of the index disaster and which are not. Thus, the numbers reported simultaneously exaggerate and minimize actual counts. Careful review of emergency logs and admissions records is necessary to determine whether a condition is related to the event and, even with careful review, not all cases can be resolved. The most accurate estimates of morbidity and mortality are probably those reported in studies conducted after the Northridge earthquake in California (1994). Even there, the range of reported morbidity and mortality is wide. Estimates from events outside the U.S., especially in areas that lack mechanisms for centralized data gathering, are expected to be even lower in accuracy.

18.14 Conclusions

In most disasters, the majority of deaths occur because people drown, are crushed by collapsing buildings or structures, hit by moving objects, or thrown against structures and objects. People drown in hurricanes, tsunamis and floods, with death often instantaneous. People die from crush and multiple traumatic injuries in tornadoes, earthquakes, hurricanes, tsunamis, and terrorist bombings. In hurricanes, floods and tornadoes, people who are in motor vehicles, motor homes, and outdoors are at greater risk of injury or death; in earthquakes, people who are outdoors are at less risk of injury or death. Burns and asphyxiation are major causes of death and injury following volcanoes and in terrorist bombings, and probably in wildfires. Many such deaths could be avoided if better warnings and evacuation plans were more effectively disseminated.

Physical injuries are the primary cause of non-fatal casualties after all disasters, and the majority are soft tissue injuries and fractures, generally to the arms and legs. When electricity is out, the use of generators and other sources of light and heat lead to increased incidents of carbon monoxide poisoning and burns.

After every disaster, the same myths are disseminated about how disasters affect the health of populations. Prominent among them are the misconceptions that dead bodies cause disease, epidemics and plagues follow every disaster, local populations are in shock and unable to function, and outsiders are needed to search for bodies and bring supplies (e.g., de Goyet, 2004; Noji, 1996; Pan American Health Organization, n.d.; Poncelet, 2000).

Despite the unpredictability of disasters, it is incumbent on researchers in this area to utilize strong research designs that are population based and incorporate pre-disaster measures, where feasible. Standardized methods of data collection are imperative, as is increased reliance on multivariate analytic strategies that can be replicated across time and events. Questions about who is at greatest risk of morbidity (physical and psychological) and mortality during and after a natural hazard or terrorist event can be adequately addressed only when researchers and practitioners agree on what constitutes an event-related health effect, and utilize research designs that allow for generalizations to the larger or denominator population.

Research forms the evidence base that guides disaster policy development and decision making. Future research should focus on strengthening the validity of research findings through improved methods such as population-based and longitudinal study designs. The lack of a shared definition of what constitutes a disaster and inconsistent methods for reporting mortality across, and within, regions leads to variable documentation worldwide. Efforts to develop greater consistency of methods and measurement can improve the quality of reporting of disaster medical research. To best interpret mortality data, particularly when evaluating trends over time, it is important to take hazard severity into account. Credible information about the severity of different hazards remains difficult to obtain (Bahadur & Simonet, 2015). Recent research on social vulnerability to disasters has advanced conceptualizations and methods used to study the impact of social factors on disaster related health consequences. There remains a need to pursue more rigorous and detailed research on morbidity and mortality associated with the impact of disasters on children and other vulnerable groups, as well as the mental health impacts of disasters. The application of consistent methods across hazards and geographies to study these factors can help lead to better understandings of social vulnerabilities and how they may, or may not, relate to resiliency across different settings.

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Part V
Communities in Disaster

Community Innovation and Disasters 19

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and Sarah E. DeYoung

I'll be happy to give you innovative thinking. What are the guidelines?

Cullum (2005)

Contents

19.1 Introduction

Much is made of the American spirit of innovation, yet innovation is certainly not a process isolated to the United States nor is it always embraced in American communities (Fagerberg, 2005). How do we come to understand community innovation, particularly as it concerns practices related to disaster management? Indeed, innovation is a much-studied subject with a vast corpus of research literature that is conflicted and contradictory. Community, too, is a troubled and often imprecise term, its colloquial meaning often at odds with the complex and sometimes antagonistic social relationships existing in a place (McMillan & Chavis, 1986; Rappaport, 1987). Yet much of disaster research and practice is grounded in at least an implicit recognition of the importance of both community and of innovation (e.g. Palen et al., 2010). If people in a community are under threat from a known hazardous condition, what do they do to change that condition? And if people do, indeed, experience a disaster, what do they do to manage its effects? How does the community adapt to instability? Hence the study of innovation in communities is central to the study of disaster, and innovation in communities is itself central to mitigating hazard, responding to emergencies and disasters, and recovering afterward.

In this chapter, we examine community innovation. We begin first by conceptualizing community and innovation as they relate to hazard – understood as a mismatch between human, natural, and technological systems (Mitchell, 1990; Palen et al., 2010) – and disaster. We identify the difficulties inherent in the terms *community, innovation,* and *community*

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innovation, presenting some working concepts that seem to align best with overall disaster research experience. We examine the characteristics of communities that make innovation both necessary and difficult, using examples of innovations drawn from the United States and internationally. This discussion will point toward some directions for future research, including an understanding of community that might be suitable for newer, complex, and diffuse hazards – such as bioterrorism, cyberterrorism, and slow onset hazards related to climate change. The discussion will also point to some needed reorientations in policy that might proceed from either subsequent or existing research.

19.2 Concepts and Definitions

Before considering community innovation as a feature of pre-disaster mitigation and preparedness and of post disaster response and recovery, we must first consider carefully what we mean by each of these terms. The terms not only have conventional uses but they also take on different technical meanings in the research literature. Moreover, *community innovation* itself requires some explanation. It barely exists as a term in disaster research. Lindell and Perry's (2001) work on Local Emergency Planning Committees (LEPCs) is a noteworthy exception, but they make little use of the innovation literature in their analysis of the effectiveness of LEPCs.

Community innovation is, however, a subtext of most work in the hazard and disaster area, and when used elsewhere has a broad diversity of meanings, emphases, and implications.

19.2.1 Community

The word community evokes an image of people in a certain geographical setting, socially organized via the mechanism of a local government for the good of the people who live in that place. One of the principal definitions of disaster (Fritz, 1961) emphasizes a strong spatiality in the very concept, and indeed, most disaster research has looked at disasters via their impact on socio-political collectives - cities, towns, and states. The fundamental assumption is that the people who live there share common interests, needs, or aspirations. But there are really many more kinds of community: professional communities, linguistic communities, ethnic communities, and religious communities that may or may not be tied to certain locations but that are instead linked by interests apart from geography. Moreover, socially organized groups sharing a certain geographic setting are often comprised of many such communities within its boundaries. This is reflected by the analysis of defining community across contexts and levels – primarily in community psychology literature and studies related to community intervention research (Kelly, 2006; Nelson & Prilleltensky, 2010; Perkins et al., 1990). More recently, disaster preparedness has been linked with a psychological sense of community (DeYoung & Peters, 2016). Taking a geographical setting perspective, one might assess the devastating impact on the community of New Orleans, Louisiana following Hurricane Katrina in 2005. Yet we know that the experiences of those from that city were quite varied in their ability to evacuate, their experiences throughout the response, and their recovery outcomes, and their participation in decision-making during that extended time period (see, for example Beatley, 2009; David & Enarson, 2012; Elliott & Pais, 2006).

We know that over the past two to three decades, there is an increasing focus on the forces internal to the social system that lead to disasters or increased risk (e.g. Wisner et al., 2003) leaving particular communities of individuals within that system differentially vulnerable and resilient (see Thomas, Cutter, Hodgson, Gutekunst, & Jones, (2003) for a review) despite sharing common political boundaries. In disaster research, as Peacock, Morrow and Gladwin (2000) point out, the warm and positive connotations of community are often more wishful thinking than reality. They see community as a collection of competing interests. Their concept of a *socio-political ecology* holds that various

groups - themselves shifting continually in composition - negotiate with each other for power and resources. Given this conception, community is characterized as much by conflict as by consensus, and the outcome of this process may lower the community's overall resistance to disaster. Moreover, it may result in distributions of risk that are unequal across the various residents. Coordination, defined as "agreed-upon relationships between independent organizations," (Gillespie, 1991, p. 55) is generally regarded as an important feature of emergency management. Comfort, too, strongly emphasizes coordination in the development of systems adaptive to threat, characterized by such features as sense of shared risk, and "common understanding" about remedial measures (Comfort, 1999, p. 31). Yet the coordination, mutual understanding, and information exchange that are necessary to respond to threat are undermined by the fractious nature of communities, and innovators may struggle for expression in such places.

19.2.2 Innovation

Innovation, like community, is a recurring theme of disaster studies, though often more implicitly understood than explicitly mentioned. Survival requires innovation. This statement is regarded as axiomatic in the corporate world, where organizations must respond to constant shifts in the competitive landscape with new products or services, more efficient communications and information technology, and streamlined, flexible, "organic" structures. Outlined in classic innovation research by Mitzberg (1979; as cited in Lam, 2005), organizational structures vary in degrees of flexibility for adaptation and periods of instability. In a highly flexible organization, innovation becomes more likely (Damanpour, 1991). Innovation itself, of course, has a reflexive quality, since it is innovations or changes occurring elsewhere in the operational environment that compel other organizations in that environment themselves to seek new strategies or methods. Innovation, then, is a key survival attribute, but it is one with a central paradox - though it denotes a break or departure from customary methods or structures, the break itself is necessary for the continuity of the organization in question. This could include either the continuity of their reputation or perceived legitimacy; the continuity of socially-constituted parameters of performance; or in extreme cases, the continuity of the organization's existence: its survival.

We examine, principally, innovation as a capacity or a process, rather than as the product, and the unit of analysis is a community (again, not necessarily linked by geography or political boundaries) that does something new in the face of crisis, either a crisis that is potential or one that is realized. The emphasis is on a departure from an established way of conceiving danger. This departure could include novel ways of thinking about potential perils, developing strategies for mitigating them in advance, becoming better prepared for threats that eventually result in disaster, and responding to disastrous events when they occur.

Much work on innovation has been done at the organizational level, and some of these findings have applicability to our consideration of community innovation. A community can be viewed as analogous to an organization because they have varying capacity to be adaptive in sudden and catastrophic events, as reflected in hazard research (Norris et al., 2008). In the disaster science literature, for example, this innovation may demonstrate itself through considerations of the manifestation of emergence – either through the structural arrangements in operation, the resources utilized, or the tasks and activities engaged in (Brouillettee & Quarantelli, 1971; Kreps & Bosworth, 1994; Webb, 1998) – in the immediate post-disaster period. Researchers generally distinguish between innovation and change, looking at change as "the adoption of a new idea or behavior by an organization [whereas in contrast, organizational innovation is seen as] the adoption of an idea or behavior that is new to the organization's industry, market, or general environment" (Daft, 2004, p. 404). However, Daft (2004, p. 404) goes on to note that when managing change in organizations,

"the terms…can be used interchangeably because the **change process** within organizations tends to be identical whether a change is early or late with respect to other organizations in the environment." We also will not make a distinction between whether the innovation is completely new, never before seen anywhere, or instead is new to that locality. In looking at creativity, for example, a concept closely allied to innovation, Amabile (1997) considers organizations that do new things to be creative, even if the idea was also thought of elsewhere. The key issue is doing something new in a given context, not necessarily being first. Similarly, Damanpour and Gopalakrishnan (1998, p. 3) argued that innovation can be brought into the organization; that is, it can originate in the organization or can be imported after being developed elsewhere.

Not only is the research literature on innovation large, it is also fraught with conflict and contradiction. For example, Bigoness and Perreault (1981, p. 69) commented that studies tend to be "inconclusive or contradictory," and they note that other researchers have arrived at a similar assessment, stating that "factors found to be important for one innovation in one study are found to be considerably less important, not important at all, or even inversely important in another study." Levi and Lawn (1993, p. 226) found a "lack of integrating theories," and suggested that fully-developed widely-applicable theory may actually be impossible, while Damanpour and Gopalakrishnan (1998, p. 2) argued, "Despite their efforts…researchers still cannot identify with certainty the causes and effects of organizational innovations." The principal challenge is the great differences in such variables as organization type, size, configuration, and environment. Even organizations that appear to be similar may differ enough to defeat attempts at generalizing factors relating to innovation.

These challenges are arguably more complex at the community level where members may be less formally bonded to each other than members of a highly structured organization or alternatively be comprised of multiple organizations. There is a further difficulty in applying existing research to the problem of community innovation, and that is that most research examines private-sector companies (see Kraemer & Dedrick, 1997). There is less literature on innovation in public sector organizations, and what there is suggests that innovations follow a somewhat different trajectory with different factors of facilitation or obstruction, especially because different demands are placed on organizations in these contexts. The same may be true for communities based around non-private sector definitions.

19.2.3 Community Innovation

The literature on innovation, as noted earlier, is quite sizable. However, much of this literature is concerned with technical or industrial innovation, and "R&D" (research and development). Research focuses in particular how new products circulate through different markets, known as diffusion of innovation (Meade & Islam, 2006; Robertson, 1967).

Diffusion is a key part of the policy process because it impacts the degree to which the policy change is successful (Shipan & Volden, 2008). Furthermore, according to Fagerberg (2005), "Diffusion is one of the three pillars on which successful introduction of new products, processes, and practices into society rests, along with invention (a new idea) and commercialization/innovation (reducing the invention into practice)" (p. 478). An innovative policy is one in which a new policy is created and diffusion occurs when the policy spreads from government to government (or jurisdiction to jurisdiction): "Pressure for policy innovation also can come from outside the polity, with the spread of innovations from one government to another, a process known as policy diffusion" (Shipan & Volden, 2008, p. 841).

Another clear description of policy diffusion is described by True and Mintrom (2001): "Taken at the most general level, diffusion studies asks the following question: In a given social system, how can we explain patterns of innovation adoption?" (p. 33). This description is

compelling because it can be applied to governments, nonprofits, and commercial organizations, since they all arguably are comprised of actors within a social system. Policy diffusion can be measured by tracking changes at the international, national, state, and local levels. Furthermore, policy diffusion can be impacted by a variety of settings (e.g., Laraway & Jennings, 2002), stakeholders (Cohen, March, & Oldsen, 1972; Kingdon, 1995, as cited in Godwin & Schroedel, 2000), and interest groups (Godwin & Schroedel, 2000). Themes from many studies on policy diffusion reveal similar mechanisms, though the authors might then operationalize them differently (e.g., emulation versus imitation). Temporal and spatial measurements are important quantitative measures in scholarly articles on policy diffusion, although limitations exist in the measuring and assessing trends of conceptual mechanisms (such as cognitive and moral legitimacy).

Community innovation, as such, is less often examined in the broad sociological literature. It is very conspicuous in urban studies and planning, and management and organization science but, again, there is a marked technological or industrial focus, looking at the distribution of new products or services, or the uptake of new technology in firms. The literature explicitly on community innovation follows a similar approach, looking at how communities or regions attract or retain certain industries or become known for producing new goods and services. However, there are many community innovation *programs*. These consist of community innovation grants and sponsorship activities associated with community social or economic development. These are themselves vast topics and include accessible technology, social entrepreneurship, sustainability, low-income support, public health interventions, anti-poverty initiatives, and an infinity of other such enterprises.

For example, the Institute for Community Innovation at Florida International University emphasizes the viability of community-based organizations such as art groups in the South Florida area, but it also has an international reach. One project focuses on rural economic development in the agricultural sector of Central America (Institute for Community Innovation, ND). Elsewhere, the Sustainable Community Grants program, a partnership of the Southern Region Sustainable Agriculture Research and Education (SARE) Program and the Southern Rural Development Center (SRDC), provides grants for projects that connect agriculture, industries, local or regional economic development, and sustainable agricultural practices (Southern SARE and SRDC, 2005). Some suggested projects include those that foster local leadership capability, public-private partnerships, and entrepreneurship. The significance for this chapter is that community innovation is a concept filled with whatever meaning potential innovators want to put in it; there is no consensus as to its content, though invariably there is a positive connotation. Initiatives are meant to create some improvement in their locales. Since all the literatures at issue here are profoundly vexed, it seems reasonable to place attention on innovations that hold both illustrative and instructional value.

19.2.4 Innovating in Communities

Given Peacock et al.'s formulation, the characteristics of community can be opposed to the characteristics of social relationships that are required for innovative action. For example, Comfort (1999) has highlighted the importance of a sense of shared risk in order for communities to be able to organize to minimize the risk. Yet, if the risks are differentially distributed across the terrain of the community, then mobilizing attention and resources is likely to be more difficult. Moreover, differential distribution may result in disparities in risk perception, which in turn may weaken community will or present barriers to decisive action.

Of course, many of the conflicts that Peacock and his colleagues identified are very deeply rooted in systems of production, of economic exchange, or in the debilitating persistence of racism or sexism. The difficulty of communities

to deal with problems that crystallize locally but whose ingredients swirl in the social mix nationally or even globally is well-documented (e.g., Patterson, 2002). In particular, the most profound social vulnerabilities – those rooted in macro-structural systems of organization – often equate to the most serious risks (Wisner et al., 2003). Thus public officials are, in their effort to reduce risk, compelled to try to take account of vulnerability as well. Reducing such vulnerability is sometimes possible at the local level, though the root causes are in conditions usually far beyond the power of local officials to affect.

The significance of Peacock et al.'s conception of community, though, is that "communities" do not innovate; individuals, groups, and organizations innovate. These might be government agencies, non-governmental organizations (NGO), citizen groups, pressure groups, or other collectives. And this means that it is appropriate to look at community innovation from an organizational perspective, because communities, fractured and schismed as they are in the sociopolitical ecology model, are conglomerates of organizations, whether acting individually or working together. *Community innovation*, therefore, takes place as *innovation in communities*.

Much of the job of public officials, as a consequence, is to try to bring about the processes of coordination that Comfort outlines while functioning in the environment that Peacock et al. (2000) have described. Peacock et al.'s conception is of the conditions that *exist* in a certain time, and Comfort's analysis shows what *ought to exist* in order to identify goals that the community as a whole can work toward. Given the differences in what *is* versus what *ought to be*, some aspects of the social organization of the community may have to be changed, on at least some functional level, in order to be aligned with the capacities that Comfort has outlined. Innovation and change, however understood, are necessary in this effort; in other words, innovative thinking and organizational arrangements are needed for innovative action.

19.2.5 Innovation Across the Disaster Phases

Disaster scholars and emergency managers customarily divide the concept of disaster into four phases: mitigation, preparedness, response, and recovery. Some argue that this is not the most conceptually sound breakdown (Neal, 1997) and, more recently, concern about national security has yielded an additional stage of the disaster cycle: prevention. Borrowing from a division of the disaster timeframe used by Quarantelli (1980) in a different sort of study, we find it useful in discussing innovation to divide the disaster timeframe into three phases: pre-impact, trans-impact, and post-impact.

The time that is available for innovating is perhaps the single greatest difference in the nature of innovation across the disaster phases. In the pre-impact phase, there is time for weighing options, considering different strategies for reducing disaster, and evaluating and adjusting new methods or techniques as their effects are observed. Sometimes these can include more modest programmatic efforts, but often these are large-scale, policy-level shifts intended to change people's perception of risk or risk-reducing action that they can take, or to actually change the way people understand and interact with the natural environment. Innovations in the trans-impact phase (immediately before, during, and after impact) include not just those that are policy-oriented but also operationally-oriented, made under great time pressure and are sometimes more appropriately referred to as certain forms of improvisations (see Kendra & Wachtendorf, 2004, 2016; Wachtendorf, 2004; Wachtendorf & Kendra, 2005). The post-impact phase, early and long-term recovery, also includes operationally-oriented innovations but may additionally include innovative approaches for handling some of the difficult decisions to be made during this phase, such as whether or how to rebuild damaged areas. In the next section, we consider innovations in these three phases, but

recognize that the boundaries between them are not distinct – that they may blend into each other at different times.

19.2.6 Pre-Impact

Most conceptions of hazard are now gathered around the premise that hazards do not exist as "things" by themselves or only as forces of nature. Rather, the idea of hazard includes, to a large extent, the choices that people make, especially in terms of where they live. Understanding those choices, particularly from the cognitive dimension, was the motivation behind much of the early hazards research (White, 1973). During the mitigation phase, public officials, emergency planners, and the community in general must *imagine* the threat they are facing. Even if it is one that has transpired before, memories of such events are often short.

Later work (e.g., Hewitt, 1983) argued that the "choices" people make were often not real choices, but were the narrowed options resulting from social, economic, and political marginalization. From these research directions, however, emerged an understanding of hazard as a mismatch of social, natural, and technological systems (Mitchell, 1990). Human activities, particularly with respect to land for settlement, clash with the climatic or geophysical forces of certain places. Mitigation then can take either or both of two directions: to modify the natural environment to redirect or contain the earth's processes, or to modify the human uses of space that are incompatible with the natural events that occur there. Examples of the former, termed structural mitigation, include such engineered systems as dams and levees but might also include more personalized devices such as home lightning rods. Non-structural mitigation involves redirecting human uses, such as keeping development out of hazardous areas through land-use regulations, bracing furniture to walls in earthquake prone areas, or education and information campaigns to alert people to local dangers (Verchick, 2010). Many of the non-structural and innovative mitigation solutions can also improve development, and also improve overall health outcomes. Environmental pollution and unsustainable fuel reliance systems have severe impacts on human health, thus green mitigation intersects with human and environmental well-being (DeYoung, 2016). In a sense, viewing global warming as both a human cause *and* a human consequence is an innovative solution for inducing behavior change in the form of introducing new systems for extracting fuel and developing land.

As Cannon (1994) stated, mitigation is too often hazard-centered rather than people-centered. Because disasters are tied to social processes, strategies that aim to reduce disaster vulnerability must pay attention to vulnerabilities in both the built and the social environment. Among scholars and emergency managers, structural mitigation has fallen out of favor as a principal strategy. White's (1973) early work showed that flood losses continued to increase even after the establishment of an elaborate flood management system on the western rivers. Development simply increased, placing more life and property at risk and, as the 1993 Midwest floods and the 1997 Red River Flood revealed, very extreme events can surpass the design parameters of such vast systems and lead to even greater flood losses. Thus, while the spectrum of mitigation strategies includes a mix of both structural and non-structural programs, the preferred emphasis is now more toward non-structural methods. Given the understanding of hazard as a mismatch of human-environment relations, non-structural mitigation requires adjusting human action. This involves, from the perspective of the hazards paradigm founded by Gilbert White, shifting people's choices away from hazard and, from the vulnerability perspective emphasized by Hewitt, ensuring the capacity of individuals, groups and communities to understand and minimize the risks of decisions, especially with respect to location and land-use.

The fundamental requirement of hazards mitigation - moving people away from areas that threaten particular land uses or, when those uses are urgent enough to merit tolerating some risk,

to promote awareness and foster protective measures - are straightforward in concept but surpassingly difficult to achieve in practice. Indeed, disaster scholars often regard localities' failure to move people away from hazard as a principal shortcoming of local mitigation strategies. Yet the challenge should not be understated. For the prelude to Hurricane Katrina, several hundred thousand residents did, indeed, depart from a hazardous location. Their departure – for the short- or long-term – has provoked multiple economic crises in the host areas, amounting to a serious national problem. Land-use is inextricably connected to social and economic patterns. Adjusting land use decision-making or adjusting other behaviors that bear on risk in communities requires modifying how people perceive the character of their environments and the potential danger they might be exposed to. This often necessitates helping people to see their environment in new ways, and to do new things. In short, it requires innovation, at all levels of community life, to enact the social changes that are reflected in different land uses or different organizational relationships that can increase the overall capability of various members to mitigate the impacts of various hazards.

An example of such a program directed at sustained change in human-environment relations was Project Impact (PI). This initiative, introduced by the Federal Emergency Management Agency (FEMA) in 1997 under the Clinton administration, provided seed money to local communities in the broad area of funding disaster mitigation and building disaster resistance. In addition to fundamental efforts to facilitate local adoption of hard mitigation projects, the initiative – where most successfully implemented – was a large-scale programmatic effort to effect the alignment of community social organization with the capacities needed for change. The program began with just 7 pilot communities, each eligible for up to $1 million in "seed money," though ultimately some 250 communities participated. The Disaster Research Center (DRC) at the University of Delaware completed a multi-year evaluation of Project Impact, concluding that many communities were successful in elevating local awareness of hazards and their willingness to implement mitigation measures (see Wachtendorf, Connell, & Tierney, 2002).

Project Impact stressed education, outreach, partnership building, and a sustained emphasis on measures that individuals as well as government could take to reduce their risk. Part of the emphasis was first to identify and publicize risks in the community. Certainly, leveraging financial resources within the community toward mitigation efforts was a central component to the initiative, but it also involved (though not explicitly expressed as such) leveraging of awareness to create shared identities of mutual exposure that could cut across the various group boundaries established by the ongoing competitions that normally exist among community groups. After the hazard was identified it was publicized through brochures, public service announcements and advertisements, educational programs in the schools, and even through direct communication, such as door-to-door public awareness campaigns by local scout troops or other organizations. Outreach materials were added as inserts in pay stubs and electric bills, handed out at sporting events through partnerships with NASCAR, and disaster expos.

Although implemented to varying degrees of success across the country, effective communities attempted to transcend conflict between its constituents by emphasizing shared risk. PI coordinators made explicit efforts to build alliances, especially between the public and private sector. These could take the form of bi-directional relationships between the PI office and business, public agencies, or community based-groups, or could involve multi-directional relationships among and between several organizations or businesses at the same time – for example, through the involvement of the local Chamber of Commerce or other consortiums of organizations. Some PI communities were able to build upon mutual interests between departments, developing innovative approaches to achieve common goals. For example, one community identified ways to leverage funds from environmental groups, leisure groups, a parks department, a planning department, and

emergency management to buy out flood-prone property and develop green space for recreational use.

The programs that were initiated under Project Impact were not necessarily, in themselves, new ideas. They were often the kinds of ground-level efforts that most disaster researchers have come to believe are important in community-level mitigation, and they often did not differ from other kinds of community development initiatives. Education, building partnerships across government agencies and the public and private sectors, and developing programs to fund various projects or to encourage people to take self-help measures are not new. And, taken as a class, these activities were not necessarily new in these communities, either. Public-private partnerships have previously tackled other kinds of public problems. The use of other trappings of Project Impact - such as mascots, advertisements, school education programs – had been done before. But all these aforementioned initiatives were deployed in new ways, for new purposes, and their ambition was to foster new thinking within the community, among the people who lived there. By shifting mitigation from a top-down initiative (for example, through structural engineers and other stakeholders carrying out mitigation) to a more bottom-up approach, this shift in who has agency over mitigation was innovative. In other words, the various initiatives under PI marked real departures from customary ways of regarding and using the natural environment, and from established norms of individual, group, and organizational relationships. Some local PI communities made commendable strides in fostering what they called a synergy on mitigation issues. Leadership spearheading mitigation initiatives were found to be key in the process and sustainability of community efforts (Wachtendorf, Connell, & Tierney, 2002). This aligns with classic innovation research that indicates the critical role of knowledge brokers for effective innovation diffusion (Cillo, 2005; Hargadon, 2002: Zook, 2004). Clearly there is an interpersonal aspect to innovation that cannot be overlooked. Mulgan (2007) also indicates that relationships can facilitate or serve as barriers in social innovation.

19.2.7 Trans-Impact

In this chapter we have adopted a fairly broad definition of innovation, essentially referring to any new and creative program, procedure, or technique that a community implements to meet the demands of their environment. In the period before a disaster, this demand is registered as a sense of risk—the belief that some aspect of the community's condition is dangerous and needs to be addressed. The change, following Amabile's (1997) definition of creativity or Daft's (2004) specifically relating to both innovation or change, does not have to be totally new, never seen anywhere before. It only has to be something that is new to the community.

Response involves "Actions taken immediately before, during, or directly after an emergency occurs, to save lives, minimize damage to property, and enhance the effectiveness of recovery" (Godschalk, 1991, p. 136). This phase of the emergency management cycle puts a premium on timely action. The temporal scale for mitigation and preparedness spans months or even years. In response, minutes or hours is the more likely span for innovating, as emergency managers assess the situation and adapt plans for the general disaster envisioned in advance to the specific disaster unfolding before them. Or, as might also happen, they must develop plans for contingencies not imagined at all. Responding to disaster is likely to yield innovative techniques or procedures that are new to those people, but given the urgency of time they are likely to also be, more accurately, *improvisations, or* combinations of new and existing knowledge made in real time (Weick, 1998). One may be tempted to say that large complex disasters generate more improvisations than smaller events, but lesser events require improvisation, too. In fact, Tierney (2002) argues that if an event does not require improvisation, it is not a disaster, so that improvisation is actually a distinguishing feature

of disaster. Wachtendorf (2004) and Wachtendorf and Kendra (2005) have identified several types of improvisational actions, based on the extent to which structures, activities, resources, or tasks serve as substitutes for a missing capability (reproductive improvisation), adapt an existing capability (adaptive improvisation), or create a capability that had not existed before (creative improvisation). We note here that discussion of innovation and improvisation brings us into potentially confusing questions of scale and the boundary between what is established or old, and therefore, not innovative, and what is new and thus innovative. New York City's effort to reconstitute its Emergency Operations Center (EOC) following the September 11, 2005 terrorist attacks serves as an example of *reproductive improvisation.* After the original EOC was destroyed as a result of the attacks, it was reproduced within days at a cruise ship facility on the Hudson River. In this sense the EOC as an organizational structure, as an emergency management function, and as a place (Perry, 1991) was not an innovation, though the original might have included innovative equipment and, indeed, the new facility required considerable innovation in its equipment and operations (see Kendra & Wachtendorf, 2003a, 2003b). The September 11 attacks on the World Trade Center did, however, yield many innovations in technologies, organizations, and strategies for accomplishing multiple response-related needs. One such *creative improvisation* strategy was the emergent waterborne evacuation of several hundred thousand commuters and others from Lower Manhattan using a wide range of vessels not previously involved in any evacuation planning efforts or schema (Kendra and Wachtendorf, 2016). After the attack, residents and workers from Lower Manhattan fled, mostly by foot, in all directions —uptown, or over the Brooklyn Bridge, or south. Those fleeing south were halted at the waterfront. Even before the towers collapsed some ferries turned around with their passengers, while others returned to pick up their regular clientele. Simultaneously, tugs and other craft moved toward Manhattan. Some vessels asked and waited for permission from the Coast Guard, but others acted on their own.

The waterborne evacuation was an unplanned use of resources. Although segments of existing crisis management plans were available for some participants (the United States Coast Guard (USCG) had contingency plans for a water parade in 2000), most participants were unaware of this or any other contingency planning. In fact, significant dimensions of the operation were developed in the earliest stages of the response, as when the USCG and local harbor pilots developed a traffic management plan for vessels around the tip of Manhattan. At the same time, many participants reported no external direction for their actions (Kendra, Wachtendorf, & Quarantelli, 2003; Kendra & Wachtendorf, 2016). Hence, this effort was not merely innovative; it was collectively innovative in the part of the harbor community, with a set of goals, norms, and procedures that emerged across a large number of participants. Over the course of a few hours, a shore-side system of directing evacuees to particular locations developed, buses deployed to bring evacuees to marshaling points, and decontamination strategies materialized at points of disembarkation. No one activity was particularly innovative, but the "collective induction of new meaning" (Weick et al., 2005) that manifested itself brought about an innovative solution to the closure of tunnels and bridges for anything but foot traffic, during an unfolding crisis, around an island. Shared collective identity (based on Weick, 1995), shared knowledge (as in Comfort, 1999), recognizing the limits of knowledge, and reworking norms according to an emerging ethos appear to be significant features of how this transpired (Kendra & Wachtendorf, 2016).

19.2.8 Post-Impact

During the mitigation phase, public officials, emergency planners, and the community in general must *imagine* the threat they are facing. Even if it is one that has transpired before,

memories of such events are often short. Innovation during the recovery stage tends to encounter conditions of support, and resistance that are similar to those seen in the mitigation phase. The issue in this phase is one of perceived risk, and in trying to foster the sense of shared risk that Comfort argues is urgent for community action, public officials are often engaged in what Gioia and Chittepedi (1991) have termed "sensegiving," imparting a comprehension of events that should inform the actions of others. As community consensus, fleeting though it may be, emerges after impact, it is possible to see processes of sense*making* (Weick, et al., 2005; Kendra & Wachtendorf, 2016) as multiple individuals and organizations read changing events through their congruent identities that foster similar interpretations and sets of possible actions. Innovations, many of them tactically oriented, appear at a rapid pace. But as has been seen after all disasters – and especially after technological disasters (Marshall et al., 2003) – previous divisions and lines of conflict re-emerge. The therapeutic community (Barton, 1969) gives way to the previous order as groups compete not just for resources, but also for legitimacy and hence for a voice in the recovery. In terms of innovation, this phase looks something like the mitigation phase: politically charged and contentious, especially in places in which the political climate is unstable and rapidly changing. Indeed, since ideally the recovery phase should include mitigation, this is not totally surprising. But, while preparedness and response are devoted to crisis, mitigation and recovery are devoted to a vision of what the community should look like. Such visions are never achieved collectively without struggle. The debates in New York City regarding the appropriate use of the former World Trade Center site (which took place in earnest for over a decade and, particularly as it relates to the storage of remains, continues) – or Ground Zero – epitomize the way competing interests can clash regarding appropriate recovery strategies. Whether or not office space should be part of the rebuilding plans, whether or not the footprints of the towers should remain relatively untouched, the aesthetics of site buildings, and the proper way to memorialize the site and those who died there, were all heatedly debated.

There are examples, however, of successful recovery innovations. One such short-term recovery approach was undertaken by the City of Santa Cruz, California after the 1989 Loma Prieta earthquake. The city suffered widespread damage to both structures and infrastructure, but also damage to its downtown business district. Faced with the need to both reestablish commerce for local businesses in the short-term, at first in response to business closures and later in reaction to customer leakage, the city countered the leakage trend by establishing pavilion tents to temporarily house dislocated businesses. Added support from labor unions and Vision Santa Cruz – a downtown recovery group with representatives from the private and public sector, as well as the community at large – was instrumental in the pavilion's quick construction and overwhelming success. Indeed, the pavilions allowed businesses to take advantage of important holiday season sales. Respondents reported a synergy and market-like or "festive" atmosphere in tent pavilions. Santa Cruz engaged in numerous promotional activities to attract customers to the city and to rebuild community spirit, including a promotional Christmas rally and a "Shake, Rattle and Roll" celebration. Customer attrition was a phenomenon that proved difficult but not impossible to reverse due to the innovative recovery approaches of the community. As we have seen in other sections, the innovations implemented in Santa Cruz are not necessarily new in their concept. The creation of temporary locations for businesses was not unique to this community. What was innovative, however, was the festive atmosphere created through the way those temporary locations were constructed and promoted in this particular community. This kind of innovation may be particularly beneficial not only for recovery of the local economy, but also for the psychological sense of recovery in the population impacted by the earthquake (Ekanayake et al., 2013).

The emergence of Tangshan, China as an economic center displays a number of large-scale

innovative aspects. The city was nearly completely destroyed by an earthquake in 1976, but Mitchell (2004) notes a number of new initiatives incorporated into the rebuilt city. For example, considerable care was devoted to the long-term treatment of people with very severe injuries, including psychological treatment, vocational readjustment, and social reintegration. This latter point includes marriage and new family life, but also having the survivors help to preserve memories of the event through writing about it and working with youth groups. The city has established a museum for the event with displays highlighting the recovery and growth since then, and implemented a number of mitigation and preparedness initiatives - a seismic monitoring system; projects considering the significance of water level and animal behavior; trained civilian observers; and anti-seismic construction techniques (Mitchell, 2004, p. 4–6).

Another example of innovation from China includes the process of bridging devastated and non-impacted communities following the 2008 Wenchuan China earthquake. The devastated areas were divided into districts and matched with distinct localities across the country to provide recovery support, including in-kind personnel and expertise (Lee, 2008). The strategy distributed the burden of support across China. Although top-down in its implementation, the partnership was an innovative way of establishing connection and responsibility between communities.

Innovation is important in communities' effort to be less vulnerable or more resilient. Consider an example of community innovation following the Indian Ocean tsunami. A community education and development group, Disaster Mitigation Institute (DMI), worked closely with a number of communities in the weeks following the disaster. From their perspective, vulnerability to hazard was a development issue. Homes were destroyed that were not insured; boats, motors, and fishing equipment were destroyed that were not insured; and moreover, some fishers had outstanding loans on boats that were now gone. Given that the government assistance package included loans (albeit low-interest) for replacement equipment, deepening debt was the likely prospect. Even setting aside the serious vulnerability inherent in living in coastal living, economic vulnerability was deeply implicated in this disaster, largely through reliance on a single industry.

DMI's approach was to broaden the economic base, by building the earning capacity of women. Many women had worked in small manufacturing or other jobs; capitalizing on these existing skills would strengthen the community's capacity. Diversifying resources is a key element of resilience because it promotes redundancy, a vital component of resilience (see Kendra & Wachtendorf, 2003a; Bruneau et al., 2003). At the same time, it decreases vulnerability. And in communities with a strong patriarchal social structure, involving women is a compelling social innovation as well, bringing their skills into the resource mix. Though perhaps the monetary sums are small, the magnitude of change in social relationships may be quite large if the communities follow through.

19.3 Facilitating and Obstructing Innovation

Damanpour and Gopalakrishan (1998, p. 4) argue that, "Innovation adoption is a means of changing the organization to facilitate the adaptation to changing environments in order to sustain or increase organizational effectiveness." External requirements often spur innovation; these relate to the survival or viability of the organization and are generally tied to some aspect of competitiveness, including such metrics as profit or market share or more hard-to-measure but still important features as reputation. Some sort of a perceived need is generally, as depicted in most research, a principal requirement for innovation in an organization. Of course, in the corporate realm, the need generally relates to productivity or profit requirements, either in an absolute sense – the company is falling behind in profit or market-share – or relative, in terms of how the organization's performance is measured against expectations of major constituents, such

as shareholders. In this sense, the need for innovation is really a response to preserving or enhancing competitive stature. While competitiveness itself is a troubled term, as Schoenberger (1998) noted, and few companies can define what is competitive enough, most commercial organizations have a sense of competitiveness tied to their prosperity and even survival.

Public organizations do not face exactly the same competitiveness demands. Their role is generally to provide a service and thus they do not have to show a profit and, except in spheres of activity that are being privatized (prisons, package delivery) they rarely face an open market of potential competitors. This does not mean, though, that they do not face demanding stakeholders or that efficiency and effectiveness are of no consequence. Maintaining legitimacy and the public trust are the public sector analogs of competitiveness and are often the reasons for the adoption of new equipment or procedures. Having the latest technology in an emergency management office, for example, conveys the image of preparedness and competence that emergency managers' desire.

In a broad way, researchers group the factors that bear on innovation into those that are either internal to the organization or external to it (Levi & Lawn, 1993). Internal characteristics relate to the structure of the organization or to the size and composition of the workforce. External factors are those relating to the organization's environment, especially competitive pressures. This general categorization is reflected in Daft's (2004, p. 404–406) assessment of five required elements of change: *"novel ideas"*; *recognition of need*; *adoption; implementation;* and *resources* (of people, skill, and money). Of these, *need* is probably most associated with externally-oriented demands and may dominate other considerations; ideas, according to Daft, may be either internal or external to an organization. Forces spurring the adoption of innovations are generally, though not exclusively, external to the organization; forces impeding innovation tend to be, though are not always, internal to an organization. Levi and Lawn (1993) found that firms are generally more alert to external factors but are less attentive to internal forces that can hinder innovation. Daft (2004, p. 426) outlined a number of potential impediments, including e*xcessive focus on cost*; *failure to perceive benefits*; *lack of coordination and cooperation*; *uncertainty avoidance*; and *fear of loss*. These factors are based on research on organizations; however, similar factors are evident at the larger community scale. These various elements of change and of potential obstruction are not precisely opposites of each other, but they share some opposing characteristics. For example, when resources are plentiful, or needs are more easily recognized, there may be less concern about cost. At the same time, some elements are clearly related to and affect each other. If perceived benefits are low, costs may seem too great. In this next section, we discuss principal elements of innovation facilitation and obstruction in the context of communities.

19.3.1 Recognition of Need

Successful mitigation initiatives, for example, require a reconstitution of a population's environmental perception, but if the hazard has not been presented as a disaster, then those who advocate mitigation strategies are arguing about, essentially, a phantom menace, which a few recognize but which must be evident to others. When a disaster has occurred in a community, the lingering risk and hazard has been laid bare for the citizens. Often, the need is not as obvious to all stakeholders or, even if they are aware of the threat, they may not know what can be done about it. Innovation always requires a recognition of need, but that recognition may not always exist, especially across the various stakeholder groups in a community. And here we include public officials and government as stakeholders. For example, the need to develop innovative approaches to warning and evacuating a migrant segment of a city's population may be recognized by those in that particular community, while at the same time the need may not be recognized by public officials, those with a greater access to decision-making power, or

other communities of individuals not exposed to the same risk, even if the heightened vulnerability contributes to the city's overall vulnerability. What makes community innovation particularly challenging compared to organizational innovation is that individuals can be a part of multiple communities, each with different interests, priorities, abilities to mobilize others, and degrees of access to power.

A need must be both identified and clearly communicated. While some conception of need is always required for innovation, even those who understand the need are generally not able to implement innovations single-handedly. Rather, what is often required are persons who can build a constituency; a (growing) group of people who share that perception of a situation that change is needed. Daft (2004) refers to these people as *champions* - those who take on the job of fostering change in technology, procedures, or organizational structures.

In the mitigation or preparedness phases, the emergency manager virtually by definition is required to champion community change in the direction of reducing risk. The emergency manager's job is to identify the existing "need" - the sources of potential emergencies that remain in the community (or communities) and to develop programs to reduce them. This is, often, a highly evangelical activity, in which the emergency manager must continually work to make the community aware of lingering risks and what can be done about them. Other ideal champions include citizens who are members of community-based organizations who have a keen relationship with their constituents, private sector leaders who have a visible role in the community, or members of environmental advocacy groups, which often focus their attention on hazards (particularly industrial hazards). In some cases, a champion may be appointed, but often a champion emerges, someone who perceives a need and is inspired and inspiring to others. Lois Gibbs, who founded the Love Canal Homeowners' Association, was one such champion who emerged following discovery of toxic waste leaks at Love Canal and who campaigned for financial assistance for nearby homeowners.

Groups who are not traditionally emergency response organizations can make a substantial contribution to the development of innovative emergency management approaches within the community. For example, some non-governmental organizations are better able to act as watchdogs and enact political pressure on governments and the private sector; some groups adopt a neutral stance and run education campaigns; still others are successful in attracting funding from sponsoring agencies. For example, after the 2015 Nepal earthquake a many health INGO's and Nepalese-based NGO's were able to obtain a substantial amount of funding from donors after the earthquake. This group then use funds not only for mitigation but for long-term activities that make communities healthier and more resilient (Penta et al., 2016). Even more interesting, the boost in funding could propel these groups into a new capacity level for raising awareness and meeting needs for urgent issues such as mental health, which is more heavily stigmatized in the Nepali context (Seale-Feldman & Updahaya, 2015). Just as non-governmental organizations vary in their functions, perspectives, and what they can achieve, so too do public and private sector organizations differ from each other and from groups within the same sector. By bringing together organizations that can offer a variety of resources, ideas, perspectives, and sources of knowledge, the collaboration can result in innovative broad-based mitigation strategies that could not be achieved if one sector or group were to work in isolation.

Again, the activities in some Project Impact communities provide excellent examples. The most successful Project Impact initiatives at the local level included not only traditional disaster planning partners, but brought to the table leaders of such groups as senior citizen organizations, those organizations that work with people with disabilities or with immigrant communities, and organizations such as Habitat for Humanity, the Boy Scouts, the Sierra Club, the Humane Society, and Neighborhood Watch. These are just a few examples of the types of groups that provided a clearer understanding of the needs of different segments of the populations but that

also had their own resources, skills, and expertise to add to the tool chest of the community's capacity.

19.3.2 Excessive Focus on Costs

Costs are usually mentioned among the challenges impeding innovation and available financing is so often a limit to action that it hardly seems necessary to mention. Nearly the entire hazards field is devoted to assessing risk; communicating risk; and persuading or forcing people to take steps to avoid risk. Expenses are generally cited as impediments to the adoption of new strategies for reducing hazards in a place. For example, acquiring land in a floodplain is one way that communities have been able to lessen hazards, by simply not allowing dwellings to remain in flood-prone areas. There are, however, a number of financial implications to consider in such a strategy. Platt (1996, p. 333–335) noted several, such as initial purchase prices or loss of tax revenue when property becomes publicly-owned.

The post-disaster period is often described as a "window of opportunity" in which a community, alerted to the particular dangers of its setting, might try to mitigate some of the hazards that are prevalent there (Birkland, 2006). Mitigation grants that are included in association with a Federal disaster declaration can help communities lessen their risk, and communities are now required to have mitigation plans (Schwab, 2010). In this sense, innovation is mandatory after a disaster, and moreover, *thinking about innovation* has to occur before disaster strikes. Of course, Project Impact also showed that some innovative steps do not have to cost money, or may require only relatively small sums of public funds or can be supplemented through donations or other sources. Classes on hurricane-proofing one's home, taught at a hardware or building-supplies store, require just a bit of goodwill from the company (which will benefit when people purchase their materials there). While financial considerations undeniably present limits on what a community can accomplish, an excessive focus on cost can stifle the imaginative consideration of novel approaches for which funding from novel sources can later be acquired (Simmons, Kruse, & Smith, 2002; Simmons & Sutter, 2011). Indeed, sometimes imagination and merely a willingness to start somewhere are key attributes in launching new risk-reducing initiatives.

19.3.3 Avoiding Uncertainty and Fear of Loss

In the community context, avoiding uncertainty and fear of loss are related to longstanding social and cultural norms and expectations. Ownership of property is a cherished principle of liberty in the United States, and ownership of land and homes is a principal means of securing wealth, especially for intergenerational transfer, at several income strata. Buy-out programs provide an example of cultural challenges, confronting residents both with uncertainties and the loss of cherished community patterns. Some are undertaken via the eminent domain power, but those that are sponsored under the Federal Emergency Management Agency (FEMA) post-disaster Hazard Mitigation Grant Program must be voluntary; FEMA will not extend the program to facilitate the exercise of eminent domain. As a consequence, public officials must engage in a substantial process of persuasion and negotiation. Even so, some homeowners occasionally hold out. The town of Valmeyer, Illinois, for example, voted to move away from the floodplain. Mitigation funds through FEMA enabled the buy-out of properties. However, some landowners resisted the program, criticizing the sums offered them for their properties. The strength of that attachment is often underestimated. Indeed, the symbolic value of property is a strong determinant in decisions to remain in hazardous areas for homeowners as well as those with a more fragile hold on physical place. Veness (1993) found that "homeless" people become very attached to their dwellings, however rudimentary, and find moving to be quite personally disruptive regardless of the paucity of their possessions. This has also

been found to be true in the context of sense of place for both disaster relocation (Cox & Perry, 2011) and preparedness (DeYoung & Peters, 2016). Therefore, the ability to implement innovative strategies requires confronting existing social norms and may demand further innovations that allow for more appropriate, or accepted, solutions.

There is an extreme and very politically charged cultural element of resistance to change and the uncertainly that change brings. Other elements might lie in certain expectations of who is responsible for disaster management—a belief that "the government" is both responsible for and able to provide a complete restoration of community life. This is always impossible. Indeed, counteracting a persistent sense that a higher level of government will continually provide assistance has become a project in policy-oriented hazards research. Scholars such as Platt (1999), Mileti (1999), and Cutter (2001) have argued that local communities have become far too dependent on Federal disaster assistance and should take on more responsibility for lessening the hazards. From this perspective, local communities are the principal sites for identifying the climatological, geophysical, or industrial hazard agents and ensuring that human activities take these into account. What these researchers are calling for is essentially a large-scale social change, a shift in *national* disaster policy to be realized at the *local* level and involving a sizable shift of expectations and substantial new norms of accountability. To the extent that communities have not attended to their local circumstances, innovation will be necessary.

The discussion of innovation adoption and implementation extends internationally. Several initiatives proposed following the Indian Ocean tsunami are likely to be extremely difficult to implement. Both India and Sri Lanka governments announced an intention to enforce existing regulations that prohibit construction in the coastal zone or to establish new ones. These regulations were originally intended both for hazard mitigation and as conservation measures, but they will now conflict with the post-tsunami recovery ambitions of dozens of coastal communities. These residents desire reconstruction of their communities in their existing locations, even though such reconstruction will reproduce the locational component of their overall vulnerability. At the heart of their vision is the maintenance of long-established patterns of community life, closely associated with fishing and proximity to the water. There is thus the potential for two competing goods: reducing vulnerability to hazard and preserving traditional practices. Clearly, innovative thinking will be required, though it is not clear what direction that might take.

The fundamental conflict transcends international boundaries: What changes should communities make in order to lessen their risk, and what degree of change should communities be expected to make so that they don't require assistance from other communities or from larger scales of social organization? What is the acceptable risk? In Valmeyer, much of the community moved, and there was significant transformation of community life. In India and Sri Lanka, there would also be significant upheaval. There, however, the recurrence interval will probably be much longer than that of floods in Valmeyer, though without warning systems the danger to life is greater. Balancing the economic advantages of a place, the desirability of preserving established rhythms of social life, and reducing hazard are difficult in any setting. Concerted community action will require a consensus on the acceptable collective risk of living there. At a minimum, in areas impacted by the tsunami, mitigation should begin with a new awareness of the environment, and it is likely that large-scale social changes will be required to lessen the risk of future such events. Innovations do not always lead to positive changes for a community, or certain segments of a community. The uncertainty of whether or not those new approaches or large-scale social changes will better or worsen community life can work to impede any innovation at all.

19.4 Conclusions and Future Research

The act or process of collective innovation would seem to be a useful line of inquiry. Virtually from the founding of the hazards field, in the human ecological tradition, the emphasis was on understanding how communities got themselves into trouble and suggesting what had to be done about it. These suggestions were for innovations – changes in how communities understood and acted in their natural surroundings. Yet the dynamics of human-environment interactions, in the US and worldwide, have hardly been static. The world's population has increased dramatically; economies have grown and faltered; new dependencies have emerged; new needs have evolved; and resources of energy and space have been strained. Innovation is needed to meet change but it also sparks the need for innovation elsewhere. Innovation in the entire disaster milieu is rarely, maybe never, carried out by a single person. Even when one person has a flash of creative insight, other people modify it during implementation. In our research on the interorganizational response to the World Trade Center, we encountered several officials who each claimed to have initiated a particular action. Were all but one of them wrong? Maybe. But maybe they were *all right*, so that collective innovation can emerge from multiple individual thoughts directed toward a shared goal. Research taking this approach would then come into view of the growing body of work on sensemaking, thereby contributing to several fields and advancing our understanding of the collective innovation process.

In this chapter we have taken a fairly positive stance toward innovation, emphasizing the virtues of change when confronting environmental hazard. Such a stance follows from the meaning of hazard - "a threat to people and what they value" (Harriss et al., 1978) - and the normative requirement that the situation be rectified. Yet innovations can go awry. The project of controlling flooding along the Western rivers, study of which was the subject of much of Gilbert White's (1973) work, was relatively mal-adaptive. The National Flood Insurance Program has earned criticism for encouraging settlement in dangerous areas (Platt, 1999) and for payouts for repetitively-damaged properties. Note that these were not innovations *in* communities, but innovations *for* communities, but still there were unintended negative spin-off effects. The principal challenge to innovation, even those that are salutary to begin with, is that they are set in a particular social and economic context. The context may change, faster than that which was innovative can be adjusted, so that in later years the innovation can actually become detrimental. Clearly more research is required for better anticipation, and also for understanding innovations as part of larger systems of social and economic activity.

In examining Tangshan, Mitchell (2004, p. 15) indicates that it is necessary for recovery planners "to hone their capacities for managing surprising contingencies." He further suggests (2004, p. 2) that the emphasis of recovery has changed over the last decades, "from the compassable goal of retrieving a known world that ***was***, towards the much more uncertain task of achieving a projected, predicted or imagined world that is ***yet to be***." Such a statement suggests that innovation is "squared" – that it is necessary to be able to innovate over innovations to take account of changing circumstances. Even with the apparent success of the recovery in Tangshan, Mitchell (2004) notes certain complicating factors. First, he argues that the city's recovery plan emphasized structural and economic concerns but subordinated more social needs of the community, the consideration of survivors with disabilities being, perhaps, an exception. Moreover, he suggests that an important element of successful recovery was not anticipated – the simultaneous opening and expansion of the Chinese economy. Meeting unanticipated developments will thus become a necessary capacity of officials who are managing recovery as well as those working in other disaster phases. In the case of Tangshan, shifts in circumstances were beneficial; with the National Flood Insurance Program they were not. While emergency managers have to be alert for

unexpected transformations that affect their plans, is it possible to plan for innovation? In some sense, yes. It is clearly possible to plan attempts to innovate, by setting up in advance the necessary preconditions (Daft, 2004) that facilitate the exchange of information and risk-taking, and by enacting policies that limit the conditions that stifle creativity (Amabile, 1997; Woodman, Sawyer, & Griffin, 1993).

Project Impact demonstrates something else about the effect of unexpected changes on innovation: it can be quite transient. Project Impact was dismantled at the national level by the George W. Bush administration when they assumed office, to be replaced by a competitive grant program. Just as communities are split by conflict, so too do they fit within a larger political universe where there are many different views about the proper relationship of local and national scales of economic and political activity. In certain places, Project Impact lives on among some dedicated devotees who advance its principles in their communities and have worked to institutionalize these innovations in their local practices. Of course, the flow of federal funding would not have lasted indefinitely; the program's durability in spite of the early termination of funding points even more strongly to its larger success. Nevertheless, the transience of Project Impact shows that we need ways of decoupling innovative programs from their political provenance, and we need ways of sustaining interest in initiatives over many years. In the US there is very little track record for sustained large-scale ambitions. The space program might be one example, though its fortunes, too, have been quite variable. Even innovative national initiatives related to climate change and reducing carbon emissions can come under threat with administration changes, undermining – or demanding – local innovations in such areas. Future research that examines the processes that better enable innovation in dynamic or uncertain conditions would greatly advance the field. Modern case studies, such as community innovation in coastal areas after the 2012 Japan triple disaster or – in the American context – the impact of the United States withdrawing from the December 2015 United Nations Framework Convention on Climate Change Paris Agreement on industry and state or city innovation regarding emission reduction.

Outside of the scholarship sphere, the intersection between community and innovation is often linked explicitly or implicitly to technological advances. For example, following Hurricane Sandy's impact on the eastern United States, the federal government launched the White House Innovation for Disaster Response and Recovery Initiative, a program that emphasized the potential of technological innovation to assist a wide range of stakeholders. Much of the early efforts focused on maps, apps, and data sharing (Lee et al., 2014). Greater emphasis needs to be placed on the innovative human process associated with such technologies. Indeed, Hurricane Sandy demonstrated a particularly innovative use, by the Occupy Wall Street movement, of an existing technology and practice. Occupy Wall Street was an emergent protest effort, situated primarily in New York City, developed to speak out against concentrated wealth in the United States. When Hurricane Sandy struck areas in and around New York City, the movement used its collective mobilization strategies to engage in a disaster relief effort. One innovative strategy they used was the Amazon.com wedding registry function. The existing online ordering system was one many potential donors were familiar with. Rather than soliciting material goods, donors could identify current needs and place an order on behalf of the relief effort. The technology was not an innovation, but the way the organization utilized the technology was.

Likewise, relatively recent discourse has centered on innovative uses of unmanned aerial vehicles – or done technology – in disaster response or relief efforts. Such efforts, though often top down in their development, could provide some space for communities to potentially utilize new technologies in innovative ways. Take a similar advance a few years ago. Geographic information systems (GIS) may be more closely identified with corporate or government top-down mapping efforts, but following

the 2010 Haiti earthquake, efforts emerged to, in an extremely innovative way, bring to bear the resources and technological skills of hundreds of volunteer mappers. As Soden and Palen (2014) describe, the "volunteer technology communities" (3) were able to leverage considerable innovations in social media and mapping efforts, as well as ideas of open access and participation through digital volunteerism to innovate in a more conceptual way what is today often referred to as crisis mapping. Significant dialogue had emerged around the crisis mapping concept the year prior to the earthquake, and when the disaster struck, the segment of the OpenStreepMap (OSM) community who had considered the potential for crisis response was able to mobilize additional digital volunteers whose attention was directed towards the unfolding events. Using existing databases and emerging imagery and information uploaded to social media by those on the ground, OSM was able to quickly document damage and emergent relief efforts. Even more impressive, the OSM effort gave way for a more comprehensive Humanitarian OSM Team (see Soden and Palen (2014) for a more detailed discussion of this effort). Here we see a very different conception of community – not one that is geographically or politically bounded but rather bounded by skill, expertise, and interest despite global participation. We also see how innovations outside the disaster sphere were utilized during a disaster event, both in the resources themselves but also through innovated activities and roles. Future research should explore if the boundaries of community impact the ways in which innovation occurs, as well as the shifting positive and negative consequences of various technological innovations in light of norms or values that may remain static or prove dynamic at a pace that differs from the innovation itself.

Similarly, community-based organizing was crucial for major NGO's engaging in rescue, relief, and recovery following the 2015 Nepal earthquake. For example, Kathmandu Living Labs, an organization the operated before the earthquake as development tech firm, mobilized quickly to create maps and critical information for first responders (Wolbers et al., in press). Now with the reconstruction and recovery underway in Nepal, community innovation may play also key role in the effectiveness of retrofitting and sound construction programs (Paci-Green & Pandey, 2016). Collective choice and cohesion have been important in community coordination and recovery in more recent disasters such as the 2011 earthquakes in Japan and New Zealand (Elliot, 2012).

Finally, we may need to fully reconsider what is meant by community in the context of hazards and emergency planning (Buckle, 1999). Aguirre et al. (2005) argued that such diffuse hazards as bioterrorism or cyber terrorism disrupt the accustomed scale of viewing community and that it may, for some hazards, be more useful to look at institutions that might be under threat, such as hospitals or schools. Such hazards may spread quickly and surreptitiously and appear very far from their point of origin. Increasing travel and globalized economies also disrupt socio-spatial connections. Owing to the growth of the South Asia tourist industry, European countries became stakeholders in the recovery and identification of victims following the 2004 Indian Ocean tsunami. And many of the victims of the 2001 World Trade Center attack lived in other cities; their relatives' desire for memorialization clashed with the more proximate resident's desire for a return to normal neighborhood rhythms. What is considered "community" can truly transcend physical linkages and create a demand for community innovation that mirrors the social rather than physical connectivity of its members.

It is impossible in a single chapter to account for all aspects of innovation in communities. Innovation is, as noted earlier, a vast area filled with conflicting theories on initiating and being successful at, change in various types of organizations. The purpose in this chapter, rather, was to highlight a number of points that seem relevant to community innovation for reducing risk and for responding to disaster. Money is certainly at issue, as is recognizing a need, though what "need" really means depends on the community's environment and the particular imperatives that it must respond to. A challenge facing

communities is when the need for action is a response to a threat that is distant, speculative, unlikely, or of unknown magnitude. Prior to such an event, coordination and cooperation may be impeded because all of the required participants in the change do not see the same necessity. Even with an organizational entity such as city government (itself composed of many organizational units) disagreements can erupt over interpretations of needs, possibilities, action, and consequences. Information technology has provided an example of such discord, as city agencies have clashed over software type and specifications. The possibilities for discord become even more numerous as one looks beyond local government to the diverse organizations and interests that comprise a community. Yet at the same time, organizing against disaster requires alignment of these interests, either via their direct involvement and participations or via the action of legitimate intermediaries (e.g., elected officials).

One of the greatest needs for innovative thinking is in establishing consensus, even if merely a grudging, functional agreement, across multiple community interest groups. Often such a consensus emerges upon a disaster event, as observed, for example, by Barton (1969). Many innovative strategies and uses of resources occur in the response phase whose implementation in non-disaster times would be slowed or precluded. Urgent need, which is plainly evident, overcomes most objections. This period, however, is short-lived and, moreover, though many important innovations may occur, others will prove to be maladaptive. In the urgent environment of disaster, some sub-optimum innovations are an acceptable risk, and generally everyone agrees on the need for action. Such need is much less obvious in other disaster phases, and the need is not merely for innovation, but just in establishing a sense that there is a need at all. Even then, certain irreconcilable interests may be at issue.

Innovation in communities occur at multiple scales of social activity; individual organizations in the community can be innovative, so if their innovation is realized to the benefit of the community as a bounded socio-economic and political entity, then in a sense the whole community receives the "credit" for that innovation. The reverse is also possible. Silicon Valley innovations don't make the local communities innovative, though obviously innovative and very successful people live there. A community innovation has to emerge from the same social-political ecology that creates the collective that is known as the community, from entities that are participating in that ecology. One of the principal requirements for successful innovation in communities, either before or after disaster, is coordination amongst various member groups. The waterborne evacuation of Manhattan, for example, involved public agencies such as the United States Coast Guard, commercial organizations such as the various tour boat and ferry companies, and private individuals acting together in a shared interpretation of the best interests of the city at that time. As Comfort (1999) emphasized, a sense of shared risk is essential. But as Peacock et al. (2000) argued, our communities are anything but coherent groups of like-minded people. It is an axiom in the hazards research field that hazards are "mismatches" of natural and social systems (Mitchell, 1990), but devastating events such as the Kobe earthquake, the Indian Ocean tsunami, and more recently Hurricane Katrina demonstrated all too ably that communities do not "share" the risk that natural forces and social systems combine to create. Innovations to benefit the community must transcend the fractures in community relationships at all scales; the most successful ones will be those that can re-engineer those relationships as well as their precarious interactions with the natural environment.

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Community-Based Disaster Risk Management

20

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Contents

20.1 Introduction

For too long have communities been used as inputs to the research cycle and not treated as part of the knowledge creation process (Gaillard & Gomez, 2015; Levinson, 2017). Deloria (1973) proclaimed: *"Why should we continue to provide private zoos for anthropologists?"* Deloria's critique on how research in communities is undertaken reverberates far beyond the 1970s and still strikes a peculiar nerve in the 2010s. So too is the work of Freire (2005) on building community knowledge just as relevant today as it was over four decades ago. In essence, communities remain the most important element in understanding how disaster risk and vulnerability are created and how it can be reduced because they are the ones most affected (Van Niekerk & Coetzee, 2012). Emerging from the 1980s, a shift in focus occurred in the management of disasters and also the role of communities within civil protection and disaster (risk) management. A growing realization from researchers and practitioners alike occurred that a greater understanding of the dynamics of vulnerabilities, hazardous exposure and resilience can only be gained if the knowledge creation process is seated within, and by those effected. Local knowledge and culture needs to be respected, and indigenous and scientific knowledge need not be mutually exclusive. However, limited resources, capacities and technical

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abilities hamper random and spontaneous community-based disaster risk management (CBDRM). Therefore, outside intervention is still needed in most cases.

This chapter aims to provide insight into disaster risk management with a specific emphasis on communities. CBDRM as a research and implementation tool will form the central argument. Although many and varied definition for CBDRM exists, this chapter provides a broad definition which relates to existing research and the body of knowledge on CBDRM. The various elements in CBDRM are highlighted and linkages are made between existing research methods and the CBDRM process. The chapter broadens to an international focus with a discussion of CBDRM examples from across the globe. Gender in CBDRM also enjoys particular attention, and commonalities, differences and constrains of CBDRM implementation are highlighted. However, the literature is fraught with inconsistencies in defining the most crucial element in CBDRM - community. The section to follow will briefly allude to how community can be defined within the broader scope of CBDRM.

20.2 "C" in CBDRM

It is common cause to find reference to community linked to location or relationships. These two characteristics, however, are not mutually exclusive. Even the early research by Durkheim (1964) showed that people develop a sense of community around skills and interests, more than around locality. Therefore, "community" goes far beyond a certain geographical area. Mills (2004) defines community as *"face-to-face groups residing in close proximity to each other, enabling people to have a comprehensive knowledge of each other"*. Mills emphasizes the smallness of scale and relationships which develops because of proximity. McMillan and Chavis (1986) propose four elements to community. Firstly, a community has to have *members*. Membership creates the feeling of belonging. Secondly, a community must be able to *influence*. This relates to the ability of the group to influence the individual, the individual to influence the group, and the collective being able to influence their environment. Thirdly, McMillan and Chavis (1986) believe that *integration and fulfilment of needs* are key to a community. Therefore, members' needs will be met by the application of the resources available in the group to address these needs. Lastly, they proclaim that a community "*share emotional connections*". Emphasis is much more on the connections between people than the physical space they occupy. This argument is aligned with that of Tonnies' (1925) *Gesellschaft.*[1] Shaw (2012) concurs with the definition of McMillan and Chavis by describing community as *"a feeling that members have of belonging, a feeling that members matter to one another and to the group, and a shared faith that members' needs will be met through their commitment to be together."* Therefore, community include aspects, elements and people transcending geographical boundaries. This is even more pronounced in the postmodern connected society than ever before (Lyu, 2012) where members of a community might never actually meet in person. However, within the domain of disaster risk reduction one must assume that physical location remains important. Physical location is linked to hazard exposure and vulnerability, and therefore one needs to take a more ridged stance on the definition of "community". For this chapter, the definition of McMillan and Charvis will suffice as this has also been used by Shaw (2012) in examining CBDRM. It can also include locality of individuals, and the abstract element of transcendence.

[1]Tonnies identifies two forms of social organization: *Geminschaft* (the communal cohesion of pre-industrial village life) and *Gesellschaft* (instrumental relationships formed to pursue individual goals). In the *Geminschaft* approach, community is established based on kinship or a place, and provided emotional support. *Gesellschaft* describes relational communities that have been developed based on some common interests, issues, or member characteristics.

20.3 Defining Community-Based Disaster Risk Management

CBDRM is a participatory process. Communities are actively engaged in the identification, assessment, treatment and planning for hazards and vulnerabilities of various kinds (Krummacher, 2014). The CBDRM process aims to enhance skills and capacities and to build resilience (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007). Communities are placed at the center of the research process. Such an approach aims to address local issues, challenges and problems from the perspective of those experiencing it every day. Community empowerment and ownership through, and of, the process is key. Shaw and Goda (2004) emphasize that CBDRM is culture and context specific, and therefore cannot be successfully implemented by "outsiders". In CBDRM, local knowledge and trust becomes very important. Chhoun (2016) believes that CBDRM should be based on "*total disaster (risk) management principles (from risk assessment, mitigation, preparedness, response and rehabilitation), but also in the application and adaptation of local indigenous risk-coping wisdom and knowledge into risk reduction*."

Shaw (2012) traces the early developments which lead to CBDRM to Community Based Disaster Management (CBDM) mostly made popular by the work of the Asian Disaster Preparedness Centre (ADPC) and a number of Asia-based international organizations in the 1980s to early 2000s. CBDM gradually evolved into community-based disaster risk management (CBDRM), and then to community-based disaster risk reduction (CBDRR). CBDRM and CBDRR, however, are often used as synonyms (DIPECHO, 2010; Salajegheh & Pirmoradi, 2013; Shaw, 2012; Van Niekerk & Coetzee, 2012).

CBDRM can be defined as inclusive, active and owned community driven processes aimed at addressing the drivers of disaster risk creation; disaster risk reduction; and societal resilience building within the context of local and indigenous knowledge and wisdom. CBDRM thus implies the direct and continued involvement of at-risk communities in the decision-making process of disaster risk reduction. It assumes that local and indigenous knowledge are akin to scientific knowledge and should be respected. The community becomes the drivers and custodians of knowledge creation, and work in unison with "outsiders" (i.e., International Non-governmental Organizations (INGOs), Non-governmental Organizations (NGOs), governments, and the private sector). Central to CBDRM is the notion that locally relevant solutions must be found and that these solutions are part of the sustainable community development process, implemented through a grassroots approach (Ekanayake, 1990).

20.4 Elements of CBDRM

The relevance of CBDRM is increasing due to the occurrence of disasters and hazards (Krummacher, 2014; UNDP, United Nations Development Programme, 2016). In the event of a disaster, local communities remain the first line of defense or the first responders to an incident. Research has shown (Krummacher, 2014; Shaw, 2012) that a top-down disaster risk reduction program often fails to address the needs of vulnerable and at-risk communities. Communities understand their own contexts and realities the best. Therefore, community involvement is a crucial element for the CBDRM approach. One of the key elements central to community involvement is the sustainability of community initiatives. A CBDRM approach assists in improving the likelihood of sustainability by capacitating at-risk communities through ownership in identifying and addressing their risks and vulnerabilities.

To measure the success of the CBDRM process in capacity development and to achieve sustainability in community initiatives, the UNDP (United Nations Development Programme, 2016) proposes certain elements, which will greatly benefit the CBDRM implementation process. These elements are:

- The existence of a local Disaster Risk Management Committee (DRMC) or organization;
- Community hazard, vulnerability and capacity/resources mapping;
- A community Disaster Risk Management Plan;
- Training in disaster risk management and community learning system(s);
- Regular community simulations and exercises;
- Early warning system(s); and
- A disaster risk reduction fund.

Although all of the above is not a prerequisite for CBDRM, they all go a long way in addressing issues of disaster risk in the CBDRM process.

20.4.1 The CBDRM Process

Abarquez and Murshed (2004, p. 20) state that the CBDRM process *"should lead to progressive improvements in public safety and community disaster resilience"*. They further believe that CBDRM should contribute to effective and equitable sustainable community development. Before engaging in the CBDRM process, a clear differentiation of the different stakeholders engaged in the process should be established. Although there are multiple stakeholders partaking in the CBDRM process, they are mainly divided into two categories (insiders and outsiders) (Abarquez & Murshed, 2004; Kafle & Murshed, 2006). The insiders refer to the communities and the DRMC at a local community level. The outsiders include various governments and their departments, NGOs, INGOs, and private sector role-players, amongst many other. The relationship between the actors is crucial for the effective implementation of the process in reaching the outcomes and the purpose of CBDRM.

The CBDRM process consists of seven (Abarquez & Murshed, 2004) or six (Kafle & Murshed, 2006; UNDP, United Nations Development Programme, 2016) stages. This chapter will discuss the seven-stage process to provide a more comprehensive overview. The steps in the seven-stage CBDRM process are sequential (Abarquez & Murshed, 2004; Kafle & Murshed, 2006; UNDP, United Nations Development Programme, 2016).

20.4.1.1 Stage 1: Selecting the Community

The first stage in the CBDRM process aims to identify and select the vulnerable communities. To do so, a set of a selection of criteria is proposed: the severity of the vulnerability of the community; the readiness of the community to engage in the DRM process; the availability and accessibility of the community; the number of people to benefit from the DRM process; governments' priority of socio-economic and physical vulnerabilities; the availability of resources; and a disaster risk reduction budget. These criteria will differ for each given community. Researchers can make decisions based on this given criteria, and through the use of a survey select the most suitable community for participating in the CBDRM process.

20.4.1.2 Stage 2: Rapport Building and the Understanding of the Community

Once the community is selected, the second stage will be to build a relationship with the selected community and to establish trust. A relationship build on trust will encourage the community to share their issues, concerns, challenges, ideas and solutions. To understand the selected community, a rapport should be built with the community – this is an essential component of the CBDRM process. Understanding a community's development and context include the following basic elements: the spatial characteristics (location of houses, facilities and resources like hospitals, community halls and fire stations); the vulnerability of households and their livelihoods; social groups (including race, gender, class, language and ethnicity); cultural arrangements like hierarchies; and economic activities influencing the community's livelihoods. Various actions can be performed to build trust with

the selected community. These actions can include: living amongst community members and participating in the daily tasks of the community; be a good listener that is open to change; and to learn from the local community. In performing these actions, the researcher should also keep in mind that one should always show humility, respect, patience, interest, confidence and to not be judgmental. These behavioral characteristics will ensure and establish trustworthy relationships with the selected community, which is key to the success of the CBDRM process.

20.4.1.3 Stage 3: Participatory Disaster Risk Assessment (PDRA)

PDRA is the third stage in which hazards and risks in the selected community are identified and possible measures to overcome those risks are proposed. All stakeholders, including the selected community, are actively participating in this stage of the CBDRM process to collect and analyze disaster risk information. This stage will enable the community and local authorities to plan and be better prepared for adverse events likely to impact the vulnerable community. PDRA forms the basis of the planning stage (Stage 4). The PDRA stage therefore involves the conducting of hazard, vulnerability and capacity assessments. Due to the specialized skills required, knowledgeable individuals will mainly conduct these assessments, however the involvement and active participation of the local community is key to the success of this stage. The PDRA involves a seven-step process similar to a disaster risk assessment process. These steps include: the description of hazards and risks; hazard mapping; vulnerability assessment; risk assessment; prioritization of risks; determining risk levels; and decide on strategies/scenarios for further action. PDRA is thus founded on the belief that local communities can and will help themselves and each other in the reduction and prevention of risks to build their resilience and ensure sustainability.

20.4.1.4 Stage 4: Community-Based Participatory Disaster Risk Management Planning

Abarquez and Murshed (2004, p. 60) state, *"planning begins with the desire to change existing undesirable conditions. Disaster risk management action planning starts with an aspiration for safety for the self, the family and the community"*. Both government (in the form of local authorities) and the selected community are involved in this stage, actively identifying risk reduction measures to enhance the communities' capabilities and resilience and reduce their vulnerabilities. Based on the PDRA, the local authorities and the community will be involved in translating the risk reduction measures into a disaster risk management plan. The plan will include risk reduction and transfer measures, mitigation measures, resource requirements, targets that should be reached, technical assistance and building communities' capabilities.

20.4.1.5 Stage 5: Building and Training a DRMC

In the first stage of the CBDRM process, researchers will learn if viable community organizations already exist within the community. If found that no community organization exists, stage five is an important step in the CBDRM process - to identify, establish and train a DRMC - one of the key elements mentioned above. Abarquez and Murshed (2004, p. 66) describe that the objective of the DRMC is to enable communities to be better prepared for hazardous events and improving community resilience. The establishing and training of a DRMC will thus assist in the implementation of activities as per the disaster risk management plan, and ensure that the objective of the CBDRM approach is reached.

20.4.1.6 Stage 6: Community-Managed Implementation

The sixth stage of the CBDRM process involves the implementation of the disaster risk management plan that was developed in the fourth stage of the CBDRM process. This stage is driven by the DRMC with the assistance of the local authorities. The DRMC will thus be responsible for the overall management of disaster risk reduction activities, while local authorities take the role of a facilitator, assisting the DRMC in the implementation of the disaster risk management plan. Some disaster risk tasks require technical skills and knowledge which might not be present in communities, and thus necessitates the involvement of the local authority.

20.4.1.7 Stage 7: Monitoring and Evaluation

Monitoring and evaluation is the final and challenging stage in the CBDRM (Abarquez & Murshed, 2004). Peoples' assumptions on the progress of the implementation of the disaster risk management plan must be examined and conflicts may emerge. For this reason, the stakeholders in this stage should all actively participate in the process, be open to learning from others, learn to negotiate to address the needs of all stakeholders, and be flexible to changing circumstances. This stage will assess the progress of activities, the way in which it has been conducted (monitoring), and how well these activities have reached the objectives of the disaster risk management plan (evaluation). For successful participatory monitoring and evaluation, harmony amongst all participating stakeholders is needed (Kafle & Murshed, 2006).

20.5 Research Approaches to CBDRM

Classical disaster research treats disasters as events that originate in earth and atmospheric systems (Mercer, Kelman, Lloyd, & Suchet-Pearson, 2008; Tierney, 2007), thus undermining the influence of social constructs of disasters. However, since the 1940s, disaster research has become increasingly open to social constructionist perspectives (Tierney, 2007). As a result, there has been a shift from the traditional extractive research (Mercer et al., 2008) to an emancipatory research paradigm characterized by community involvement and participation (Pelling, 2007). There is thus a move away from 'top-down' approaches to 'bottom-up' planning through community engagement (Van Niekerk & Annandale, 2013). Such an approach is driven by the realization that top–down approaches ignore local perceptions, needs, and the potential value of local resources and capacities (Zubir & Amirrol, 2011). As a result, a number of approaches under the umbrella of CBDRM have been introduced to build peoples' coping capacity with disaster risks and reducing their vulnerability, thereby developing safer and more resilient communities (Salajegheh & Pirmoradi, 2013).

CBDRM falls within a broad band of participatory techniques, which are in themselves a bundle of research techniques placing emphasis on participants producing detailed accounts using their own words, knowledge and frameworks of understanding (Chambers, 1994a; Pain & Francis, 2003). Participatory techniques are interactive and collaborative, providing meaningful research experience that promotes both learning and generates research data through a process of guided discovery (Mercer et al., 2008). In particular, action research is a robust and versatile research strategy that is used to understand complex community structures and interaction, determine various types of vulnerability, assist in community capacity building and skills transfer, ensure community participation, and allow for the strengthening of livelihoods (Van Niekerk & Van Niekerk, 2012).

20.5.1 Participatory Research

Participatory research methods are geared towards planning and conducting research with those people whose life-world and meaningful actions are under study (Bergold & Thomas, 2012). It focuses on a process of reflection and

action, carried out with, and by, local people rather than for them (Cornwall & Jewkes, 1995). Actually, participatory approaches did not originate as a methodology for research, but as a process by which communities can work towards change (Pain & Francis, 2003). The defining characteristic of participatory research is not so much the methods and techniques employed, but rather the degree of engagement of participants within and beyond the research encounter (Pain & Francis, 2003). In participatory research, all participants are involved as knowing subjects who bring their perspectives into the knowledge-production process (Bergold & Thomas, 2012). Participatory research covers a wide range of approaches and applications and this chapter only illuminates the three main approaches, namely participatory action research (PAR), rapid rural appraisal (RRA) and participatory rural appraisal (PRA).

20.5.1.1 Participatory Action Research (PAR)

Participatory action research (PAR) originates from two research approaches, namely action research and participatory research (Khanlou & Peter, 2005; Van Niekerk & Van Niekerk, 2012). In simple terms, PAR is a way of bringing participation into action research (Khanlou & Peter, 2005). The concept was introduced by Kurt Lewin (1948) as bridging theory and practice, incorporating planning, action and investigating the results of actions. PAR refers to research that engages people usually regarded as 'subjects' of research in aspects of research design and/or process (participatory), with an explicit intention of generating practical changes (Banks et al., 2013). According to Gershon, Rubin, Qureshi, Canton, and Matzner (2008), PAR recognizes that there are many ways in which knowledge can be obtained and a strong emphasis is placed on the experiences of community members (Van Niekerk & Van Niekerk, 2012). PAR can involve either quantitative, qualitative, or combined data gathering methods, depending on the issue under investigation (Khanlou & Peter, 2005). PAR is an empowering process that emphasizes collaboration and co-learning among workers and researchers, therefore it promotes knowledge generation and improvements in organizational and occupational settings (Gershon et al., 2008).

The success or failure of an action research venture often depends on what happens at the beginning of the inquiry process: in the way access is established, and on how participants and co-researchers are engaged early on (Wicks & Reason, 2009). PAR is marked by tension surrounding the simultaneous realization of the aims of participant involvement, social improvement, and knowledge production (Pain & Francis, 2003). Despite its limited use in disaster research, participatory action research (PAR) methodology is considered by Gershon et al. (2008) as an effective tool in identifying and implementing risk reduction strategies and interventions. According to Zubir and Amirrol (2011), working in partnership with at-risk communities, builds local capacity and coping mechanisms to reduce disaster risks and respond to disasters if the occur. As these community-based activities are deeply rooted in the society and culture of an area, they enable people to express their world-views, real needs and priorities, allowing problems to be defined correctly, and responsive measures to be designed and implemented.

20.5.1.2 Rapid Rural Appraisal (RRA)

Rapid Rural Appraisal (RRA) began as a coalescence of methods devised and used to be faster and better for practical purposes than large questionnaire surveys or in-depth social anthropology (Chambers, 1994a). RRA is part of the group of research approaches that involve people merely as informants (Cornwall & Jewkes, 1995). In RRA, information is elicited and extracted by outsiders as part of a process of their data gathering (Ghorbani, Khodamoradi, & Bozorgmanesh, 2011). The approach emerged in the 1970s as a cost-effective way for outsiders to learn about problems faced by communities (Ghorbani et al., 2011). The basic idea in this approach is to quickly collect, analyze and evaluate information on rural conditions and local knowledge. According to Cernea (1999), the main reason for the emergence of RRA was

to find short-cuts in the search for relevant information on rural development issue in order to avoid costly and time consuming research procedures.

Its methods include semi-structured interviews, transect walks with observation, and mapping and diagramming - all these done by outside professionals (Chambers, 1994b; Ghorbani et al., 2011). The rapid rural appraisal is guided by key principles of optimizing data collection using the community as part of the data collection process. The strength of this approach is that it emphasizes learning as being from, and with, the local people to build on prior knowledge. Learning is conducted directly within the community, benefiting from indigenous technical and social knowledge and skills. The local community is taken to be the custodian of the wisdom required and has the capacity to uplift their standard of living (UNISDR, 2005). The demise of the approach was that information is gathered from the community and the analysis is done elsewhere by experts (Ghorbani et al., 2011) and as a result, in the late 1980s and early 1990s, the practice of RRA evolved to participatory rural appraisal (PRA) (Chambers, 1994a).

20.5.1.3 Participatory Rural Appraisal (PRA)

Chambers (2015) describe PRA as a growing family of approaches, methods, attitudes and behaviors to enable and empower people to share, analyze and enhance their knowledge of life conditions and to plan, act, monitor, evaluate and reflect. The approach recognizes the expertise of the non-experts, that the local people are more knowledgeable about their environment than the external experts (Chambers, 1997). As such, outside institutions and researchers play the role of facilitators and coordinators of development programs (Abarquez & Murshed, 2004).

PRA methodology often involves participatory diagramming with other techniques such as interviewing and observation (Pain & Francis, 2003). The PRA methods, are extensively practiced in development activities, and particularly for disaster research, are often used for carrying out the vulnerabilities and capacities analysis (VCA) (Vatsa, 2004). Developed in the context of relief work undertaken by NGOs, VCA is an assessment by dividing societal capacities and vulnerabilities into three categories: physical/material; social/organizational; and motivational/attitudinal (Vatsa, 2004). In addressing local disaster risks and events, PRAs can empower people with the knowledge and skills they require to sustain themselves, using local resources (Phiri, 2014). However, the PRA approach suffers from a few flaws, even with the underpinning assumption that solutions to all problems can be found exclusively within an ordinary community (Cronin et al., 2004). For instance, purely bottom-up planning is not always feasible, especially in the development of emergency plans where coordination of activities between communities and other agencies/administrators is needed (Cronin et al., 2004). Moreover, the typical orientation of PRA is to place more value on local knowledge than on outside or "western" knowledge (Chambers, 1994a), and sometimes this may result in neglect or disparagement of non-local knowledge (Kapoor, 2002), and a loss of opportunity for education (Von Kotze, 1998).

20.5.2 Community-Based Disaster Risk Assessment and Action

Community-Based Disaster Risk Assessment is a diagnostic process to identify the risks that the community faces and how people overcome those risks (Abarquez & Murshed, 2004). It should however be noted that risk assessment is not simply a matter of collecting data about meteorological patterns, but rather identifying hazards and understanding how danger is constructed at the local level, and who is most exposed (Enarson et al., 2003). The people most directly affected can identify problems and suggest solutions, and are the best advocates for changes that make life safer. A thorough assessment of the community's hazard exposure

and analysis of their vulnerabilities as well as capacities should be the basis for activities, projects and programs to reduce disaster risks (Abarquez & Murshed, 2004). Vulnerability mapping' in the DRR includes the listing, frame-working and analysis of vulnerabilities of different categories of people under different circumstances (McCall, 2008). This kind of risk assessment is a vital tool for learning what makes daily life risky and how people's lives can be made safer (Enarson et al., 2003).

Community-based vulnerability assessments start with community organizing and depend on people's local knowledge (Enarson et al., 2003). The community should be involved in the process of assessment, planning and implementation. This approach will guarantee that the community's real needs and resources are considered. In this regard, there is more likelihood that problems will be addressed with appropriate interventions (Abarquez & Murshed, 2004). Community-Based Disaster Risk Assessment approaches claim to use qualitative methods to produce data that are owned by the subjects of the research, and that the research process contributes to local empowerment (Pelling, 2007). Most importantly, community-based disaster risk management research approaches yield the best results and most trustworthy primary data in understanding the disaster risk that communities face (Van Niekerk & Annandale, 2013). This is so because CBDRA puts communities at-risk at the heart of the entire disaster risk management research process (Abarquez & Murshed, 2004).

Community-based methods have been successfully applied to assess the impact of individual projects or for local-level assessments of vulnerability or capacity (Pelling, 2007). For Chambers (1987), the essence of participatory approaches is to understand and give voice to local conceptions of reality through local people's own analysis of challenges and capacities. Some of the activities under this approach include participatory GIS (Kienberger, 2005) or participatory mapping towards hazard identification and risk mapping. The values of seeking local knowledge include mapping direct experiences and historical 'folk memories' of hazards, exposure and vulnerabilities various kinds (McCall, 2008). It must however be noted that each local assessment has its own uniquely derived conceptual framework, making comparison and aggregation across locations extremely difficult.

20.5.3 CBDRM Research in Practice

The diversity of participatory approaches is growing and the list discussed above is not exhaustive. In practice, it is difficult if not impossible to stick to one rigid approach in conducting CBDRM research and therefore flexibility and adaptability in response to changing contexts are often essential. CBDRM approaches have been used by NGOs and academia as a common approach to build resilient communities in their DRR efforts (Shaw, 2013). The approach has been initially implemented in the developing world by local NGOs followed by international organizations. The approach is now increasingly promoted among communities and local authorities to strengthen the links between the official disaster risk management systems and community-based organizations (Shaw, 2013). Since there are many organizations currently implementing CBDRM in various developing countries with the practice gaining momentum and becoming widespread, there are many case studies of DRM research projects with community-based approaches by academia, NGOs and local governments. A few of these will be highlighted in the next section.

20.6 Regional Evidence of CBDRM

Although the process of CBDRM has been widely used, it implementation varies across regions. A selection of examples has been identified from Asia, Latin America and the Caribbean, Australasia, North America and Africa.

20.6.1 Asia

Asia faces threats from diverse and frequent incidents of hazards in the region. The risk posed by hydrometeorological and geological hazards, have the ability to undermine the fragile development progress of many countries. Limited resources, constant threats, and diverse terrain complicate efforts to reduce risk. As a result, CBDRM has become a much-used tool for helping at-risk communities. Information dissemination and capacity building has been a common element of CBDRM in Asia. NGOs have been significant contributors to CBDRM activities through their work in facilitating capacity building and skills development (livelihood related).

Oxfam Great Britain partnered with the Doaba and Help Foundations within **Pakistan's** Punjab province (Oxfam Great Britain, 2012) to lead interventions directed towards assisting community members to deal with the implications of living in highly flood-prone areas. The CBDRM programs have focused on increasing local capacity, improving livelihood resilience and enabling resource provision (Oxfam Great Britain, 2012). The program worked with community members to craft a village level disaster risk management plan as well as for providing training in the areas of first aid and search and rescue practices. Capacity building in this project extended beyond traditional awareness and preparedness practices to include strategic agricultural practices and animal husbandry. This approach acknowledges and validates the important links between vulnerability and livelihood security. Additionally, residents were provided with livelihood related resources (such as goats for livestock rearing) and hand pumps for accessing ground water (Oxfam Great Britain, 2012).

Community Based Action Teams (CBATs) were created with local community members within targeted villages in **Indonesia** (Kafle, 2010). These teams led awareness dissemination activities among the wider population as a prevention activity as well as coordinating community response and communicating threats within the locality. The **Nepalese** have taken a unique approach for involving community members in their CBDRM initiatives. Street performers were engaged as primary communicators for sharing disaster risk-related messages to communities (Gautam, 2009). The two factors which contributed to the use of the street drama technique, included the recognition that the population was primarily comprised of a diverse group of immigrants and the fact that traditionally men have taken on the primary role in community discussions. The idea of street performance was determined to be a tool that could reach the most vulnerable and often overlooked groups in the community context such as women, youth and minorities. The participants were invited to attend disaster risk management trainings within the communities and were taught how to write scripts and act in locally relevant plays. "It has had increased awareness among the audience but also provided performers with skills to implement risk reduction" (Gautam, 2009). The dramatic presentations have been instrumental in inspiring local members of the community to create rules and regulations regarding the protection of river banks. They have initiated plans directed at eliminating grazing in specific areas and have taken a proactive approach to self-funding small scale initiatives rather than waiting for government handouts in times of adversity (Gautam, 2009).

In Divinubo (**Philippines**), CBDRM examined the use of participatory 3-dimensional modeling initiated through workshops and focus groups (Maceda, Gaillard, Stasiak, Le Masson, & Le Berre, 2009). This approach involved local community residents engaging in disaster risk reduction workshops and collaborating to create a physical multi-dimensional model to highlight the hazard threats, vulnerable areas, and potential resources (Maceda et al., 2009).

Support for CBDRM is a defining factor in shaping the success of initiatives. Its value is based on its inherent and undeniable links to development and planning. This is the case in **Cambodia** where "the government considers CBDRM as an integral part of its rural

development program to alleviate poverty" (United Nations Economic and Social Commission for Asia and Pacific, 2008).

The **Japanese** have the practice of *Jishu-bo-sai-soshiki* (or *Jishubo*), which is recognized as an autonomous organization for disaster reduction and as a neighborhood association for disaster preparation and rescue activities (Bajek, Matsuda, & Okada, 2007). The *Jishubo* serves as a voluntary organization, and local governments encourage involvement in disaster risk management programs at the community level (Bajek, Matsuda, & Okada, 2007).

In some instances, CBDRM is regarded as primarily a community initiative with greater support from NGOs than local government. In Palang Merah **Indonesia** (PMI), the Canadian Red Cross (CRC) aimed to integrate disaster risk reduction at the community level as well as prioritize its inclusion into development planning, preparedness, response, recovery and prevention activities (Kafle, 2010). The program targeted 43 villages within Aceh Jaya, Aceh Besar and Nias in response to the devastation of the December 2004 tsunami (Kafle, 2010). In the Philippines, NGOs involved in CBDRM have worked extensively in advocacy and lobbying for policy reforms at the national and local levels (Asian Disaster Preparedness Centre, 2008).

20.6.2 Latin America and the Caribbean

Latin America and the Caribbean are regions that experience an annual onslaught of threats from hurricanes, tropical storms and floods as well as geological hazards such as earthquakes and mass land movements. The diversity of the region presents opportunities and challenges for implementing CBDRM projects.

As a small country in Central America, **Belize** is located below sea level and as such is particularly prone to coastal flooding (The Pan American Development Foundation, 2015). It is also vulnerable to the effects of climate change and acknowledge the growing threat of sea level rise to the population. The Pan American Development Foundation has sought to establish a CBDRM project in Dangriga and Hopkins to assist communities in building resilience through capacity building and training activities, developing early warning systems (for flooding) and implementing climate adaptation strategies (The Pan American Development Foundation, 2015).

In Jeffrey Town on the island state of **Jamaica**, local farmers' associations have been active in the process of identifying procedures and strategies to be employed at community level in response to, recovery and preparing for a number of hazards (United Nations Development Programme, 2015). The Jeffrey Town Farmers' Association worked with the broader community and in collaboration with both the St. Mary Parish Disaster Committee and Parish Emergency Operations Centre to create a community-based disaster plan for directing local level response to hazard threats (United Nations Development Programme, 2015).

Youth have been identified as the lead group in CBDRM activities in the sub-watershed region of the Acahuapa River in **El Salvador**. Young people served as the focal point for capacity building activities but more importantly, they were supported in efforts to develop community risk maps and subsequent community level mitigation projects (United States Agency for International Development, 2011).

20.6.3 Australasia

Extensive CBDRM activities have been conducted across the Pacific islands over the past decade. A number of projects have taken place on the island of **Samoa** (Gero, Méheux, & Dominey-Howes, 2011). They involved various partner and funding agencies including the Red Cross, the United Nations Development Programme and local faith-based organizations. The majority of these projects have targeted education and community awareness activities relating to the diverse needs of at-risk communities. Another project in Samoa, involved developing a village level response plan booklet for households based on the education and community

awareness. A CBDRM project also extended beyond traditional hazard awareness to include understanding of food security, nutrition and sustainable livelihoods. This diversity in focus was seen as a means of remedying continuous dependency of local residents on remittances in times of crisis (Gero, Méheux, & Dominey-Howes, 2011).

Projects in Navua, **Fiji** involved local level risk management approaches with a focus on capacity building activities especially including community members as well as local authorities and relevant NGOs (Gero, Méheux, & Dominey-Howes, 2011). A broader scale program worked with key members of the Catholic community with Fiji, Samoa, Kiribati and Vanuatu to create skilled religious local leaders, capable of communicating critical information to residents (Gero, Méheux, & Dominey-Howes, 2011).

CBDRM was used in **Papua New Guinea** as a tool for accessing and integrating isolated settlements in efforts to understand risk. The project aimed to identify how indigenous and western knowledge utilized within indigenous communities could be integrated to reduce their vulnerability to environment hazards (Mercer et al., 2008). It worked towards creating a forum where marginalized traditional knowledge could be recognized and validated within community focused risk reduction plans.

20.6.4 North America

CBDRM has been documented in the Red River Floods in Canada and the United States in 1997 (O'Neill, McLean, Kalis, & Shultz, 2016). Research in Winnipeg **Canada** examined CBDRM from the viewpoint of community development and social capital (community bonds) (Buckland & Rahman, 1999). The findings showed that the communities with the strongest community-oriented patterns of development, such as the Rosenort (a predominantly Mennonite community) and St. Jean Baptiste (predominantly Francophone) areas responded more effectively to the flood (Buckland & Rahman, 1999).

In 2005, the **United States** became famous for its failures in the government's management and response to Hurricane Katrina. Despite the debate over national responsibility for disaster preparedness and relief efforts, a number of community-based organizations took the lead in directing community disaster response efforts. Many pre-existing community, faith-based and non-profit organizations utilized their organizations' skills in areas such as care giving, social support and general care (Patterson, Weil, & Patel, 2010). An example of the contributions of community organizations were the activities directed at communicating hazard threats to the socially isolated immigrant (Vietnamese) families and their collaboration to support their evacuation from the affected areas (Patterson, Weil, & Patel, 2010). Following the onset of the hurricane and the collapse of the levees, similar groups helped to support the return of evacuated families and worked together to support efforts to rebuild and repair their homes and communities.

20.6.5 Africa

Africa as a continent, has struggled for decades with development-related challenges and high rates of extreme poverty. The ongoing complexity of risk faced in this region is compounded by the spread of HIV/AIDS and its effects on already vulnerable populations (Holloway et al., 2015). Governments, NGOs and aid agencies have recognized the need for seeking to reduce disaster-related risk in the region.

The Buzi District of Sofala Province (**Mozambique**) went beyond awareness and capacity building activities and included disaster simulation exercises as means of preparing community members for the risks of area flooding (Hellmuth, Moorhead, Thomson, & William, 2007). Oxfam Great Britain worked in **Niger** to train 3000 people including 943 women in disaster risk management in response to drought and water scarcity related risk (Global Facility for

Disaster Reduction and Recovery, 2014). The training was part of a larger project to help develop local coping strategies for working with locally pertinent hazards.

The Girls in Risk Reduction Leadership (GIRRL) project method has been recognized as a powerful approach for promoting adolescent girl driven CBDRM in **Southern Africa** (United Nations International Strategy for Disaster Reduction, 2008). Originally designed as a small pilot project the approach has been scaled up and implemented across **South Africa, Lesotho** (Mphaki), **Malawi** (Gwazanyoni/Kalulu/Malisero/Mazanani and Chidawa/Losiyati/Malinda/Moya/Mtandaza), **Zimbabwe** (Tshidhixwa), and **Zambia** (Kanyama settlement, Lusaka) (Genade & Van Niekerk, 2014). It used a Participatory Action Research approach to focus on understanding the needs of the vulnerable groups (specifically adolescent girls) in disadvantaged communities (Forbes-Biggs & Maartens, 2012; Forbes-Genade and Van Niekerk, in press). The girl participants drove the direction of the intervention based on their perceptions of individual and community risk. The approach aimed to develop capacity in otherwise marginalized groups and then promoted these groups as leaders and role models for reducing risk in the community. Stakeholders and participants identified the critical issues that contributed to their risks within the local context (Forbes-Genade and Van Niekerk, in press). Capacity building sessions varied across sites based on needs. However, common sessions included: mental, physical and sexual health, personal safety, fire safety, positive thinking and career guidance, peer education, family planning, community involvement, climate change, disaster risk management, environmental awareness, first aid training, community disaster risk assessments, effective communication, and community event planning (Forbes-Biggs & Maartens, 2012). In 2011, CARE Southern Africa Region partnered with the African Centre for Disaster Studies at North-West University (South Africa) to use the GIRRL Project model of female empowerment for CBDRM in the *Integrating Adolescent Girls in Community Based Disaster Risk Reduction in Southern Africa Project* (IAG) (United Nations International Strategy for Disaster Reduction, 2015). The IAG Project was adapted to the unique parameters of each pre-identified hazard and the dynamics of each community.

The GIRRL Model in the IAG Project has gone on to involve girls in local disaster committees (**Zambia, Lesotho, Malawi**), conducting community risk maps (**South Africa, Zambia**), as partner with boys in sharing risk reduction knowledge (**Zambia**), collecting water samples for testing (**Zambia**), hosting and developing community awareness events (**Zimbabwe, South Africa, Malawi**), being trained in first-aid (**Zimbabwe, Zambia, South Africa, Lesotho, Malawi**) and fire safety (**South Africa, Zimbabwe**) (Genade and Van Niekerk, in press; United Nations International Strategy for Disaster Reduction, 2015). In 2016, the GIRRL Model was again rolled out in four Southern Africa countries (**Namibia, Botswana, Swaziland and Mozambique**) under the USAID funded "Engaging African GIRRLS in Gender Enriched Disaster Risk Reduction (EAGER)" project.

20.6.6 Europe

There are very few examples of CBDRM in Europe despite the fact that the region is a main contributor to international projects and programs with that focus. It begs the question of the prevalence of externally driven projects, such as those funded by European or North American agencies and the potential implications or benefits. Does this contribute to less accountability for the state and greater dependency on external support or does it fill a critical gap? While not exclusively the case, it is a common occurrence as presented in the aforementioned examples. External assistance, while seeking to provide help and support greater self-sufficiency at community level, may unintentionally undermine the autonomy of nations to affect their own disaster risk reduction strategies (Ullberg & Warner, 2016).

20.7 Gender as an Integral Element to CBDRM

Gender has been receiving more promotion and recognition within disaster risk management activities, in line with the sentiment of the Sendai Framework for Disaster Risk Reduction (United Nations Office for Disaster Risk Reduction, 2015). Effective CBDRM must take gender into consideration. However, many of the projects mentioned above, appeared to approach communities as homogenous groups. Others included gender as a 'box' to tick off rather than as integral element in planning and implementation. The 'boxes' usually reflected the gender disaggregation of participants as opposed to the degree of active engagement and gendered participation in the project. Gender serves as a primary element in defining human identity and shaping the lived experienced of persons in a particular community or context. As a result, it influences the factors such as access to resources, ability to protect oneself and to respond to adversity (Ikeda, 1995; Laska, Morrow, Willinger, & Mook, 2008; Richter & Flowers, 2010).

The empowerment of women is a critical ingredient in building disaster resilience (UN, 2015), and in ensuring successful and representative CBDRM (United Nations International Strategy for Disaster Reduction, 2008). Whereas, women's vulnerability to disasters is often highlighted, their role in fostering a culture of resilience and their active contribution to building disaster resilience has often been overlooked and has not been adequately recognized (UNISDR, United Nations International Strategy for Disaster Reduction (UNISDR) 2009). This despite the fact that the capacity and knowledge that women and girls have, play an important role in individual as well as community resilience (UN, 2015). With women and children most vulnerable to disasters, a gendered approach to examining their conditions and aspects of vulnerability, capacity and coping is important in CBDRM. A gender-conscious approach to disaster risk reduction is based on the premise that disasters affect men and women and boys and girls differently because of their position in family and society. According to Delica-Wilson (2005), gender- and culture-sensitive CBDRM recognizes that men and women have different needs, different activities, different perceptions of risk and different priorities. Due to existing socio-economic conditions, cultural beliefs and traditional practices, women are more likely to be disproportionately affected by disasters (UN, 2015; Neumayer & Plümper, 2007). Enarson, Fothergill, and Peek (2007) posits that understanding differences among women based on race and ethnicity caste and class, nationality and culture, sexuality, religion, life stage and physicality is vital in disaster risk management. Thus, she calls specifically for more direct attention to gender and race/ethnicity and more broadly to gender and cultural differences (see Enarson, 2012, 2009, 1998; Enarson et al., 2003; also see the chapters on Gender and Disasters by Enarson et al., and Children and Disasters by Peek et al. in this book).

20.8 Commonalities, Differences and Constraints in CBDRM Approaches

The CBDRM project and programs presented above shows the achievements of communities across the world. Despite the diversity of hazard threats or vulnerabilities, each project sought to approach disaster risk management from the local level in order to help protect those persons directly affected by the adverse effects of disasters. Activities varied from street performances in Nepal, 3-D modeling in the Philippines, risk mapping in Jamaica, South Africa, Zambia and El Salvador and sharing evacuation notifications in America. Disaster response activities helped communities by improving capacity in terms of search and rescue in Pakistan and first aid provision in the GIRRL/IAG Projects sites of Southern Africa.

A critical point of deviance was the leadership of the projects or program. Many of the projects were driven and funded by external NGOs and introduced to communities and only a handful were instigated by the government (similar

findings were reported by Van Niekerk & Coetzee, 2012). What was even more significant was the fact that so few were promoted as being initiated by the communities themselves and supported by other role players. There could be a number of reasons for this; however, it is worthy of mention since they take on the role as an organization's project rather than having the community's true face.

CBDRM needs to take into the account the diversity of the community and acknowledge the wealth of knowledge that each member can provide in terms of past disasters, and identifying key vulnerability and capacities among all residents. By regarding communities as key partners in risk management, governments and NGOs can help target limited resources, define gaps and build on the strengths of each community to help build greater resilience.

Shaw (2012) as well as Van Niekerk and Coetzee (2012), further identified a number of current constraints in the implementation of CBDRM. Although the theory of CBDRM and methods (see Sect. 20.4 above) is fairly well established, practice still lags behind theory. It is common cause for practitioners to equate normal development activities to CBDRM without making a noticeable distinction. Most CBDRM approaches still follows a "top-down" approach, where implementation is driven by NGOs, INGOs and government - not communities. The involvement of these communities is thus assumed, but concealed. The lack of governance structures, institutions and policy frameworks can largely be blamed for the shifting of responsibilities to the NGO/INGO sector. Although this ironically assists in bringing CBDRM closer to communities it leads to absconding of coordination, responsibilities, empowerment and financing on the side of governments.

20.9 Conclusion

CBDRM not only assists in the creation of a better understanding of the dynamics of disaster risks, but also allows space for solving intricate problems and building societal resilience. In defining community beyond space and time allows for a deeper understanding of the disaster risk creation process. However, CBDRM is not a spontaneous process and requires thorough planning, capacity development, understanding and ownership. CBDRM must be seen as a complementary research tool which allows practitioners and academics alike to better understand complex issues such as disaster risks. As with many other research methods, CBDRM lends its relevance from the development sector and should thus be treated within the same space. Communities do not readily define their problems in terms of disasters, but rather development problems. In this context, CBDRM provides ideal ground for the integration of disaster risk management and development issues. However, one needs to be cautious in over reliance on deep technical understanding of natural hazards or vulnerabilities from communities. Research has shown that external facilitation is sometime still needed to drive the CBDRM process and knowledge, although locally generated, must be judged with through appropriate filters. It can be argued that CBDRM has been much more successful in the developing than developed world due to the type of development interventions in these countries. Communities form an integral part of the consultation process because in many instances the needed governance structures are non-existent. On the other hand, well off countries have much more resources for disaster risk reduction and mitigation and thus communities can rely on such resources.

Future research on CBDRM needs to solidify a broad, but robust theoretical grounding on the topic. A number of possible research questions from this chapter arises such as: What are the linkages between the theory and practice of CBDRM? Why does CBDRM succeeds in some instances and fail in others? What are the key components which makes CBDRM projects successful and why? What different types of CBDRM can be identified and what are their integration with development activities? Which of these are normally internally or externally led,

and which are more successful – and why? Does CBDRM lead to better disaster response and recovery? Is community ownership the key to successful CBDRM, or external facilitation? How does gender as a distinct element influence CBDRM? How is CBDRM integrated into other disaster risk management processes/projects? Is there evidence that CBDRM leads to a significant reduction of disaster impacts? When is CBDRM interventions most appropriate? Who governs/should govern CBDRM? Is there evidence of CBDRM in non-traditional disaster risk reduction disciplines? What new research approaches to CBDRM has been/can be developed?

Answering some of the questions above will provide a steady foundation from which CBDRM can become an integrated and important aspect of disaster risk management. CBDRM thus has the potential to greatly impact, influence and inform decisions leading to safer and more resilience communities.

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Population/Community Displacement

21

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21.1 Introduction

> Latest historical models suggest that even after adjusting for population growth, the likelihood of being displaced by a disaster today is 60 percent higher than it was four decades ago (IDMC, 2015a, p. 8).

Population displacement, the forced removal or uprooting of people from their home or country, is a global phenomenon triggered by multiple causes, including physical and socioeconomic vulnerabilities, exposure to natural hazards, civil war and ethno-religious conflicts, environmental and natural resource degradation, landlessness, food insecurity and megaproject developments (Belcher & Bates, 1983; Cernea, 1997; De Wet, 2009; Esnard & Sapat, 2014; IFRC, 2015; IOM, 2011; Oliver-Smith, 2005, 2012; Oliver-Smith & Sherbinin, 2014; Singh, 2012; Weber & Peek, 2012). Countries such as China, India, and the Philippines remain on our radar given multiple and repeated displacement by natural disasters and mega-development projects, while countries such as Bosnia and Herzegovina have experienced displacement caused by both conflict and disaster (IDMC, 2015a).

People in protracted patterns of displacement are generally more vulnerable to repeated displacement and face getting caught in further cycles of crises, disaster and displacement. As noted by Esnard and Sapat (2014), repeated

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displacement and adjustment sets back recovery and development gains, undermines resilience, and compounds vulnerability to other disasters or crises. In the context of natural disasters, emerging scholarship on population displacement aligns most closely with three interrelated aspects of disaster vulnerability research. First, exposure to natural hazards, and socioeconomic and livelihood vulnerabilities, predisposes households and communities to displacement. Second, disasters have differential impacts within communities, and vulnerabilities of households and communities are exacerbated during displacement and protracted recovery periods. Third, the resources and capacities of individuals, households, organizations, political institutions, and communities are vital for offsetting cumulative vulnerabilities of displaced households and communities. We agree with the assessment that responses to displacement must be informed by a comprehensive and nuanced analysis of its drivers and their linkages (IDMC, 2015a, 2015b) and an understanding of how multiple drivers interact and accumulate over time. This chapter adds to extant disaster research by discussing displacement as a multi-dimensional construct with determinants and outcomes that overlap in multiple ways. The first two sections of the chapter discuss physical, socioeconomic, and political factors as drivers of displacement, and the spatial and temporal facets of displacement and their impacts on displaced populations. A variety of terms continue to be used by agencies, organizations, practitioners, scholars, and the media to describe people displaced by disasters. The adoption of terminology is rooted in social constructions of displaced persons and has real implications for determining certain rights and expectations for services, as well as who benefits and loses from policies. A section in this chapter is devoted to terminology and semantics as a backdrop to highlighting more subtle dilemmas for disaster researchers and practitioners.

Disasters can also have repercussions on other countries which serve as receiving areas and host countries for displaced persons. The impacts of the 2010 earthquake in Haiti were felt in the United States and other countries where there are large numbers of an ethnic diaspora who assist Haitians in Haiti through remittances and initiatives by non-governmental organizations (NGOs) (Esnard & Sapat, 2011; Sapat & Esnard, 2012). A section of the chapter is devoted to a case study on Haiti to illustrate in more detail the transboundary impacts of the Haiti earthquake, the causes, consequences and outcomes of displacement, and the responses by government, non-governmental, and diaspora organizations.

The chapter concludes with a section on policy recommendations and knowledge, research and practice gaps that should be filled as part of the quest toward finding appropriate policy frameworks and durable solutions to population displacement. From practical, policy and governance perspectives, the root causes and lingering impacts of population displacement needs to be addressed across all phases of the disaster life cycle to ensure appropriate interventions that can ultimately reduce displacement vulnerability.

21.2 Displacement Vulnerability

> Vulnerability is the concept that explains why, with the equivalent force of disaster, people and property are at different levels of risk (NRC, 2006, p. 217).

Vulnerability is a multidimensional construct captured in physical/exposure, socioeconomic/human dimensions, and society's capacity to withstand disasters (Bohle, Downing, & Watts, 1994; Bogard, 1988; Cutter, 2003; Downing, 1991; Dow, 1992; Dow & Downing, 1995; Smith, 1992; Wisner, 2016). Physical vulnerability refers to exposure of people, property and livelihoods, as well as locational characteristics and structural integrity. Location in flood zones, earthquake prone areas, landslide prone areas, coastal areas and barrier islands, wildland-urban areas prone to wildfires, and other hazard zones predisposes communities to adverse impacts of disasters, including displacement.

Socioeconomic vulnerability is more nuanced and complex and is produced by unequal exposure to risk coupled with unequal access to resources (Bolin & Stanford, 1998). The inability of people, organizations, and societies to withstand adverse impacts to hazards adds to social vulnerability. Traditional indicators include demographic, socioeconomic and housing attributes, including income, poverty, job security and livelihoods, age and gender, race/ethnicity, housing tenancy and homelessness, and social and political networks and institutions (Bolin & Stanford, 1998; Bohle et al., 1994; Bogard, 1988; Cannon, Twigg, & Rowell, 2004; Cutter, 2003; Cutter, Burton, & Emrich, 2010; Downing, 1991; Dow, 1992; Dow & Downing, 1995; IFRC, 2016).

Displacement is a process that derives from both preexisting and cumulative physical, socioeconomic, political and institutional vulnerabilities. At the global level, the list of socioeconomic indicators has grown to include displaced populations, migrants and returnees (IFRC, 2016). Non-displaced populations and returnees are often ignored but they can face dire declines in livelihood assets, and secondary levels of vulnerability and insecurity. The Tata Institute of Social Science (2005) reported that after the 2004 tsunami, some unaffected households in coastal villages who were left in place experienced a disruption to livelihood dependency chains common in coastal fishing communities. Decline in livelihood assets and job options is a problem in developed countries as well.

As noted by Esnard and Sapat (2015, p. 212), post-disaster recovery outcomes are highly influenced by institutions, both formal (rule of law, regulations, constitutional codes) and informal (cultural norms, traditions, governance processes). Institutional type, strength, and effectiveness, discussed in more detail in a later section, are responsible in large part for different levels of vulnerability across geographical areas. Challenges are especially notable when countries face repeated disasters, and when repeated displacement results from overlapping consecutive civil conflict and natural disaster. For example, Eastern Mindanao, one of the poorest areas of the Philippines was beset by armed conflict and violence. In late 2011, that area was affected by Typhoon Washi. In early 2012, close to 200,000 people were displaced by armed conflict and violence (IDMC, 2013), and in late 2012, that same area was hit by Typhoon Bopha. As noted in Esnard and Sapat (2014), while that region was not directly affected by Typhoon Haiyan in late 2013, the redirection of aid to other parts of the Philippines further undermined the pace of recovery.

Measurement and forecast of displacement vulnerability remains a challenge and a work in progress. It is important that disaster researchers and scholars heed Wisner's warning that patterns of vulnerability are far too complex and dynamic to support absolute categories and characteristics given that the vulnerability of households and communities change over time, and that "the interaction of everyday and large-scale threats in a temporal context of multifaceted change demands understanding of people's situation, not their category" (Wisner, 2016, p. 9). Guadagno (2014) also warned about painting a broad picture that portrays displacement as an automatic undesirable outcome. Referring to displacement as a result of climate change, Wilmsen and Webber (2015, p. 78) cautioned that organized resettlement away from the hazard might be the only option for those without freedom of mobility. Additionally, McLeman (2014, p. 32) cautioned that displaced persons are not entirely without agency,[1] and can therefore exhibit a significant range of decision making and choices with respect to their final destinations, depending on their circumstances. This is consistent with assessments by scholars such as Wisner that our focus (as disaster researchers, scholars and practitioners) on vulnerability (versus capacity) is misplaced and misleading especially since we do not account for the fact that communities and its residents have the capacity to protect themselves from disasters and their effects (Wisner, 2016, p. 8). When presented with a choice of host

[1]Agency is used here to mean the freedom in choosing migration options and destinations.

community or nation, reasons by individuals, households or communities are often based on factors such as proximity to damaged homes, family, friends and social networks, access to jobs, livelihoods and social services (IDMC, 2015a, 2015b; Iuchi 2015; Islam and Hasan 2016) and even past colonial ties (Skinner, 2002). Isle de Jean Charles, located in Terrebonne Parish, Louisiana has shrunk significantly from 5 × 12 miles in 1950 to ¼ × 2 miles in 2013 (Maldonado et al., 2014). The community has been losing land due to coastal erosion and salt-water intrusion since the 1800s, and since 1965, the Parish has experienced 18 presidentially declared disasters (Nelson & Ehrenfeuct, 2016, p. 72). Tribal leaders have made the decision to resettle their community further inland, and one of the overarching goals is to reunite dispersed tribal members and restore culture as part of resettlement.

21.3 Spatial and Temporal Facets of Displacement

Temporal and spatial dimensions of displacement, and migration more generally, are largely intertwined, and rooted in the duration and distance moved whether within a country or across the globe (McLeman & Hunter, 2010; Nelson & Ehrenfeuct, 2016, p. 69). Displacement can be permanent or temporary and distances moved can vary across the spectrum from intra-neighborhood to transnational. What constitutes short- and long-term displacement is yet to be universally defined in terms of a specific number of months or years and is complicated by disagreement on when displacement begins and ends and who determines that status (Mitchell, Esnard, & Sapat, 2012). Overall, "knowledge about the duration of displacement following disasters is ad hoc and unconsolidated" (IDMC, 2015a, p. 17).

After Hurricane Katrina in 2005, more than one million people were displaced from their homes throughout the Gulf Region, and many found temporary refuge in communities across the United States (Button, 2009; U.S. Senate 2009; Weber & Peek, 2012). Vulnerability to being displaced had been produced over several decades, given the cumulative exposure of residents, housing, businesses and critical infrastructure to natural hazards. According to the Data Center, New Orleans lost over half of its population a year after Hurricane Katrina (Plyer, 2015). Repeated displacement was also the story of many residents who had to leave New Orleans, Louisiana before and after Hurricane Katrina. Repeated displacements can result when vulnerable households with children are forced to relocate several times after the initial displacement, primarily because of the difficulty of finding suitable and affordable housing (Fothergill & Peek, 2015), or because of the lack of livelihood options and food insecurity. Weber and Peek (2012) reported that many disadvantaged Hurricane Katrina displaced persons relocated anywhere from two to more than twelve times, and African American females relocated more than any other demographic groups. As reported by Meyer (2013, p. 333), discrimination in housing and labor markets funneled displaced persons into economically- and ethnically-segregated communities, slowing their recovery and fostering continued marginalization and vulnerability. Esnard (2017) describes this phenomenon as "cultural-economic displacement" in host communities and reminds us that we should not ignore in situ displacement which applies to both affected individuals and households that find themselves in host communities, as well as the prior residents. The concept of in situ displacement refers to displacement experienced by people while staying in place, where people find themselves in a new position in the social hierarchy, leading to exclusion and impediments to physical and social movement (Feldman, Geisler, & Siberling, 2003, p. 9).

The most thorough accounts of experiences of households with children who were scattered around the country in prolonged states of limbo and disrupted life trajectories have been documented by Weber and Peek (2012) and Fothergill and Peek (2015). The dependence of children on their families for physical security and emotional support made them more vulnerable to

cumulative impacts of disasters. In referring to children, Fothergill and Peek (2015, p. 25) warn us that "in understanding the concept of cumulative vulnerability, it is important to keep in mind that it has a temporal component, in that vulnerability unfolds over time. But it also has an additive component: the more that risk factors accumulate, the more likely children are to experience developmental delays, poor mental or physical health, or negative educational outcomes."

Tension, and at times violent clashes, can also arise between displaced persons and "locals" in host communities. The Manam volcanic eruption in 2004 led to more than 10,000 Manam islanders fleeing to the mainland of Papua New Guinea. Tensions arose between Internally Displaced Persons (IDPs) and local communities, particularly over land use issues, and led to periodic violent clashes (IDMC, 2015a, p. 55). Efforts to systemically analyze, measure, and address displacement vulnerability are also complicated by lingering issues and questions related to definitions and the terminology used for displaced populations.

21.4 Terminology and Semantics

Conceptualizations, terminology and definitions should not be dismissed as merely semantic. A variety of terms continue to be used by agencies, organizations, practitioners, scholars, and the media to describe people displaced by disasters. They include: affected, climate migrant, displaced person, displace, evacuee, exiles, homeless, Internally Displaced Persons, refugee, survivor, and victim (see Box 1 for some of these definitions). Furthermore, there is some conceptual confusion embedded in the spatial, temporal and socio-legal dimensions used to distinguish between voluntary and forced displacement. Voluntary migrants, such as those who are moving to improve their economic and professional lives are often seen as less 'deserving' than displaced persons who are fleeing devastation caused by disasters or political persecution and conflict (Bansak, Hainmueller, & Hangartner, 2016). Designations and terminologies often reflect perceptions driven by socially constructed narratives and accompanying discourses (Berger & Luckmann, 1966; Cobb & Elder, 1983; Donovan, 1993; 2001; Schneider & Ingram, 1993; Stone, 2001). As noted in Sapat and Esnard (2012), these terminologies and definitions are not merely semantic in nature; rather they play an important role in determining certain rights and expectations for services, as well as who benefits and loses from policies.

Box 1

Definition: Internally Displaced Persons

Persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of, or in order to, avoid the effects of armed conflict, situations of generalized violence, violations of human rights, or natural or human-made disasters, and who have not crossed an internationally recognized State border (UNHCR, 1998, p. 5).

Definition: Refugees

A person who, owing to a well-found-ed fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion, is outside the country of his nationality, and is unable to or, ow-ing to such fear, is unwilling to avail himself of the protection of that country (IOM, 2011, p. 79).

Definition: Climate Migrants

Persons who abandon their place of origin as a result of climate change effects: floods, pests, climate cycle disorder, global warming, as well as the implementation of the capitalist economic model that deforests, degrades, and uncontrollably extracts non-renewable resources and encourages monoculture (World People's Conference on Climate Change and the Rights of Mother Earth (http://pwccc.wordpress.com/2010/04/16/working-group-6-climate-migrants/).

A parallel but related debate is taking place about how to refer to people displaced by climate change. Common terms include: climate change refugee, climate evacuee, climate migrant, climate refugee, disaster refugee, eco-refugee,

environmental displacee, environmentally displaced person, environmental migrant, environmental refugee, environmental-refugee-to-be (ERTB) and forced climate migrant (Brown, 2008; Esnard & Sapat, 2014; Matthews, 2013; Oliver-Smith, 2013; Terminski, 2012). Some of these terms have no formal meaning and are used to describe the phenomenon of non-voluntary population displacement for those forced to relocate in response to changing climates and environmental disasters. In the context of climate change and climate migration, Brown (2008, p. 13) further notes that the choice of definition will have very real implications for the obligations of the international community under international law.

Terminology has also been brought to the forefront by forced displacement and resulting historic refugee flows from the Syrian Arab Republic to Europe. The dire conditions braved by these refugees including a record number of child refugees, has shone a spotlight on humanitarian assistance needs and host country issues. Yet, the United Nations High Commissioner for Refugees report that that the majority of persons forcibly displaced worldwide reside within their own countries as IDPs by a margin of 2 to 1 over those who have crossed an international boundary to live outside their country of origin as refugees (McLeman, 2014; UNHCR, 2015). In 2015, the refugees mainly originated from the Syrian Arab Republic, Afghanistan, and Somalia (UNHCR, 2015), but there were other refugee flows from Central American countries of El Salvador, Guatemala and Honduras to Mexico and the United States. Overall, the spatial distribution – the act of crossing an international boundary – is a key element in the distinction between IDPs and refugees.

21.5 Case Study: Insights from the 2010 Haiti Earthquake

Repeated disasters, protracted displacement and the slow pace of recovery in Haiti highlight the pre-existing patterns of systemic and cumulative societal and physical vulnerabilities, weak institutional and governing structures, and the political, economic, and ecological fragilities that have plagued the island for centuries (Bissell, 2013; DesRoches,Comerio, Eberhard, Mooney, & Rix, 2011; Farmer, 2011; Fatton, 2011; Herard, 2012; Olshansky & Etienne, 2011; Schuller & Morales, 2012). This case study highlights the causes, consequences and outcomes of the population displacement after the 2010 earthquake, and lingering transboundary impacts.

21.5.1 Vulnerabilities and Predisposition to Household and Community Displacement

The island of Haiti is prone to hurricanes, flooding, storm surge, landslides and earthquakes and is at risk to recurrent disasters. Haiti has seen its fair share of disasters in this millennial – hurricane Jeanne in 2004, tropical storm Fay and hurricanes Gustave, Hanna and Ike in 2008, the 2010 Haiti earthquake, Hurricane Matthew in 2016 and Hurricane Irma in 2017. It was the 2010 earthquake, measuring 7 on the Richter Scale, that dealt the most catastrophic blow to the island nation and its capital city, killing more than 200,000 people, injuring approximately 300,000, and displacing close to 2.3 million people (Esnard & Sapat, 2014). The vulnerabilities prior to the 2010 Haiti earthquake were exacerbated by the concentration of the island's population and GDP in its capital city, Port-au-Prince.

In addition to the regular exposure to natural disasters, the country continues to face significant challenges including endemic poverty, fragile health systems, and inadequate access by all residents to water, sanitation, and other basic services. The fragility and informality of the land tenure system and land ownership laws in countries like Haiti are barriers to community recovery as post-disaster rebuilding and reconstruction of permanent housing and infrastructure are slowed down or halted while aid organizations seek proof of land ownership (Brown & Crawford, 2006; Ferreira, 2013; Kennedy, 2012; Marshall, La

Grange, & Esnard, 2017). According to Castor (2012), at the time of the earthquake, Haiti had only five percent of land that was surveyed, registered, notarized, publicly filed and verified in accordance with local and national law. Contested land rights and land tenure issues have contributed to the protracted recovery period, and in turn protracted displacement.

21.5.2 Transboundary Impacts and Policy Implications

According to IFRC (2012), one-sixth of Port-au-Prince's population was forced to seek refuge in other provinces, while EERI (2010) estimated that approximately 150,000 Haitians left the island nation. In October of 2016, Category 4 Hurricane Matthew caused serious devastation to the western part of Haiti, resulting in a significant number of displaced persons (IOM, 2016). At the time of writing this chapter, there are some discrepancies from various reports as to the actual number of deaths and displaced persons. However, these repeated disasters are a major setback to Haiti's recovery and resilience. We categorize the Haiti earthquake as a transboundary disaster given the effects experienced by populations and groups beyond their country's borders. What makes this case unique is Haiti's geographic proximity to Miami and other cities in the United States. The South Florida region, home to over 300,000 Haitians and rich with Haitian-American organizations, served as a receiving area for severely injured earthquake survivors and for school-aged displaces (Esnard & Sapat, 2011, 2014; Sapat & Esnard, 2012, 2013). Ramifications for host communities were economic, political, social, and legal, involving both state and non-state actors at different levels of government (Sapat & Esnard, 2013, 2016). The role of diaspora groups in host countries and transnational forms of social capital has also been shown to be critically important in advocating for services and rights of Haitians in the United States (Esnard & Sapat, 2011; Fagen, 2006; Fagen et al., 2009; Newland, 2010; Sapat & Esnard, 2012).

As noted in Sapat and Esnard (2016, p. 252), some of the policy implications and the lessons learned from this transboundary disaster were: that catastrophic disasters increasingly require better coordination between international institutions and agencies and local civil society organizations; that ad hoc and temporary aid mechanisms do not help engender sustainable recovery processes; and, that the inclusion of diaspora and local civil society organizations into recovery processes can help target aid more usefully in recovery and stem both internal and transnational displacement. Further research by disaster scholars and practitioners is needed, however, into the disruptive nature of such disasters and the ways in which they are perceived, framed, and managed by policy-makers in affected and host countries. Additionally, more research is needed to advance our understanding of the transnational dimensions of disasters, including complicating and lingering questions about sovereignty, legal frameworks, institutional arrangements, and strategies to protect displaced persons in their home and host countries (Sapat & Esnard, 2012). Given the potential number of refugees fleeing climate-change-related events and other disasters, as well as and the effects of globalization, how these issues are addressed by policies will have implications for crisis and disaster management in both impacted and host communities.

21.6 Challenges and Opportunities in Developing Policy Frameworks and Solutions

> The scope and severity of displacement situations are determined by political factors that include state fragility, weak governance, corruption, prioritising economic interests over IDPs' needs and rights and misuse of resources. (IDMC, 2015b, p. 4)

While there are several drivers and triggers of displacement, the quality of governance, policies and political leadership can be critical in affecting the type, length, and nature of population displacement. Governance quality and political concerns also affect the search for and adoption of policy solutions to tackle displacement in

various ways. There are several challenges to developing policy frameworks and solution including coordination among multiple stakeholders, development of cross-cutting solutions, weak and fragile governance systems, and developing appropriate housing recovery and reconstruction strategies.

21.6.1 Coordinating Multiple Actors and Stakeholders and Fragmented Governance

> …coordination among state, inter-governmental, private sector and civil society actors is needed to understand how displacement starts, what determines its scope, scale and patterns over time, how it impacts different people in different ways and how and when it ends. (IDMC, 2015b, p. 5)

Since displacement has multiple drivers and is a complex, multi-faceted phenomenon, dealing with displacement involves multiple actors and stakeholders. These actors and stakeholders include state (governments at all levels) and non-state actors such as civil society organizations, non-governmental organizations, private organizations, international organizations and institutions, and displaced populations. It also includes organized interest groups and coalitions that may be composed of state and non-state actors, citizens, and other stakeholders. Policies to deal with displaced populations also need to be undertaken in multiple policy arenas including housing, employment, healthcare, education, social services, and others. Spatial and geographical considerations need to be taken into account as well. Actors and stakeholders that are affected by and that affect displacement may be in multiple locations such as affected areas that people evacuate and leave, areas through which they transit, and host communities to which they migrate, relocate or resettle either temporarily or permanently. Affected areas which displaced populations are forced to leave and host community areas to which they relocate or resettle may be politically, socially, economically, and culturally distinct from each other; this increases the complexity of the tasks facing policymakers.

Coordinating and implementing policies to deal with displaced populations are further facilitated or exacerbated by the type of governance structures. The lack of integration between numerous stakeholders with different priorities, processes, operating procedures, goals, and objectives in disaster recovery processes can render horizontal and vertical coordination among various stakeholders problematic and result in fragmented silo-based decision-making processes and fragmented governance structures (Sapat, 2017; Smith, 2012; Smith et al., 2013). For instance, after Hurricane Katrina, there was friction between Federal Emergency Management (FEMA) and Department of Homeland Security (DHS) officials in providing housing assistance for displaced residents and in working on the transition from sheltering to housing programs. Turf battles also ensued between Housing and Urban Development (HUD) and FEMA, with uncertainty on both sides about the role each was expected to play (Sapat et al., 2011). Similarly, coordinating NGOs, government organizations, international institutions, and other civil society organizations was difficult as noted in the case study of Haiti discussed above. Coordination among multiple entities following the December 2004 tsunami and the March 2005 earthquake was also a very challenging task in some of hardest hit areas such as Aceh and Nias in Indonesia. While a master plan for reconstruction was developed by Indonesian authorities and a reconstruction commission, it lacked a comprehensive assessment of reconstruction needs that was shared among different stakeholders, negatively affecting housing recovery for displaced survivors (Guarnacci, 2012).

21.6.2 Developing Cross-Cutting and Holistic Policy Solutions

There are different institutional mechanisms and legal and regulatory frameworks to address displacement, which are often distinct and separate. Institutional and government policies to address displacement due to natural hazards as compared

to displacement due to conflict, or displacement due to environmental causes, are often distinct with separate frameworks and policy processes. At the international level, for instance, disaster risk reduction is addressed by frameworks such as the Sendai Framework for Disaster Risk Reduction 2015-2030 and climate change is addressed through mechanisms such as the Intergovernmental Panel on Climate Change and the agreements reached at the 2015 United Nations Climate Change Conference. Conflict-induced displacement is primarily addressed by peace-keeping missions and humanitarian state and non-state interventions. At the national and local levels as well, there is institutional and regulatory fragmentation as there are different institutions and policy processes to deal with those displaced by disaster and those affected by conflict and climate change. In a detailed comparative study of four countries (Kenya, Ghana, Bangladesh and Vietnam), Zetter (2011) finds that while these countries have developed disaster risk reduction policies and institutions such as national disaster management organizations and disaster risk reduction plans, legal frameworks to deal with those displaced by conflict are often distinct and take the form of human rights commissions and frameworks. He also finds that institutional measures and policy processes to protect those displaced by slow-onset disasters are lacking and are insufficiently linked to disaster risk reduction strategies (Zetter, 2011, p. 43).

The development of separate frameworks and protections specifically targeted to displacement issues related to disaster risks, conflict, and environmental and climate change concerns is needed to effectively address each of these issues, but there is a lack of coordination between these various mechanisms and programs. The lack of coordination between institutional frameworks and mechanisms has also led to different terminologies and language (i.e., refugees vs. IDPs as discussed above) with differing legal implications. The presence of different institutions and policy processes at the international, national, and local level without much coordination between them also continues despite the fact that there are complex, intersecting, and cascading connections between various drivers of displacement. For instance, scholars have amassed evidence that climate change effects contribute to political conflict (Hsiang et al., 2013). In a recent study undertaken for the National Academy of Sciences, Kelley et al. (2015) argue that one of the root causes of the conflict in Syria and the resulting levels of mass internal and international displacement of populations was the Syrian drought from 2007-2010 brought about by anthropogenic changes and unsustainable land use practices. The resulting drought led to high levels of internal migration to urbanized areas in Syria and civil unrest by exacerbating unemployment, corruption, and inequality that was coupled with a slow and ineffective government response (Kelley et al., 2015). Effective policies to tackle displacement thus need to take a more holistic systematic response via common frameworks, coordinated programming, and analysis to account for the complex linkages between root causes of displacement (IDMC, 2015b).

21.6.3 Weak States and Fragile Governance Systems

In states that are characterized by weak or fragile governance systems, institutional structures, actors, and measures to reduce displacement by disasters or due to other causes may be weak or absent and governance may be further weakened by disaster (Sapat, 2017). For example, 15 out of 17 Ministry buildings and a large percentage of Haiti's civil service were destroyed by the 2010 Haiti earthquake discussed above, further weakening a very thin layer of administrative capacity and leading to an overwhelming reliance on NGOs and international organizations for disaster recovery (Zanotti, 2010). While weak or fragile states can make it difficult to provide protections for displaced populations, the quality of governance, or the lack thereof, is also seen as a root cause and the main driver of displacement. As noted by Betts (2013), when states are unable or unwilling to protect the rights of their citizens,

wider sets of threats can lead to deprivations of populations and survival migration and displacement. Similarly, Thomaz (2013, p. 35) argues that the 2010 Haiti earthquake acted as trigger and not as the main driver for the displacement of populations and that the fragility of the Haitian state and its inability to secure its citizen's basic subsistence needs for years was the root cause.

21.6.4 Housing Recovery and Reconstruction

Levels of damage and destruction to housing have been rising on a global scale contributing to increases in displaced populations. Shelter and housing dilemmas following disaster have been well documented (Bates & Peacock, 1987; Bolin, 1986; Quarantelli, 1982) and continue to remain one of the biggest challenges to the relocation, return, and resettlement of displaced populations who have lost their homes. While housing recovery is a keystone of overall community recovery (Comerio, 1998), it is hard to achieve as it is very complex, multi-faceted, and affected by myriad factors such as market forces, pre-disaster social and physical vulnerabilities of communities, and the types of policies governing the management of risk and resilience (Sapat & Esnard, 2017). A persistent problem that has surfaced time and again in housing recovery includes policy gaps with respect to renters. Housing recovery policies are usually targeted towards owner-occupied single family housing (Comerio, 1998) and have favored middle-class home owners at the expense of lower–income renters (Esnard & Sapat, 2014; Fothergill & Peek, 2004; Kamel & Loukaitou-Sideris, 2004; Levine et al., 2007; Mueller et al., 2011; Peacock et al., 2014; Sapat et al., 2011; Sapat, 2017). Building back better often takes the form of gentrification, and higher rents after disaster lead to greater levels of protracted displacement for lower-income renters. Renters with lower incomes and fewer personal resources often cannot afford to repair existing homes (Peacock et al., 2014; Van Zandt & Rohe, 2011). They rarely return to their units after disaster (Levine et al., 2007). Renters also tend to lack an advocacy base and lack political power to push for policy changes in housing assistance (Sapat et al., 2011). Moreover, as compared to homeowners, access to recovery programs is also more difficult for rental property owners due to more complicated ownership structures (Gould, 2009; Wu & Lindell, 2004). Despite repeated disasters and accompanying loss and damage to housing, policy learning and change in housing recovery is problematic because of these factors (Sapat et al., 2011).

A second and more persistent set of policy issues is the problem of land and location, which includes problems in finding locations for temporary, transitional and permanent housing to resettle displaced populations and issues related to land tenure (Sapat, 2017). Resentment and hostility towards displaced survivors in host communities can render it difficult to find locations for temporary or permanent housing or to resettle displaced populations. After Hurricane Katrina, about half of the parishes in Louisiana banned group trailer sites as they were heavily stigmatized as representing blight and residents often formed human and vehicular barrierchains to block the construction of temporary housing sites (Aldrich & Crook, 2008). As Lizarralde (2014) notes, the lack of affordable, vacant, or suitable land can lead to the relocation of communities to urban peripheries. Relocation to distant sites can lead to the loss of social networks, access to employment, healthcare, and other services.

21.7 Concluding Remarks

Population displacement is a global phenomenon that is becoming increasingly complex to address. As discussed above, relocation decisions, weak and fragile governance systems, and uncoordinated responses can have significant negative economic, social and cultural impacts, and lead to protracted displacement and increased vulnerability of displaced populations. The perspectives discussed in this chapter point

to the need for disaster researchers and practitioners to play closer attention to reducing displacement vulnerability and to address dilemmas resulting from or compounded by household and community displacement. More specifically, we offer the following insights and recommendations for disaster scholars and practitioners:

1. ***Terminology***: Ongoing dialogue is needed about the use of standard definitions and terminology for displaced persons in agencies and organizations. As Mitchell et al. (2012) noted and as discussed above, a number of problems arise from displacement terminology, or lack of it and the ongoing dilemma of determining when displacement begins and ends. Terminology and definitions are critical because of the legal ramifications associated with them and the lack of any clear definition of those displaced by sudden and slow-onset disasters, who do not qualify as refugees under the 1951 Refugee Convention. Their vulnerability and levels of displacement have humanitarian, equity, global security, and environmental consequences. As King (2005) argues, a new international coordination mechanism between key international agencies is needed to address their problems. International coordination mechanisms and institutions should seek the use of common terminologies that are linked to policies to protect those displaced.
2. ***Promote and adopt integrative enumeration and analysis***: Researchers need to work in conjunction with practitioners to better understand, characterize, collect data and quantify how displacement (and what kind of displacement) contributes to both vulnerability and resilience. We are also in agreement with IDMC's assessment of the importance of integrated data collection and analysis (i.e. one that incorporates both natural and human-made disasters and conflicts) as the basis for policymaking and planning given the complex mix of overlapping hazards that contribute to displacement, and that determine patterns of movement and needs particularly in fragile and conflict-affected countries (IDMC, 2015a, p. 9).
3. ***Adopt a multidisciplinary and multi-sectoral approach***: Household and community displacement, and strategies toward durable solutions are a shared responsibility of practitioners, researchers, NGOs, think-tanks and agencies who represent multiple disciplines including anthropology, business and economics, education, emergency management, global studies, humanitarian assistance, law and sociolegal studies, migration studies, planning, public administration, public health, psychology, social work and last but not least, sociology. A multidisciplinary approach in disaster research must be actively promoted to tackle the complex multi-faceted dimensions of population displacement.
4. ***Broaden Stakeholder Groups***: Typically, displaced persons are served by non-state actors such as non-governmental organizations (NGOs) and religious groups. These non-state actors are critical links to these populations, and need to be included and considered as key stakeholders in promoting appropriate policy processes and programs to assist displaced populations. Displaced persons themselves should also be given a more active role in making policy choices that are often made on their behalf. They should be included in decision-making processes and be accorded representation and legitimacy in the search for policy solutions. The invisibility of displaced persons, sometimes by choice, need to be acknowledged as problematic for this type of outreach, and for the types of enumeration and analysis recommended above. As Crisp et al. (2012) have pointed out, displaced persons (including IDPs and refugees) are increasingly not found among host communities or camps in rural areas, but are instead, attempting to blend into towns and cities, or nearby marginalized settlements on the outskirts of cities.
5. ***Search for Durable Solutions to Displacement in Research and Practice***: A durable solution to displacement is an important goal

and guiding principle, promoted by governments, humanitarian organizations, funding agencies, and international institutions. The how and by whom remains a work in progress. With respect to IDPs, the Guiding Principles for Internal Displacement (UNHCR, 1998) and the Inter-Agency Standing Committee (IASC) provide guidance and help define what a durable solution would be. According to the IASC framework, "a durable solution is achieved when IDPs and other people affected by displacement, such as members of host communities, no longer have specific assistance or protection needs or vulnerabilities directly linked to the phenomenon" (IASC, 2010). But a one-size-fits-all approach is not feasible given the multiple and overlapping drivers of displacement that complicate a community's ability to measure progress. We agree with the Internal Displacement Monitoring Centre that achieving a durable solution is a gradual and complex process (IDMC, 2015a, p. 17); one that must be facilitated by filling knowledge gaps. There is also need for more in-depth, international, and interdisciplinary research that focuses on the impacts and consequences for displaced populations; both for those who remain in places with high levels of vulnerability, and for those who seek refuge in host communities where they remain marginalized and vulnerable to repeated and protracted displacement.

The recommendations discussed above are intended to suggest ways to focus disaster scholarship on displacement and its relationship to vulnerability and to advance understandings of displacement in disaster research. The need for this focus is particularly important given the growing numbers of people caught in protracted and chronic patterns of repeated displacement that are further complicated by multiple and overlapping disasters, crises and conflicts. Positive recovery trajectories of displaced persons in home and host communities and countries will require sustained and coordinated initiatives and policies that are integrated both horizontally across organizations and vertically across different levels of government-local, regional, national, and international. Discourses in research and policy solutions should focus on developing new methods to collect critical data on displaced populations, inclusive and participatory practices that involve displaced populations in decision-making, and capacity building and training for humanitarian workers who serve at the frontlines in aiding displaced populations. Since displacement levels are likely to rise significantly as the effects of climate change increase in frequency and scope, addressing displacement ranks as one of the most critical challenges that practitioners and disaster researchers will face in the coming century.

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Part VI
Communication and the Mass Media

Communicating Imminent Risk

22

Michael K. Lindell

Contents

22.1 Introduction

Each year around the world, environmental hazards cause thousands of deaths and injuries that could have been avoided if people were warned to take protective action before hazard impact. In many countries, casualties are decreasing because of significant advances in technological systems for detecting and assessing environmental hazards. These include satellites for hurricanes, radar for tornadoes, seismograph networks for earthquakes, and DART buoys for tsunamis. There are also increasingly sophisticated methods of disseminating warnings to threatened populations. In addition to existing channels such as commercial television and radio, there are now electronic sirens, tone alert radios, emails, and cell phone texts. However, technological advances are only part of the solution. A broader perspective, originated by Lasswell (1948), requires a consideration of a warning's source, transmission channel, message content, and receiver characteristics to assess its effect on protective action—including the stimulation of receivers' attempts to close the feedback loop by confirming the warning.

This chapter will begin with a brief review of past warnings and warning research, followed by a summary of the *Protective Action Decision Model* (PADM) that will be used to organize the remaining sections. The PADM follows the broad outlines of Lasswell's framework but

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elaborates it based on subsequent research and tailors it to the specific circumstances of warnings about environmental hazards.

22.2 A Brief History of Warnings and Warning Research

The practice of warning people to evacuate from the threat of disaster has a very long history. Perhaps the most ancient warning system is the Memphis Nilometer, which provided measurements of the Nile River (Bell, 1970). This flood gage could be used to initiate flood evacuations or preparations for drought (Rawlinson, 1886, p. 28–67). However, systematic research on warnings did not emerge until the 1950s. Fritz and Marks (1954) mentioned only a few findings about warnings—primarily the relationship between the amount of forewarning and the time required to implement protective action, as well as social milling during which groups of people develop a consensus about ambiguous situations. Other assessments of disaster research at that time had little (Killian, 1954) or nothing (Powell, 1954) to say about warnings except as a topic for future research. Later, Friedsam (1962) reported that older persons were less likely to receive warnings because they were likely to be less integrated into informal warning networks and less likely to seek warning confirmation through radio than other age groups. Janis (1962) identified warning message themes of threat severity, certainty, and immediacy, and response efficacy as significant to recipients' psychological reactions—especially vigilance for further information and motivation for protective action. He also called attention to the effects of warning message ambiguity, conflicting environmental cues, and previous false alarms on warning response—especially in slow onset disasters.

Just over two decades later, Drabek (1986), building on an earlier work by Mileti, Drabek and Haas (1975), identified many research findings about organizational ability to disseminate timely and accurate warnings, and also about warning message content, receiver characteristics, and warning response. Among the most prominent issues were local emergency managers' receipt of incomplete, ambiguous, conflicting, or tardy information and lack of source credibility—together with withholding of information they had because of concerns about causing panic. The most important aspects of warning messages he identified were a) specificity about the type, location, severity, and timing of the threat; b) consistency among warning messages; c) identification of messages as coming from high credibility sources (especially government officials); and d) a protective action recommendation (PAR). Among receiver characteristics, personal experience with disaster impacts was reported to have a positive effect on protective action whereas false alarms have a negative impact. Drabek concluded that females are more likely, and older persons less likely, to believe and respond to warnings; and ethnic minorities differ from the majority in their perceptions of the credibility of authorities, news media, and peers (friends, relatives, neighbors, and coworkers). In most cases, people's first response to a disaster warning is disbelief so some continue normal activities, but many seek additional information from environmental cues or social sources. In addition, they may relay warnings to peers, engage in preparatory actions (e.g., packing suitcases for evacuation), or take immediate protective action (Perry, Lindell & Greene, 1981).

The 1980s saw an increase in warning researchers' concern for practical application. The US Nuclear Regulatory Commission (1980) established requirements for nuclear power plant operators to establish alert and notification systems and produce evacuation time estimates for their Emergency Planning Zone populations. In response, planners and researchers began to address the characteristics of different warning technologies, including their rate of warning dissemination. For example, Lindell and Perry (1987, 1992) categorized print (newspapers, magazines, and brochures), electronic (commercial radio and television), voice telephone, route alert broadcast (loudspeakers mounted on vehicles), tone alert radio, siren (mechanical and electronic), and face-to-face (dyadic conversation or group presentation) channels in terms of their

dissemination rate and precision, penetration of normal activities, message specificity/distortion, sender and receiver requirements for specialized equipment, and feedback/receipt verification (see Lindell & Prater, 2010, for an update that included telephone text, Internet, and social media in an application to tsunami warning systems). In addition, they criticized evacuation planners' arbitrarily assumed warning dissemination distributions and identified empirical distributions derived from actual disasters. Lindell and Prater later addressed these and other aspects of evacuation models—residents' and transients' number of evacuating vehicles, PAR compliance/spontaneous evacuation rates, departure time distributions, proximate destination/route choices, and ultimate destinations.

Similarly, the need to adopt best warning and evacuation practices for the Army's Chemical Stockpile Emergency Preparedness Program led to further work on warning dissemination times and warning message content (Sorensen, 2000; Sorensen & Sorensen, 2007). Rogers and Sorensen (1988) proposed a set of warning dissemination distributions for four warning technologies and Sorensen and Mileti (1989) concluded that warning response times typically following a logistic (S-shaped) curve that depends on perceived threat urgency. They summarized the most important message elements as the nature of the hazard, expected time and location of impact, protective action guidance, and identity of the warning source. In addition, they proposed that a warning message should address five style aspects—message specificity, consistency, accuracy, certainty, and clarity. They noted that warnings are disseminated more slowly at night, informal warning systems playing an important role in warning dissemination, and evacuation shadow (response in areas not warned by authorities to evacuate) tends to offset incomplete (less than 100%) warning compliance (Sorensen, 2000; Sorensen & Sorensen, 2007).

Finally, the years since Hurricane Katrina have seen a major convergence in work by social scientists and transportation engineers on household behavior in hurricane evacuations. This has led to the utilization of actual behavioral data, rather than unsupported assumptions in evacuation analyses (Lindell, 2013a; Lindell & Prater, 2007; Murray-Tuite & Wolshon, 2013). The profusion of hurricane evacuation studies has nearly been matched in tornado research, but there has been relatively little empirical research on warnings for other hazards such as earthquakes, volcanic eruptions, landslides, floods, and tsunamis (Lindell, 2012). Research is also needed on these hazards because they vary in characteristics, such as speed of onset/forewarning, intensity, and scope of impact, that have significant implications for warning dissemination.

22.3 The Protective Action Decision Model

The findings of warning research can be organized using the Protective Action Decision Model (PADM, see Fig. 22.1), which begins with environmental and social cues, and warnings (Lindell & Perry, 1992, 2004, 2012). Environmental cues are sights, smells, or sounds that signal the onset of a threat whereas social cues arise from observations of others' behavior. Warnings are messages that are transmitted from a source via a channel to a receiver, resulting in effects that depend on receiver characteristics (Lasswell, 1948; Johnson, Maio, & Smith-McLallen, 2005). The relevant effects are changes in receivers' beliefs and behaviors, whereas receivers' characteristics include their psychological—cognitive (e.g., primary and secondary languages), psychomotor (e.g., vision and hearing), and physical (e.g., strength)—abilities and disabilities (Stough & Mayhorn, 2013). Other receiver characteristics are economic (e.g., money and vehicles) and social/political (informal community networks and formal community organizations) resources.

Environmental cues, social cues, and warnings transmitted by authorities, news media, and peers initiate predecision processes that, in turn, elicit perceptions of the environmental threat, alternative protective actions, and relevant stakeholders—especially information sources.

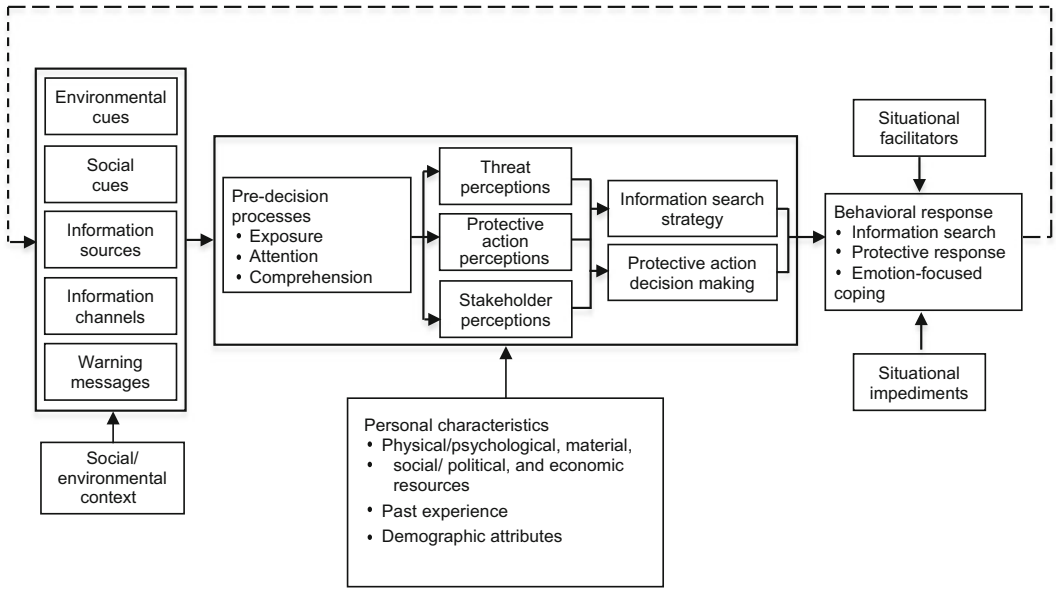

Fig. 22.1 Information flow in the PADM. *Source* Adapted from Lindell and Perry (2012)

These core perceptions provide the basis for protective action decision making which, in conjunction with situational facilitators and impediments, produces a behavioral response. In general, this response can be characterized as information search, protective response (problem-focused coping), or emotion-focused coping. Information search provides a feedback loop as information is sought from additional environmental/social cues and warnings. The sequence of stages in Fig. 22.1 characterizes the way people "typically" make decisions about protective actions for environmental hazards, but not everyone follows every step in the model in this exact sequence.

22.4 Environmental Context

Protective action decisions are made in an environmental context that has physical, social, and household components (Lindell et al., 2016a). One part of the physical context is the geophysical, meteorological, hydrological, or technological process that generates a hazard and transports it to the locations where people are exposed (see Lindell, 2013b). These hazards vary in their onset speed, and their impact severity, scope, and duration. The physical context also includes the structures in which people are located at the time of hazard impact, which are important because they protect occupants (e.g., upper floors in a flood) or threaten them (e.g., mobile homes in a tornado). The social context is defined by the presence or absence of other people who can provide information and assistance or who, themselves, need information and assistance (e.g., children). The household context comprises the presence or absence of household members, who typically seek information about absent members to confirm they are safe (Perry et al., 1981). Until family members have been reunited or separated family members can agree upon a place to meet, evacuation tends to be postponed (Drabek & Boggs, 1968). To a large extent, the social and household contexts are determined by time of day. Environmental context affects warning response by impeding access to warning channels, such as power outages that have left TVs and radios inoperable (Carter, Millson, & Allen, 1989; Mitchem, 2003), people being in motor vehicles during warnings (Glass et al., 1980; Mitchem 2003), or storms happening at night when people are asleep and have TVs

and radios off (Schmidlin, King, Hummer, & Ono, 1998).

22.4.1 Environmental and Social Cues

There is substantial variation across hazards in the extent to which people are warned by environmental and social cues. In some cases, such as earthquakes, environmental cues are the primary source of initial information about the threat, whereas in other cases, such as radiological releases, there are no environmental cues whatsoever. Other situations fall in between these two extremes, depending on a hazard's speed of onset and the sophistication of detection and dissemination systems (Perry, 1983), as well as the degree to which people have experience or training to interpret ambiguous environmental cues such as shoreline recession as a tsunami cue.

Tornado warnings are challenging for meteorologists because they often provide only a few minutes of forewarning (Carbin, Heinselman, & Stensrud, 2013) so there are cases in which half of the survivors had only environmental cues to warn them (Schmidlin & King, 1995). In other cases, people are warned by social sources but search the horizon for a funnel cloud to confirm that warning (Tiefenbacher, Monfredo, Shuey, & Cecora, 2001). Like tornadoes, volcanic eruptions are difficult to predict, so many of those living near Mt. St. Helens were warned by environmental cues during the May 18, 1980 eruption—30% in Toutle/Silver Lake close to the volcano but only 14% in Woodland farther away (Lindell & Perry, 1987). Tsunamis provide a special challenge, not only because of their rapid onset but also because their environmental cues can be quite ambiguous; many victims are unaware of that earthquake shaking (Esteban et al., 2013; Yun & Hamada, 2015) and shoreline recession (Bird, Chagué-Goff, & Gero, 2011; Gregg et al., 2006) are indicators of tsunami onset. Those who correctly interpret these cues as evidence of an imminent tsunami take appropriate protective actions and warn others to do so (Lindell et al., 2015a).

The extent of reliance on environmental cues is quite variable, as indicated by the Perry et al. (1981) finding that the percentage of respondents first warned by observation of high water was lowest when the water rose slowly (in the town of Snoqualmie—1.3%) and highest in a flash flood (in the town of Fillmore—27.8%). Environmental cues are unlikely to stimulate protective response to hurricanes because of the long forewarning of these storms. However, there is an effect of social cues such as peers' visible preparations to evacuate or businesses closing (Baker, 1991; Huang, Lindell, & Prater, 2016).

Future research on this topic needs to systematically extend the few studies that have examined people's erroneous beliefs—or lack of beliefs—about environmental hazards (Whitney, Lindell, & Nguyen, 2004) even when they receive a hazard warnings (Wei, Lindell, & Prater, 2014). Such research needs to examine the extent to which people are able to correctly interpret environmental cues, understand hazard characteristics such as speed of onset and likely personal impacts, identify the most effective ways to train people about environmental cues, and evaluate the most effective ways to disseminate this information beyond the few people who take such training classes.

22.4.2 Information Sources

One important part of the social context is the network of organizations and individuals that comprise the formal and informal warning networks (Lindell, Prater, & Peacock, 2007). Most hazard information is generated by a detection system that uses satellites, radar, and other technologies to detect indicators that are too subtle for risk area residents' unaided senses. From there, information passes to a dissemination system comprising *broadcast* and *diffusion* processes (Rogers & Sorensen, 1988). As Fig. 22.2 indicates, an original source can transmit a message by means of a simultaneous *broadcast* process directly to end users of that information (see the chain from *Original source 1* to *End user 1*) and a sequential *diffusion*

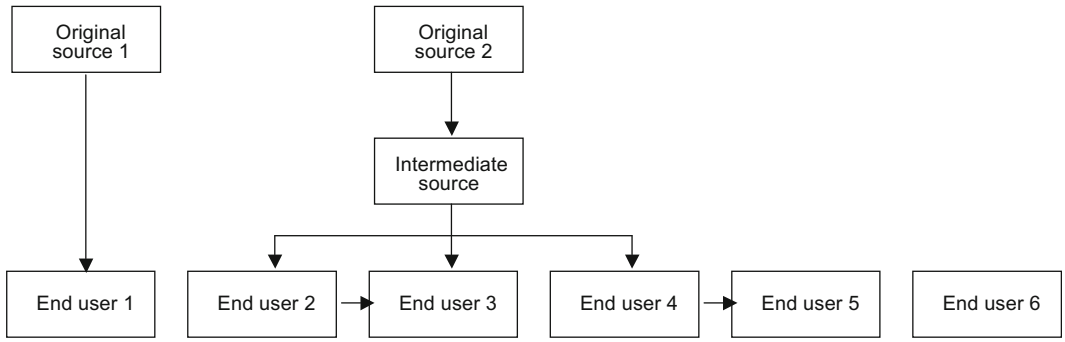

Fig. 22.2 Communication network model. *Source* Adapted from Lindell and Perry (2004)

process through intermediate sources who, in turn, relay messages to end users (see the chain from *Original source 2 to End users 2, 3 and 4*). These peers might also transmit messages to each other, resulting in some people receiving multiple warnings (*End user 3*), whereas others receive no warnings (*End user 6*). The combination of multiple broadcast channels (many TV and radio stations) and a complex diffusion network can generate confusing and conflicting messages that require searching for warning confirmation and additional information.

The relative proportions of those at risk who are first warned by authorities, news media, and peers varies by hazard as well as across different instances of a given hazard—due to variations in community characteristics (e.g., emergency preparedness) and situational context (e.g., time of day). Nonetheless, many studies have found that first warnings are more common from news media than from peers which, in turn, are more common than from authorities. This pattern has been found for hazards as diverse as tsunamis (Perry, 2007; Yun & Hamada, 2015) and hurricanes (Baker, 1991; Huang et al., 2016). The news media are especially important for hazards providing ample forewarning, such as hurricanes. For example, 58% of respondents reported leaving news media channels on all day when a hurricane is within 2–3 days of striking their area (Dow & Cutter, 2000). Similarly, Perry et al. (1982a) found that 55% of those living near Mt. St. Helens monitored the news media for updates four or more times per day before the May 18, 1980 eruption. However, continuous information seeking was less effective in anticipating the volcano's eruption because its timing was more difficult to predict than a hurricane landfall.

The patterns of first warning source are especially variable for disasters having little forewarning. Perry et al. (1981) reported that two of their flooded communities (Fillmore and Sumner) had no warnings through the news media and authorities were more important than peers in Fillmore (62% vs. 38%) whereas the reverse was true in Sumner (11% vs. 89%), where flooding was caused by a nighttime levee failure. In the other two communities (Valley and Snoqualmie), the percentages warned by authorities and peers were approximately equal but more people received warnings from the news media in Valley (23%) than in Snoqualmie (9%) because Valley residents were alerted days in advance of the ice dam that eventually caused the flooding. Similarly, Perry and Greene's (1983) data on first warning source during the Mt. St. Helens eruption revealed that more people in Toutle/Silver Lake (closer to the volcano) were warned by authorities (48%) than by peers (41%) or news media (11%). By contrast, warnings from peers (58%) were more common in Woodland (farther from the volcano and unaffected by flooding) than warnings from authorities (21%) or the news media (21%).

The pattern for tornadoes can be even more distinctive; a storm in which most people had only environmental cues resulted in 16% receiving warnings from peers, 13% from news media and none from authorities (Schmidlin & King, 1995).

Being warned first by an authority is important because it produces greater risk perception and immediate protective action (Perry & Greene, 1983). Indeed, even when people receive information from authorities less frequently than from other sources (Lindell, Lu & Prater, 2005), public officials' PARs strongly affect evacuation (Peek & Mileti, 2002; Sorensen, 2000). In particular, households are more likely to evacuate if they receive official evacuation orders, especially if these are—or are perceived to be—mandatory (Baker, 1991; Huang et al., 2016). Indeed, official warnings appear to have a direct effect, as well as an indirect effect, on household evacuation (Baker, 1991; Gladwin, Gladwin & Peacock, 2001). A direct effect, in which people comply with the source regardless of their own situational assessment, is theoretically consistent with the Elaboration Likelihood Model's peripheral route to persuasion (Petty & Cacioppo, 1986; Johnson et al., 2005). Unlike the central route, which engages cognitive processing of message content, the peripheral route comprises cues such as source characteristics and message length.

Because the results on source of first warning vary so substantially, future research needs to explain the conditions under which different sources become more prevalent. In addition, research on warning sources needs to identify the types of information typically provided by the first source and subsequent sources; and the effects of first source and subsequent sources on recipients' psychological processes, recipient warning confirmation, warning relay, and protective actions.

22.4.3 Warning Channels

Research has found that all warning channels have limitations as well as advantages. For example, mechanical sirens can transmit a tone rapidly—Lachman, Tatsuoka and Bonk's (1961) study of the 1960 Hilo tsunami found that 95% of respondents reported hearing sirens activated before wave arrival. However, such sirens cannot provide specific warnings —10% interpreted the siren only as an "alert" that had no specific behavioral implications. Similar confusion about how people should respond to tsunami sirens has continued to the present (Gregg et al., 2007). By contrast, tornado sirens are used more frequently and predictably (during severe storms, especially in the Midwest and Southeast US) and tend to produce better results. For example, 88% of those in an area with tornado sirens received a warning and most of these received their warnings from a siren (62%) or radio/television (34%). By contrast, only a minority (29%) of those in an area without sirens received a warning and 73% of these received their warnings from radio or TV (Liu et al., 1996).

When there is enough time to disseminate warnings through broadcast media, this does not necessarily mean that everyone at risk will receive a warning at all, let alone promptly. Lindell, Huang and Prater (2017) found that people's highest levels of news media access were only 11 hr/day for both TV and radio, so even the most connected individuals lacked contact with the news media for most of the day. Nonetheless, TV and radio can be common warning channels; Beatley and Brower (1986) reported that respondents named TV (53%) and radio (42%) as their primary sources of hurricane information. Perry's (2007) study of tsunami warnings in Mauritius during the 2004 Indian Ocean tsunami also found that TV (51%) and radio (28%) were the most common warning

channels. Similarly, Lindell et al. (2017) found that TV (66%) and radio (21%) were major channels in a water contamination incident and Brown, Archer, Kruger and Mallonee (2002) found that two of the most common tornado warning channels were TV (80%) and radio (17%). One limitation of the broadcast media is the need for electric power, which can be lost before warnings are issued. For example, Carter et al. (1989) found that most respondents in their study had access to TV (51%) or radio (85%) and many (45%) had monitored these channels before the tornado struck. However, the storm disrupted electric power so people were unable to receive warnings from the news media unless they had battery powered radios. The consequence of news media access can be seen in Schmidlin and King's (1995) finding that the survival rate was 70% for those who were watching TV before tornado impact but only 25% for those who were not (see also Legates & Biddle, 1999).

Recent research suggests that the Internet in general, and social media in particular, are becoming increasingly valuable warning channels. A decade ago, Lindell et al. (2005) reported that the Internet was by far the least important information channel in Hurricane Lili and Hayden et al. (2007) found that only about 5% named the Internet as their primary channel for weather information, although this rose to 40% when people were asked to report all channels. More recently, 34% of respondents listed the Internet as a major information channel during a water contamination incident (Lindell et al., 2017). Major advantages of social media are the capability for two-way communication between official sources and risk area residents (Alexander, 2014) and the ability of those who receive an initial warning directly from civil authorities and the news media to relay those warnings through informal peer networks (Parker & Handmer, 1998; Vihalemm, Kiisel, & Harro-Loit, 2012). Twitter users can provide new information, relay or synthesize existing information, and relay information about sources to follow (Starbird, Palen, Hughes, & Vieweg, 2010)—with information relaying accounting for about half of all disaster-related tweets (Vultee & Vultee, 2011). Twitter users also can respond rapidly; the Tōhoku earthquake prompted a massive number of tweets within an hour (Spong, 2011). However, some studies have found Twitter to be much less frequently used than Internet websites and cell phone contacts with peers (Sutton, Palen, & Shlovski, 2008). Moreover, Twitter was considered less credible than mass media after the 2010 earthquake in Chile (Castillo, Mendoza, & Poblete, 2011) so it is unclear how much people actually rely on the this channel in making protective action decisions. It is also unclear what proportion of tweets involve communication with people at risk, rather than unthreatened observers who are merely commenting on the incident.

One important new warning channel is the wireless emergency alert (WEA) system that can transmit 90-character warnings to cell phones and other mobile devices (Bean et al., 2015a). One obvious advantage of WEA is that it can increase the likelihood of people at risk receiving, heeding, and understanding that the warning applies to them. Such messages are necessarily limited to verbal and numeric information but it is possible to embed links to Internet sites that provide graphic information. With few exceptions (e.g., Sutton, League, Sellnow, & Sellnow, 2015), research on this channel has been limited to public health interventions (e.g., Abroms et al., 2012) and food hazards (e.g., Frisby, Veil, & Sellnow, 2013).

22.4.4 Warning Dissemination Times

There have been some significant advances in estimating warning time distributions since initial studies reported data from four floods and the eruption of Mount St. Helens (Lindell & Perry, 1987) and two hazardous materials accidents (Rogers & Sorensen, 1989). People in risk areas vary substantially in the time of warning receipt,

but warning dissemination can be quite rapid in some incidents and slow in others. For example, Perry and Greene (1983) reported that most people received warnings within one hour of the eruption (87% in the area of greatest risk, 59% in the area of lesser risk) and most had been warned within four hours (96% and 97%, respectively). By contrast, Perry's (2007) study of tsunami responses in Mauritius following the 2004 Indian Ocean tsunami showed that it took about six hours after the earthquake before the first warnings were issued. Although tsunami waves struck repeatedly 1.0–4.5 hours after warnings were initiated, only 42% of the respondents received a warning by the time the *last* wave arrived and it took almost eight hours to notify 94% of the population. Warning times were also quite variable for a water contamination incident in which about 25% of the respondents received a warning within the first four hours after the incident began but another 40% were warned within the next two hours, which coincided with a major time for TV viewing (Lindell et al., 2017). Finally, Angulo et al. (1997) reported only 10% of their respondents were aware of a water contamination incident after 10 days, and Ram et al. (2007) reported only 39% of their respondents were aware of a boil water advisory six weeks after it was issued.

Tornado studies have also addressed times of warning receipt but these have focused on the length of time before impact rather than the length of time since warning initiation so it is difficult to compare results of tornado studies with those of other hazards. For example, Carter et al. (1989) described tornado response in a community where 25% of the respondents reported no forewarning, 66% reported less than one minute, and the remainder reported less than five minutes. Hammer and Schmidlin (2002) reported that 5% of their sample had less than 5 min of forewarning, 17% had 5–15 min, 20% had 15–30 min, and 57% had greater than 30 min. Similarly, Legates and Biddle (1999) reported that few residents had no warning at all (2%) or less than 1 min of forewarning (5%), many residents had 2–5 min (22%), or 6–10 min (11%), but most (40%) had more than 10 min.

Future research on warning channels needs to collect more data on dissemination times for hazards with different characteristics (especially speed of onset/amount of forewarning, scope of impact, and impact severity) in different physical, social, and household contexts. In particular, there is a need for a better understanding of peer dissemination processes to improve mathematical models of warning dissemination (e.g., Hui, Goldberg, Magdon-Ismail, & Wallace, 2008). However, these models need to distinguish among those in risk areas, fringe areas, and beyond because people in these three areas differ significantly in their risk and, thus, are likely to differ significantly in the likelihood of receiving warnings that are relayed by peers. Future research needs to cross-tabulate warning receipt time by warning channel and also distinguish between time of receipt after warning initiation by authorities (the most common procedure) and time of receipt before disaster impact (the practice in tornado studies). Such research also needs to extend Sorensen's (1991) work on identifying predictors of household warning reception times in the 1987 Nanticoke Pennsylvania chemical incident.

22.4.5 Warning Messages

Reviews of warning research have concluded that messages should describe the threat, affected (and safe) areas, protective action recommendations, message source, implementation deadline, and sources to contact for additional information and official assistance (Lindell & Perry, 2004, Chap. 5; Mileti & Sorensen, 1987). Warning messages providing information that is specific (contains details about message elements), consistent (among sources at a given time and across time for a given source), certain, clear, and accurate (Bean et al., 2015; Mileti & Peek, 2000), are expected to produce situational risk perceptions about likely casualties, damage, and disruption to the community in general and to one's family in particular (Huang et al., 2012).

Some recent studies have examined the extent to which warning messages actually contain the recommended message elements. In the American Samoa tsunami (Lindell et al., 2015a), the rank order of warning message elements was safe areas (49%), tsunami threat (46%), protective action recommendation (35%), affected areas (26%), sources of assistance (10%), and sources of additional information (6%). One possible explanation for the inconsistency with recommendations from previous research is that the appropriate protective action (evacuation) was implicit in the recommended safe area and the identification of a safe area implicitly defined the affected area. However, none of the message elements was significantly correlated with evacuation, a result that might be due to earthquake shaking as a powerful environmental cue that substantially reduced the need for social warnings.

In the Boston water contamination incident (Lindell et al., 2017), the rank order of warning message elements was threat (82%), protective action recommendation (76%), affected areas (52%), sources of additional information (16%), and safe areas (9%). Here too, the results were inconsistent with research recommendations, especially the finding that only 52% of the messages mentioned the affected areas because this would be an essential element in conveying a perception of *personal risk*—a critical condition for protective action (Mileti & Sorensen, 1987; Withey, 1962). However, affected areas were more prominent in the news media warnings, which were broadcast to thousands, than in peer warnings, which were delivered either face-to-face or through telephone messages. This is presumably because these channels provide a one-to-one relationship between sender and receiver, making it clear that the message recipient is at personal risk. Consistent with recommendations, 76% of the first warnings included a PAR—possibly because the appropriate protective action is not quite so obvious for a water contamination incident as for a tsunami.

There appear to be some significant differences among warning sources in the message content they provide (Lindell et al., 2017). Specifically, peers were significantly less likely, and the news media were significantly more likely, to provide information about all aspects of message content except threat. This suggests that peers perform a function that is much like that of a siren's "general alert"—to interrupt normal activities by providing an ambiguous signal that "something is wrong" (Lindell & Perry, 1987). By contrast, the news media provide the detailed information about what is the threat, who is (and is not) at risk, what to do for protection, and where to obtain additional information.

Most research has focused on verbally communicated warnings but more recent studies have examined people's interpretation of graphic displays—especially probable impact areas. Broad, Leiserowitz, Weinkle, and Steketee (2007) examined people's interpretations of *uncertainty cones,* which are geometric figures that display forecasters' uncertainty about hurricane tracks. They contended that, although the uncertainty cone is a 67% confidence interval, some people believe the cone contains *all* of the forecast errors (see also Meyer, Broad, Orlove, & Petrovic, 2013). However, Baker's (2005) survey of the Hurricane Charley evacuation found no statistically significant differences among those reporting having seen a line (i.e., forecast track), an uncertainty cone, or both. Moreover, Wu, Lindell, Prater, and Samuelson (2014) found no appreciable differences in the patterns of strike probability (p_s) judgments among those who viewed forecast track only, uncertainty cone only, both. In particular, p_s judgments for sectors outside the uncertainty cone were not zero—even for those in the opposite direction of the track.

Other experiments have examined alternative graphical displays such as a track ensemble display that generates potential hurricane tracks in proportion to their historical likelihood of occurrence (Cox, House, & Lindell, 2013). Ruginski et al. (2016) assigned participants to five display conditions—track only, cone only, track/cone, fuzzy cone, and track ensemble. There were some small differences among the displays, but all elicited a pattern of declining damage judgments with distance from the track centerline. Finally, a study of dynamic decision making examined

information search patterns of participants tracking hypothetical hurricanes (Wu, Lindell, & Prater, 2016), as well as their p_s judgments for six cities around the Gulf of Mexico and their protective action recommendations for the jurisdiction to which they were assigned (Wu, Lindell, & Prater, 2015). The p_s judgments in this latter study showed a pattern similar to that in Wu et al., (2014); they were initially highest ($p_s \geq .5$) and steadily increased for the target city, were slightly lower ($p_s \leq .4$) and declined for adjacent cities (generally 200–300 mi—320–480 km—from the target city), and were substantially lower ($p_s \leq .2$) and declined almost to zero for remote cities that were even farther away.

There has also been research on tornado warning polygons that found only 26.3% of their respondents could correctly explain what one was (Mason & Senkbeil, 2014) and that respondents tended to misjudge the area of highest risk (Sherman-Morris & Brown, 2012). Ash, Schumann and Bowser (2014) found that a standard warning polygon had the highest overall ratings of fear and protective action in a small area at the centroid. By contrast, a spectral format that divided the polygon into nine regions defined by a range of hues from the color spectrum and a red gradient format that divided the polygon into five regions defined by varying shades of red produced much larger areas of high ratings for both dependent variables and these were located close to the storm front. In a different experiment, participants responding to 15 standard warning polygons made p_s judgments and rated the likelihood they would take nine response actions ranging from continuing normal activities to getting in a car and driving somewhere safer (Lindell, Huang, Wei, & Samuelson, 2016a). Consistent with a distance-decay heuristic, the highest p_s was highest at the polygon's centroid, lower just inside the edges of the polygon, still lower (but not zero) just outside the edges of the polygon, and lowest in locations beyond that. Moreover, higher p_s values were associated with lower expectations of continuing normal activities, higher expectations of seeking information from social sources, and higher expectations of seeking shelter. A subsequent study that found that embedding the polygon within its natural context—a radar display of the storm cells—significantly reduced the centroid effect by increasing p_s ratings at the polygon edge nearest the location of the tornadic storm cell (Jon, Huang, & Lindell, in press).

In summary, the limited research available suggests that the list of "essential" warning message elements depends on the nature of the hazard, the environmental context, and—especially—warning recipients' prior beliefs about the hazard and appropriate protective actions. Thus, the more knowledgeable people are about the threat and appropriate protective actions, the less information sources need to communicate in warning messages. In addition, the ability of WEA systems to deliver location-targeted messages has the potential for overcoming the difficulties that people have in orienting themselves on risk area maps (Arlikatti, Lindell, Prater, & Zhang, 2006; Zhang, Prater, & Lindell, 2004). However, it is unclear if this potential advantage will be realized in practice and, moreover, if people would prefer to see maps, because they provide a comprehensive view of the situation, even if viewers do not process graphical information effectively. Finally, there is a need to conduct more research on the relative effectiveness of verbal, numeric (i.e., individual and tabular strike probabilities), and graphic (i.e., geographical background and probability representation) information modes in communicating uncertainty through warnings and hazard awareness messages. Such research is relevant to research on warning channels because of the constraints of channel limitations on message mode and length.

22.5 Receiver Characteristics

People's processing of information about environmental hazards is affected by cognitive limitations in attention, working memory, and long-term memory; a disparity between concrete experiential and abstract semantic systems of memory; and the effects of emotions on cognitive processes (Lindell, 2014). Abstract schemas (Fiske & Taylor, 2008) or mental models (Wood, Bostrom, Bridges, & Linkov, 2012)—

the terms are nearly intersubstitutable—are generic knowledge structures comprising objects, attributes that differentiate these objects, interrelationships among the attributes, and interrelationships among the objects. As an example, the PADM depiction in Fig. 22.1 is a mental model. Schemas/mental models influence predecision processes and can be rapidly accessed to produce overall judgments about threats and protective actions that are congruent with the available (and inferred) information about a situation. People vary in the degree of differentiation in their schemas about environmental hazards, protective actions, and stakeholders. Morss, Demuth, Bostrom, Lazo, and Lazrus (2015) examined the differences among forecasters', public officials', and media broadcasters' mental models of the process of detecting, forecasting, and disseminating warnings about flash floods in Boulder Colorado. A companion study by Lazrus, Morss, Demuth, Lazo, and Bostrom (2016) collected data from local residents of that area, which showed that most respondents had incomplete conceptions and misconceptions about flash flood risks that could adversely affect their warning response.

People can develop hazard schemas through personal experience (Baker, 1991; Huang et al., in press), disaster subcultures (Wenger, 1978), and formal training programs (Dudley et al., 2011) but there is limited and conflicting evidence of the effects of these three sources on people's hazard schemas and, in turn, warning processes. First, there is mixed evidence about the effect of experience on warning response, with some studies suggesting that disaster experience increases protective action in subsequent events (e.g., Blanchard-Boehm & Cook, 2004; Simmons & Sutter, 2007), but other studies have raised questions about the relative effects of personal and vicarious experience in changing subsequent behavior (Hanson, Vitek, & Hanson, 1979) and whether there are significant changes in behavior as a function of experience. For example, some studies have found no effect of experience because there was the same level of protective action in subsequent tornadoes (Comstock & Mallonee, 2005) and hurricanes (Dow & Cutter, 1998); most people took the same action on both occasions and those who took more protective action in a second event were offset by those who took less protective action.

Such conflicting findings have raised questions about the equivalence of different measures of "experience" (Baker, 1991; Lindell & Perry, 2000)—with some surveys asking questions such as whether a respondent "had been in" a hurricane, the number of hurricanes experienced in the respondent's lifetime, the number of hurricanes experienced in recent years, the dollar cost of personal hurricanes losses, and the experience of personal consequences—injuries, damage, and disruption—by self and family (Huang et al., in press; Lindell, 2012). Another relevant issue is what people learn from their experience (Weinstein, 1989). For example, Baker (1991) called attention to the problem of "false experience" among people who believe that, because they have survived *strong* wind speeds from a given storm, they have survived *the strongest* wind speeds from that storm—even though their houses might have been subjected to relatively slow wind speeds on a hurricane's fringe. As a result of this misconception, some people overestimate their homes' ability to withstand a major hurricane and, thus, are less likely to evacuate from subsequent storms.

There is also conflicting evidence about the degree to which people's evacuation decisions are affected by their experience with a false alarm. Most people who evacuate for a hurricane that subsequently misses their community would nevertheless evacuate when another storm threatened (Baker, 1991; Dow & Cutter, 1998). In general, hurricane evacuation surveys show a nonsignificant effect of "unnecessary" evacuation experience on evacuation decisions (Huang et al., in press). However, Trainor, Nagele, Philips, and Scott's (2015) study of tornadoes found that most people accurately interpret a false alarm as "a predicted event that did not happen" but a notable minority thought it meant that the threat never existed. Most of their respondents also believed that false alarms are extremely rare or nonexistent events and their ratings of false alarm

frequency were unrelated to the actual incidence of false alarms in their area but were related to their protective actions. These conflicting results might be due to different groups of people interpreting their experience in different ways. For example, Dillon and Tinsley and their colleagues have conducted an extensive line of experiments on people's interpretations of near misses (e.g., Dillon, Tinsley, & Burns, 2014), which some people interpret as a "disaster that did not occur" because the system is resilient; thus they have lower estimates of future hazard probabilities and take riskier actions. However, other people interpret a near miss as a "disaster that almost happened" and thus conclude that the system is vulnerable, have higher estimates of future hazard probabilities, and take more protective actions.

Frequent, recent, and severe impacts make the community's vulnerability to hazards more memorable and more likely to stimulate action. In some cases, this leads to the development of a *disaster subculture* in which community residents adopt routinized patterns of disaster behavior (Wenger, 1978). Moreover, community members maintain awareness of their hazard exposure by communicating their experience through successive generations and to newcomers to the community (Fritz & Kallegeris, 2008; Gaillard et al., 2008).

Few researchers have studied the impact of formal hazard awareness and training programs, but one recent study found that attendance at earthquake and tsunami meetings increased later situational threat perceptions although they had no impact on outcomes such as evacuation delay and household casualties (Lindell et al., 2015b). Receipt of earthquake and tsunami brochures also increased situational threat perceptions but had no other effects. Interestingly, there was a much higher high level of recognition that an earthquake could produce a tsunami than would be expected from the low levels of participation in meetings and receipt of brochures. This suggests that the connection between earthquakes and tsunamis is very easy for participants in meetings or recipients of brochures to communicate to others either before or immediately after an earthquake.

The principal receiver characteristics examined in most studies are demographic characteristics. Although warning studies consistently find significant effects of some demographic variables, the effects are generally weak in each study and tend to be inconsistent among studies (Baker, 1991; Huang et al., 2016). Part of the problem is that few demographic variables directly measure people's resources as, for example, annual household income is a measure of financial resources. Instead, most demographic variables measure an unknown combination of resources as, for example, age is related to a variety of cognitive (memory impairment), psychomotor (vision loss), physical (mobility decline), economic (increased poverty), and social (increased social isolation) resources (Perry & Lindell, 1997; Stough & Mayhorn, 2013).

Finally, most research has focused on the effects of receiver characteristics on immediate protective action. Thus, it has neglected examination of other aspects of the warning process such as reception time; predecision processes; situational perceptions of threat, protective actions and stakeholders; warning confirmation; and protective action decision making. Another important topic for further research is assessing risk area residents' schemas of hazard exposure processes because studies of water contamination (Lindell et al., 2015b) have found that people's beliefs about the hazards of different exposure paths ranging from superficial skin contact (e.g., taking a shower) to drinking untreated tap water (and in the latter case, the amount consumed) differ noticeably from the distance-decay heuristic used for other hazards such as hurricanes (Wu et al., 2014) and tornadoes (Lindell et al., 2015a). Researchers also need to examine different measures of hazard experience and identify the elements that are most useful in explaining warning response. Finally, although research indicates that demographic variables have inconsistent correlations with disaster response, further research is needed to determine if they have stronger effects on earlier stages of

the warning process such as perception of the threat, protective actions, and stakeholders.

22.6 Psychological Processes

Psychological processes are defined by three sets of activities—predecisional processes; situational perceptions of the threat, alternative protective actions, and social stakeholders; and protective action decision making. The three predecisional processes of exposure, attention, and comprehension are largely automatic processes that take place outside of conscious processing (Fiske & Taylor, 2008). The three most relevant perceptual objects—environmental threats, alternative protective actions, and societal stakeholders—can elicit either automatic or reflective judgments, depending on the degree to which people have schemas providing readily accessible beliefs about those objects and the degree to which situational information is consistent with those schemas.

22.6.1 Predecisional Processes

Warning reception is influenced by people's routine channel access and preferences (Lindell et al., 2017). Moreover, hazards that provide advance cues—such as tornadoes and hurricanes—prompt people to monitor warning channels more frequently than normal. Moreover, people's attention to the available information is determined by their expectations, competing attention demands, and the intrusiveness of the information. Finally, the comprehension of warning messages depends upon whether the message is conveyed in words the receivers interpret correctly. For example, Aguirre (1988) concluded that an inadequate translation of the English word "warning" into the Spanish word "aviso" (which does not carry the same sense of urgency) contributed to the 29 deaths in Saragosa.

22.6.2 Core Perceptions—Threats, Protective Actions, and Stakeholders

Unlike comprehension, which provides the literal meaning of the words in a warning message, perceptions of the threat, alternative protective actions, and stakeholders involve an integration of situational information with pre-existing schemas within which beliefs about the threat, protective actions, and stakeholders are embedded.

22.6.2.1 Perceptions of Threat

As explained in greater detail by Lindell and Perry (2004, 2012), people's decisions about how to respond to an imminent threat begin with risk identification, which poses the basic question, "Is there a real threat that I need to pay attention to?" to produce a *threat belief*. The next step, risk assessment, involves evaluating the threat, which results in *protection motivation*. The most commonly studied attributes of people's environmental threat perceptions are probability and consequences, but some other well-known attributes are *dread* and *unknown* risks (e.g., Slovic, Fischhoff, & Lichtenstein, 1980). Lindell (1994) combined dimensions from Slovic and his colleagues with ones that had been identified by disaster researchers (hazard agent characteristics, impact characteristics, perceived personal consequences, and affective reactions) and Trumbo et al. (2016) extended this line of research by developing a cognitive/affective scale for hurricane perception. Hazards researchers have emphasized the definition of perceived risk in terms of people's expectations of the personal impacts that an extreme environmental event can cause (Mileti & Peek, 2000; Mileti & Sorensen, 1987). Such personal consequences include death, injury, property damage; interruption of essential services such as water and electric power; and disruption to daily activities such as work, school, and shopping (Huang et al., in press). Much research on environmental hazards has examined the ability of

expected personal consequences to predict protective actions such as evacuation (Sorensen, 2000) but has neglected other warning responses such as warning confirmation, warning relay, and timing of protective action initiation.

The importance of affective reactions has long been recognized in warning research (Janis, 1962; Janis & Mann, 1977) and has continued to attract interest (Prati, Catufi, & Pietrantonio, 2012). Recently, Lindell et al. (2016b) found that expected personal consequences were significantly correlated with three relatively distinct affective reactions; shock and fear were strongly correlated with each other but fear was negatively correlated and shock was uncorrelated with vigilance. These correlations indicate that researchers might need to adopt a differentiated conception of emotional reactions rather than assuming that affect is a unitary construct (e.g., Slovic & Peters, 2006). They also need to carefully examine the relationship between affective reactions and (cognitive) risk perceptions in actual emergencies in order to assess the generalizability of findings from laboratory studies (Slovic, Finucane, Peters, & McGregor, 2007).

Perceived personal risk is related to the recency, frequency, and intensity of people's personal experience with hazard events (Lindell & Hwang, 2008; Weinstein, 1989). Like perceived risk, personal experience can involve casualties or damage experienced by the respondent him/herself, by members of the immediate or extended family, or by friends, neighbors, or coworkers (Lindell & Prater, 2000). In turn, hazard experience is correlated with proximity to earthquake (Palm, Hodgson, Blanchard, & Lyons, 1990), hurricane (Peacock, Brody, & Highfield, 2005), and flood (Preston, Taylor, & Hedge, 1983) sources. In addition to the indirect effect of hazard proximity on risk perception (via hazard experience), there can also be a direct relation between hazard proximity and perceived personal risk that is determined by a perceived risk gradient relating increasing proximity to increased risk (Lindell & Earle, 1983; Lindell et al., 2016a). However, these perceived risk gradients can produce inaccurate conclusions because people have inaccurate beliefs about their location in risk areas (Arlikatti et al., 2006; Zhang et al., 2004). Risk perception also has been reported to be significantly related to some demographic characteristics, but the only consistently significant correlation appears to be with female gender (Fothergill, 1996; Lindell, 2013c). Although this gender effect is consistent, it is less clear why it occurs (Davidson & Freudenberg, 1996).

Research on threat perceptions needs to examine the interrelations among perceptions of hazard agent characteristics, impact characteristics, expected personal consequences, and affective reactions to see how they affect each other and how they influence warning confirmation and protective action decision making. In particular, warning research needs to examine the relationship between risk perception defined in terms of broad hazard dimensions (Lindell, 1994; Trumbo et al., 2016), personal consequences (Huang et al., 2012; Mileti & Sorensen, 1987), hazard intrusiveness (Ge, Peacock, & Lindell, 2011; Lindell & Prater, 2000), and affect (Lindell et al., 2016b; Terpstra, 2011).

22.6.2.2 Perceptions of Protective Actions

If a threat is judged to be real and some unacceptable level of personal risk exists, people are motivated to engage in protective action search—which poses the question "What can be done to achieve protection?" to produce a *decision set* of potential protective actions. These protective actions might be recalled from previous experience with that hazard, experience with similar hazards, observing the behavior of others, or receiving PARs in warnings. After people have established that at least one protective action is available, they begin *protective action assessment*, which involves examining the alternatives, comparing their consequences to those of continuing normal activities, and determining the most suitable response. At this point, the primary question is "What is the best method of protection?" and its outcome is an *adaptive plan*.

Lindell and Perry (2004, 2012) proposed that, like long-term hazard adjustments, immediate protective actions can be characterized by *hazard-related* and *resource-related* attributes. Hazard-related attributes, such as efficacy in protecting people and efficacy in protecting property, address the link between a protective action and a hazard. These attributes have been found to be significantly correlated with adoption intention and actual adjustment (Lindell & Whitney, 2000; Lindell & Prater, 2002; Terpstra & Lindell, 2013; Wei et al., in press). Resource-related attributes (cost, knowledge and skill requirements, time requirements, effort requirements, and required cooperation with others) address the link between a protective action and a household's resources. These attributes are predicted to have negative correlations with both adoption intention and actual adjustment adoption, but these have generally been small and nonsignificant in studies conducted to date. However, the hazard adjustments in these studies have generally had small resource requirements, so it is unclear if the lack of support for the significance of these attributes is due to this factor (Lindell et al., 2009). Moreover, few studies have systematically assessed perceptions of protective action attributes. Lindell and Perry (1992) reported evacuation was rated higher than sheltering in-place and expedient respiratory protection in efficacy for protecting persons (a positive consequence), but it also was judged to be higher in resource requirements for time, effort, skill, cost, and barriers to implementation (all negative consequences). Lindell et al. (in press, b) examined profiles of protective actions on hazard-related and resource-related attributes to identify reasons why people preferred to use bottled water rather than boil it or personally chlorinate it and found that perceived effectiveness in protecting health was the most important correlate of protective action. The importance of bottled water's effectiveness caused this dimension to offset poor ratings on other attributes such as cost. A few studies have assessed specific attributes of protective actions such as evacuation impediments, with Huang et al. (2016) concluding that attributes such as concerns about looting, property protection, evacuation expenses, and traffic jams were not significantly correlated with hurricane evacuation.

People's adaptive plans vary widely in their specificity, with some being only vague goals (e.g., "We'll stay with my sister's family") and others being extremely detailed. At minimum, a specific evacuation plan includes a destination, a route of travel, and a means of transportation (Perry et al., 1981). More detailed plans include procedures for reuniting families if members are separated, advance contact to confirm that accommodations are available at the destination, consideration of alternative routes if the primary route is unsafe or too crowded, and alternative methods of transportation is the primary one is not available. These issues of evacuation logistics have received increasing attention in hurricane research (e.g., Lindell et al., 2011; Wu et al., 2012) but this issue needs to be addressed in studies of other hazards as well.

Research on protective action perceptions needs to examine people's pre-existing beliefs about different protective actions for imminent threats, as well as the susceptibility of these perceptions to change through warning messages from different information sources. In addition, there is a need to continue examining the effects of protective action attributes on adoption intentions and actual adoption to see if hazard-related attributes such as efficacy in protecting persons and property have significantly higher correlated with adoption intentions and actual adoption than the resource-related attributes.

22.6.2.3 Perceptions of Social Stakeholders

Although more complex typologies have been proposed, Drabek's (1986) categorization of authorities, news media, and peers is quite useful for disaster researchers. These stakeholders have been characterized in terms of their perceived expertise, trustworthiness, and protection responsibility (Lindell & Perry, 2000). Like research on protective action perceptions, most research on stakeholder perceptions has focused

on long-term hazard adjustments rather than response to imminent hazards. As noted earlier, there is significant variation in the extent to which people receive warnings from different types of sources and there is typically a substantial amount of milling during which people seek to confirm the warnings they have received. As yet, however, empirical data are lacking regarding the extent to which recipients' perceptions of the characteristics of their initial or subsequent warning sources affect the warning confirmation process.

One study found that none of the information sources listed was perceived to have a high enough level of expertise, trustworthiness, and protection responsibility to be considered as a completely sufficient information source (Lindell et al., 2017). This result is a bit surprising because Lindell and Whitney (2000) and Arlikatti, Lindell, and Prater (2007) found that multiple stakeholders, including local officials, were high on these dimensions. However, those studies only mentioned broad categories of stakeholders, so it is possible that judgments of abstract categories of stakeholders before an incident produce different results from judgments of specific officials during an actual incident. More generally, research is needed to assess the mechanism by which information sources' perceived credibility (expertise and trustworthiness combined) affects PAR compliance. Specifically, source credibility could affect PAR compliance indirectly by communicating information that changes receivers' perceptions of the threat, their awareness of different protective actions, or their perceptions of the protective action attributes. This is the Elaboration Likelihood Model's central route. Alternatively, source credibility could affect receivers' PAR compliance directly. That is, people might comply with local officials' PARs simply because they are authorities—the Elaboration Likelihood Model's peripheral route. Moreover, a wide range of stakeholders other than hazard information sources could affect PAR compliance by providing situational facilitators and overcome situational impediments. Finally, some research on stakeholder perceptions has found that the most credible information sources vary by community (e.g., Lindell & Perry, 1992, Chap. 7). Further research is needed to replicate this finding and also to determine if the most credible information sources differ by hazard.

22.7 Situational Impediments and Facilitators

The actual implementation of behavioral response depends not only on people's intentions to take those actions but also on contextual conditions that can impede actions that they intend to take or that can facilitate actions about which they are indifferent (Triandis, 1980). In most cases, the lack of correspondence between protective action intentions and behavior is caused by impediments rather than unexpected facilitators; there are many instances in which people have wanted to evacuate but lacked access to a personal vehicle (Kang, Lindell, & Prater, 2007; Wu et al., 2012), lacked personal mobility due to physical handicaps (Stough & Mayhorn, 2013; Van Willigen et al., 2002), or had pets that would not be accommodated on public transportation or in public shelters (Heath, Kass, Beck, & Glickman, 2001).

There is also evidence for the effects of situational impediments to tornado response. Balluz et al. (2000) found that people were almost three times as likely to shelter in above ground locations (63%) as in basements (22%) because few houses had basements. Consequently, Hammer and Schmidlin (2002) reported that only 53% of those who received a warning remained home when the tornado struck. Residents of mobile homes are in particularly difficult circumstances because these structures can be destroyed by even relatively weak tornadoes so their occupants are advised to abandon these structures when they receive a tornado warning (Hammer & Schmidlin, 2002). Unfortunately, few mobile home communities have adequate community storm shelters. Moreover, the majority of mobile homes are sited individually so the occupants are unlikely to be able to afford the entire cost of a storm shelter. Consequently, many people take

actions that conflict with National Weather Service guidance.

22.8 Response Actions

22.8.1 Information Search

When people find that the available information is insufficient for a confident appraisal of the threat or implementation of a protective action, and time is available, they ask "What information do I need to answer my question?" to identify a *information need* about a threat or protective actions. To date, warning researchers do not seem to have addressed people' information needs assessment by asking respondents to report what were the specific types of information they sought after their first warning.

Identification of needed information does not necessarily determine where it can be obtained, so people consider "Where and how can I obtain this information?" to identify information sources and channels as part of an *information search plan*. Uncertainty about the threat and appropriate protective actions often stimulates questions directed to officials but, more commonly, the news media. Perry and Greene (1983) reported that people sought confirmation from the news media (33% in Toutle/Silver Lake, 59% in Woodland), authorities (29% and 19%, respectively), and peers (18% and 8%, respectively). Perry (2007) reported that, after learning about the Indian Ocean tsunami, people sought additional information from TV (58%), radio (36%), face-to-face contacts (31%), telephone (4%), or Internet (4%). In the American Samoa tsunami, Lindell et al. (2015b) found that radio was an extremely important channel of additional information (55%) but TV was not (4%)—possibly due to the larger number of radio stations (10) than TV stations (2). Phone calls were also an important channel (29%) but less so than the face-to-face contacts (41%) that were probably due to the large proportion of respondents who were in their own homes or those of peers (62%).

The final step in the information search process is communication action implementation, which provides *decision information* by answering the question, "Do I need the information now?" If the answer to this question is positive, people actively seek the needed information from the most appropriate source through the most appropriate channels. Drabek's (1969), (Drabek & Stephenson, 1971) research indicates people will go to great lengths, contacting many people if the prospect of an imminent disaster needs to be confirmed.

Research on information search needs to address information needs assessment and communication action assessment in more detail. A review of research on information seeking in response to other types of threats concluded that people are likely to engage in unbiased search in a variety of conditions (Lindell, 2014). However, they sometimes seek additional information that is attitude-consistent, especially when they feel that important beliefs, attitudes, or behaviors to which they are committed are being challenged (Hart et al., 2009). For example, some people at risk from tornadoes reassure themselves by accepting claims that tornadoes are deflected by hills and follow rivers. One promising perspective is to frame the information search process as a decision task. Howell and Sheppard (2012) found that having people think about their reasons for seeking or avoiding information about a medical condition decreased their avoidance of information seeking, especially when the medical condition was described as treatable—that is, when the information actually had some value in determining future actions—see also Goodall and Reed (2013). Both studies found support for the proposition that accuracy motivation is enhanced when information is perceived to be useful in making decisions that have important personal outcomes. Griffin, Dunwoody, and Neuwirth's (1999; Griffin, Dunwoody, & Yang, 2012) *Risk Information Seeking and Processing* model is also a promising approach to this topic.

22.8.2 Warning Relay

Drabek (1986) noted that people often relay warnings to others or discuss the implications of the information they have received, a response that continues to be found. Perry (2007) reported that 30% of the respondents' first response to learning about the Indian Ocean tsunami was to warn someone face-to-face whereas 14% phoned friends/family. Unfortunately, it is unclear if phoning others was intended to confirm a warning or to relay it to others. Further research is needed to better understand who relays warnings, those to whom the warnings are relayed, and what is the content of those messages—especially the degree to which information is distorted as it is passed through informal warning networks.

22.8.3 Protective Action Implementation

Protective action implementation occurs when all the previous questions about risk reduction have been answered satisfactorily and the question "Does protective action need to be taken now?" yields a *threat response*. Most studies have found incomplete PAR compliance. Perry et al. (1981) reported that evacuation rates in their four flooded communities ranged from 41–56% and Baker (1991) reported that evacuation rates varied from 33–97% across locations for Hurricane Frederic and there were similar ranges for three other storms. Perry (2007) reported that people's first response to learning about the Indian Ocean tsunami was to continue normal activities (33%) and only 13% took immediate protective action. One limitation of many studies has been that data were only collected in areas that were warned to evacuate but Zeigler, Brunn, & Johnson's (1981) study of the Three Mile Island nuclear power plant evacuation found *evacuation shadow*—substantial departure rates from areas outside the official evacuation zone. Lindell and Prater (200) reported that evacuation expectations data used to plan evacuations in Texas coastal counties varied by distance from the coast and hurricane category, with both incomplete PAR compliance and evacuation shadow for every hurricane category.

When making protective actions decisions, people should consider decision errors. That is, they should judge the probability and cost of a false positive (e.g., evacuating for a hurricane that dissipates or strikes elsewhere) against the probability and cost of a false negative (e.g., failing to evacuate for a hurricane that does strikes that risk area). Czajkowski (2011) extended this idea in a sequential decision model in which risk area residents decide during each time period (e.g., after receiving an update from the National Hurricane Center) whether to evacuate or to wait for additional information in the next time period. To date, only Christensen and Ruch (1980), Meyer et al. (2013), and Wu et al. (2015, in press) have collected data on warning response as a sequential decision process. Wu et al. found that experiment participants failed to recommend evacuations early enough, even though they were given evacuation time estimates for their jurisdictions. This is consistent with findings that hurricane warning recipients often endanger their safety by waiting until the last minute to begin their evacuations. Unfortunately, they fail to recognize that adverse weather conditions and a high volume of traffic can significantly reduce the average speed of evacuating vehicles, thus running the risk that their evacuation will not be completed before storm conditions make roads impassible (Lindell, 2013a).

22.9 Discussion

Researchers have made substantial progress in developing a comprehensive understanding of warning processes in recent decades. Much more is known about the role of critical psychological processes as mediators of the effects of environmental context, environmental and social cues, information sources and channels, warning messages, and receiver characteristics on information seeking and protective action. Accordingly, warning research has progressed to the

point that its findings are being applied extensively in other areas such as evacuation transportation analyses. However, progress in warning research has been impaired by limitations in samples, variables, research methods, and analyses.

22.9.1 Samples

Warning research has produced significant variation in results across studies, which suggests that researchers will ultimately need to develop a contingency model of warning effectiveness. In a contingency model, the effects of warning channel choice and message design on PAR compliance and timeliness might depend on context variables such as hazard characteristics (onset speed/forewarning, impact intensity, scope, and duration), temporal context (time of day), and community characteristics (public- and private-sector warning technologies, as well as other aspects of government and household emergency preparedness). To assess this contingency model, there will need to be studies on many more incidents involving each hazard, temporal context, and type of community.

In addition, the vast majority of empirical warning studies have been conducted in developed counties, so future warning research should follow the lead of researchers such as Gregg et al. (2006) and Gaillard et al. (2008) by studying developing countries as well. Even within developed countries, there is a need for more extensive warning research on ethnic minorities (e.g., Eisenman et al., 2009; Perry, Lindell, & Greene, 1982b) and those with physical and mental disabilities (e.g., Rahimi, 1993; Stough & Mayhorn, 2013). Warning research also needs to address a notable deficiency in past research—the fact that such decisions are generally made by households but questionnaires are usually completed by a single individual within that household. This disparity would be expected to attenuate the correlations of the *respondent's* perceptions of threat, protective actions and stakeholders with the *household's* protective actions.

22.9.2 Variables

There are significant limitations to the conclusions that can be drawn about the effects of many variables that previous research has shown to affect warning response because so few studies have examined their effects. Thus, warning studies should collect data on more variables and report those data more completely. In addition, warning research had suffered from substantial variation in the ways that researchers have measured important variables. For example, Huang et al. (2016, p. 28) echoed Baker (1991) in noting that conflicting conclusions about the effects of hazard experience on hurricane evacuation might be attributable to measuring this variable as

> whether the respondents think they have "experienced" a hurricane; the recency, frequency, severity, or number of hurricanes experienced; whether the experience was personal or vicarious (and whether the experience was by others who were known personally or by strangers seen on the news media); and the nature of the personal impacts experienced—family casualties, personal property damage, and social disruption. Second, respondents differ in the ways they interpret the word "experience," with many people on the periphery of a hurricane thinking they have experienced the full force of that storm—what Baker (1991) called "false experience" (see also Bourque, Reeder, Cherlin, Raven, & Walton, 1973).

Finally, warning research needs to examine the findings from related areas such as rumors. For example, DiFonzo and Bordia (2007a) found that, in a threatening situation, the number of rumors is positively correlated with uncertainty and anxiety (which are related to feelings of lack of control—DiFonzo & Bordia, 2002) and negatively correlated with trust in the company and formal communication quality. Other relevant perspectives include health risk communication (Glik, 2007). These results have obvious implications for environmental hazard warnings.

22.9.3 Research Methods

Much warning research has involved surveys that are, inherently, retrospective. Some scholars have challenged the validity of data collected weeks or months after a disaster has struck. However, such criticisms of retrospective data fail to distinguish between trivial and potentially life-threatening events. Lindell et al. (2016b) have cited evidence supporting the validity of retrospective accounts of disaster response, but there is probably variation in people's accuracy for reporting different aspects of their disaster experiences. For example, memories might more accurate for the first warning (a primacy effect) and the last warning (a recency effect) than for intervening warnings. They also are likely to be better able to *recognize* message elements ("Did the first warning identify the threat?") than *recall* them ("What were the main elements in the first warning?"). It is also likely that people have better memories for a warning message's gist than for its verbatim content (Reyna, Weldon, & McCormick, 2015). Consequently, researchers need to supplement qualitative and survey research with experiments that control the presentation of different types of warning messages. Experiments are useful because they can allow researchers to disentangle otherwise interrelated variables such as, for example, the difficulty in distinguishing between the effects of social cues and official warnings on hurricane evacuation (Baker, 1991). Experiments also can provide responses to situations that have rarely or never before occurred (e.g., a Category 5 hurricane making a 90 degree turn and travelling toward a section of coast that had not yet evacuated). However, there is concern that experiments will collect data on artificial and oversimplified decision problems. Fortunately, there is at least preliminary evidence that responses to hypothetical hurricane scenarios are generally similar to those of actual hurricanes, but there are significant differences in the effect sizes for seven variables (Huang et al., 2016). Moreover, Kang et al. (2007) found evidence that people do have relatively accurate expectations about aspects of their protective responses that are similar to more commonly performed actions. Nonetheless, the conditions under which people's beliefs about their future behavior (general behavioral expectations rather than specific behavioral intentions as defined by Fishbein and Ajzen 1975) need to be more clearly identified.

One common reservation about laboratory experiments is that the student samples cannot be presumed to be "reasonably representative" because it is questionable whether their results will generalize to other population segments. In order to assess sample representativeness, one must consider the population to which any findings will be generalized and whether there are any critical characteristics on which the sample and population might differ. The major difference between student and nonstudent samples that affects generalizability is task familiarity (Gordon, Slade, & Schmitt, 1986), which is likely to vary from one hazard to another. Consequently, laboratory experiments on warnings should carefully consider the degree to which students' hazard familiarity (or lack thereof) might affect study conclusions. One promising methodological development is the availability of Amazon Mechanical Turk and other Internet data collection methods that provide access to participants with a greater diversity in receiver characteristics such as demographic variables, hazard experience, and training (Paolacci & Chandler, 2014; Stewart et al., 2015).

22.9.4 Analyses

One limitation of many warning studies is that they are largely descriptive in nature. That is, they report the percentages of respondents who received a warning from a specific type of source or channel or who took a specific protective action. Even the descriptive data are incomplete because studies often report data on only a small subset of the variables that previous research has shown to affect warning response. Information is also frequently lacking about the correlations among these variables because researchers neglect to report the intercorrelations among all the variables that were measured. The unavailability of such correlations impedes the

replacement of narrative literature reviews, such as this one, with meta-analyses (Borenstein, Hedges, Higgins, & Rothstein, 2009; Huang et al., 2016) that can assess the magnitude of the independent variables' intercorrelations with each other and their effects on warning response. Failure to report correlations among variables is especially problematic when reporting the results of regression analyses because many studies have reported only the results of analyses that identify the most parsimonious set of predictor variables. Such analyses can produce extremely misleading results when, for example, two independent variables are correlated with each other but one has a slightly higher correlation with the dependent variable. Such analyses can retain variables having only slightly higher correlations with the dependent variable—even if that correlation is trivially higher—perhaps because of sampling fluctuations. Thus, the analyst will conclude that one of the independent variables is an important predictor and the other is not when, in fact, both variables are approximately equally important predictors (see Huang et al., 2016, for a more detailed discussion of this issue).

Another problem is that research analyses testing single stage–single equation models cannot assess the validity of mediation models, such as a model proposing that community integration → warning receipt → risk perception → protective action. Multistage-multiequation models are needed because they can make it clear that variables lacking significant correlations with protective action can nonetheless be relevant to the warning process because they are related to variables that influence earlier stages of this process. However, it is important to note that the effects of variables in early stages of the process tend to be diluted in later stages because the mediated effect is the product of the path coefficients (Preacher, 2015). If warning researchers adopt these changes in sampling procedures, measurement strategies, research designs, data analyses, and reporting practices, future reviews will be able to extract much more valuable information from the studies that are published.

22.10 Conclusions

Research on environmental hazard warnings can be summarized as indicating that people's major information sources are environmental cues (sights, sounds, or smells that indicate disaster onset), social cues (observations of businesses closing and people evacuating) and social warnings from authorities, news media, and peers. The social sources are differentiated in terms of their expertise, trustworthiness, and responsibility for providing protection. Broadcast media (radio and TV) are extremely common warning sources in slow onset disasters such as hurricanes but peers and authorities are common first sources in very rapid onset hazards such as flash floods. Warning messages are most likely to produce appropriate protective actions if they provide information receivers need to understand the threat, expected time of impact, affected (and safe) areas, appropriate protective actions, and sources to contact for additional information and assistance. Such information produces situational risk perceptions that can be characterized in term of expected casualties, damage, and disruption to the community in general and to one's family in particular. Depending on their perceptions of the information sources, the hazard, and alternative actions, people continue normal activities, actively seek (or passively await) additional information, or prepare for and take protective action. People's choices of response actions can be frustrated by situational inhibitors (e.g., the lack of a reliable vehicle in which to evacuate) or enhanced by situational facilitators (e.g., the availability of neighbors who have room in their cars) that arise from their physical, social, and household contexts.

In many respects, research on warnings has progressed significantly over the past five decades yet re-examination of sources such as Drabek (1986), Janis (1962), Janis and Mann (1977) and Withey (1962) can still yield fresh insights into the warning process. Consequently, warning researchers should seriously consider taking the time to read what might easily be dismissed as "outdated" sources. One of the most promising developments in recent warning research has

been the increase in social scientists' collaboration with physical scientists (e.g., Gregg et al., 2006, 2007; Velotti et al., 2013) and engineers (e.g., Trainor et al., 2012) that has sometimes led to integrated research agendas—see the *International Journal of Mass Emergencies and Disasters* special issue on a tornado warnings (Volume 31, Issue 3). Trying to integrate perspectives from very different disciplines is extremely challenging but is critically needed to avoid the propagation of wildly erroneous assumptions about people's behavior in disasters (e.g., Leach, 1994; Vorst, 2010). In addition, interdisciplinary collaboration can be extremely useful in overcoming disciplinary blinders that focus research on one aspect of warnings and neglect research on other aspects. For example, a systematic examination of transportation engineers' assumptions about warning and evacuation found that social science research had produced a relatively good understanding of the factors affecting evacuation decisions but had almost completely ignored evacuation timing (Lindell, & Prater, 2007). In summary, coupling a greater awareness of past warning research with interdisciplinary research will yield better theoretical models. In turn, testing these models on more diverse samples (including those with disabilities) using more sophisticated research methods will produce results that will be more useful to emergency managers and public health officials in reducing casualties from environmental hazards.

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News Media and Disasters: Navigating Old Challenges and New Opportunities in the Digital Age

23

Brian Monahan and Matthew Ettinger

Contents

Much has been written about the relationship between media and disasters. Media can play an important role before, during, and after emergency events, but that role is often misunderstood in ways that result in critical information gaps or flawed narratives about causal agents or recovery needs. When a disaster strikes, people will use media outlets to find information about what is happening, where to go, or what to do. Prior to an emergency event media can be integral to the overall effectiveness of early warning systems and evacuation procedures. Media coverage can serve as a galvanizing force in a community by providing an outlet for those experiencing loss and trauma or bringing needed attention to the challenges that emerge in the aftermath of a disaster. However, media are not always available or willing to provide coverage for disaster events. And when they are the coverage too often promotes myths and spreads false information that can give rise to reactionary behaviors or otherwise undermine response and recovery efforts.

Several studies have found that media can promote prosocial effects through their coverage of disasters, such as more effective warning systems, timely updates, and increased community cohesion. Unfortunately, many more studies have found evidence to suggest that media may do more harm than good through their coverage of disasters and mass emergencies. Though this can take many forms, the most commonly noted challenges associated with media involvement include a tendency for media reports to promote misinformation, propagate myths, spread rumors, and generally favor sensationalistic visuals and human interest storylines over measured, fact-based reporting. The challenge, then, is to develop an understanding of why these issues exist and what those involved – emergency management practitioners, news workers, public officials, and the general public – can do to more

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effectively utilize media for emergency preparedness and response.

This chapter examines the role of media in preparing for, managing, and responding to mass emergencies. We explore extant research on the media-disaster relationship to highlight the many ways that media can positively contribute before, during, and after a disaster, while also noting the many concerns associated with media coverage of disasters. Additionally, the chapter takes a broad look at the role of media in society as well as the social processes through which information and events are identified, processed and presented as news, while also noting how recent trends in technology and culture are fundamentally reshaping the production and consumption of news in modern life. The chapter closes with a discussion of potential future directions for media-disasters research as well as some suggestions for media workers and emergency management practitioners to more effectively manage the media-disaster relationship before, during, and after emergency events.

23.1 Defining Media

Disaster scholars have long noted how difficult it can be to arrive at an agreeable definition of disasters (Perry, 2006). For instance, there are official definitions put forth by government agencies and actors as a basis for policy and legislation, but these often conflict with the definitions used by emergency managers, public agencies, journalists, community members or others who engage with disaster events in some capacity. This is not surprising, as definitions of social categories and social phenomena are the result of a complex mix of factors, including the goals of the definers, the context in which they engage in this work, and the adaptations of those who apply created definitions to their own endeavors.

Media scholars report experiencing similar definitional challenges. For the most part researchers have used the term *mass media* to refer to the varied technologies that can be used to send information to mass audiences (media is, after all, a plural of medium). Early definitions tended to view mass media as synonymous with mass communication, defined as "any form of communication transmitted through a medium (channel) that simultaneous reaches a large number of people" (Wimmer and Dominick, 2013, p. 2). Thus, for some, media refers to the various mediums we use for mass communication (e.g., television broadcasts, newspapers, smartphones, billboards, and so on). Others take a broader view of media, using the term in reference to the communication technologies as well as the content transmitted therein. Still others having attempted to offer more focused definitions of media by categorizing the broad category into subcategories (i.e., news media, entertainment media, social media). This is not a debate we take up here; rather, we introduce these issues as a way to highlight the inherent fluidity in how we engage with media and the subjectivity involved in our interactions with the various methods of mass communication (for more on challenges associated with defining media see Croteau, Hoynes, & Milan, 2012; Kozma, 1994; Marris & Thornham, 1996).

The present chapter is focused primarily on traditional news and information media (i.e., local news, 24/7 cable news and emerging digital media modeled largely in the traditions of print newspapers and periodicals). This more limited scope serves two purposes: first, it allows us to probe the intricacies of media in the digital age and the news media-disasters relationship with greater depth; second, it avoids overlap with other chapters in this volume that look at the ways that social media and mediated popular culture intersect with disasters. In the remainder of this chapter we will offer a detailed look at the role of media in society, examine how and why mainstream news content takes shape as it does, and review research on the relationship between news media and disasters. This reveals the many and varied intersections of media, disasters, and public life and, ultimately, highlights how patterned practices and messages found in media coverage of disasters reflect the broader structural and culture contexts in which news gets created and disseminated to audiences.

The speed and extent of technological transformations in communication and information in recent decades continue to alter the media-disaster relationship in important ways. We are now in what media analysts and communication scholars refer to as the *digital age*, a period marked by rapid advancements in technology, increasing emphasis on speed of communication, and 24/7 interconnectedness of people and media content. As a result, we find ourselves in a globalized media environment that is undergoing rapid transformation under the pressure of continuing expansion, fragmentation, digitalization, and technological elaboration (Cupples & Glynn, 2014). These technological shifts have introduced important changes in how news gets made and how it gets communicated, and many of these have important implications for how media cover disasters and how disaster practitioners communicate with the public.

The traditional model of disaster communication – indeed, virtually all manner of mass communication – was characterized by a "one-way flow" of information (i.e., from a designated news source to a mass public, as seen in television broadcasts, radio programming or print media) and typically with the roles and responsibilities of those involved in the communication process (e.g., disaster management organizations, disaster victims, indirectly affected populations, population at risk and the wider community) more or less predefined. This is no longer the case. Members of the media audiences of today not only receive information, they are also now also in a position to produce and disseminate their own information via *Twitter*, *Facebook*, cellular phones, email, blogs, and a vast array of other social media platforms (Geo, Barbier, Goolsby, & Zeng, 2011). In this shifting media environment "old" media such as newspapers, radio, and television must compete with "new" media, including "citizen journalists", blogs, podcasts, and a host of other websites for control over content, audience attention and commercial resources (c.f., Lewis, Kaufhold, & Lasorsa, 2010). The expansive growth of media formats and communication outlets can be beneficial for media officials, disaster practitioners, and even the general public – provided they know how to effectively utilize the resources at their disposal.

23.2 The Role of News Media in Society

News is a term that encompasses a broad range of ways that information can be organized for presentation to mass audiences. As such, it serves many roles in modern society, one of which is that it helps us know about and engage with all sorts of things that we cannot directly experience. People rely on news media to receive information about their communities, learn about social issues, and keep abreast of emergencies and other dramatic moments in public life. Of course, substantial technological advancements in recent decades—the advent of 24/7 news, the emergence of the Internet and digital media, growing reliance on social media, and other factors—have contributed to tremendous shifts in how, where, and when people access news content. Despite these massive transformations in the form and function of news in the digital age the fact remains that each and every one of us relies on news in some capacity just about every day.

News media have long been incredibly powerful in bringing public awareness to social issues and shaping how and how much people talk about those issues. Researchers have developed a number of terms intended to capture these aspects of news, with two of the most commonly cited being *agenda-setting* and *framing*. Agenda-setting refers to the ability of media organizations to directly and indirectly influence the agenda of political leaders, public officials and the general public. In essence, it advances the idea that by devoting attention to certain topics media push those topics to the center of public consciousness, thereby influencing the issues that people discuss and care about. This is important to keep in mind because numerous studies have shown that the amount and the nature of media coverage afforded a particular issue will shape how the public will view that issue in terms of salience and seriousness which

can, in turn, affect how resources are allocated and policies are developed around those issues featured in the mainstream news media (Barnes et al., 2008; Blumer, 1948; McCombs and Shaw, 1972; Olsen, Carstensen, & Hoyen, 2003).

The influence of media coverage is not limited just to being able to direct attention toward particular issues. That is, media not only help to influence *what* we see, their efforts can also guide *how* we view and assess the things that come to our attention. This is referred to as the *framing* function of media (Snow, Rochford, Worden, & Benford, 1986). Frames can be verbal (words, on-screen graphics, headlines and so on) or more visual in nature (images, video footage, symbols, facial expressions, and so on). Frames are essential components of all manner of communication and social interaction because we rely on them to organize our ideas about the world around us and interpret our experiences and observations. We use frames every day to organize our experiences, make sense of complex events and issues, and bring structure to our interactions with others (Edelman, 1988). One significant area in the research on framing relates to how frames are used among those who make the news. For these individuals, a core part of their organizational routines stems from the need to quickly bring order to a virtually unlimited stream of information, images and complex issues as they work to turn events and issues into reportable news (Gitlin, 1980). News workers must identify newsworthy material, gather information, and organize that information for presentation to the audience, which is challenging enough before we consider the pressures created by deadlines, limits on time and space (e.g., minutes of broadcast time, column inches or word counts), the profit-goals of the company's executives and shareholders, and the expectations of the audience. Within this context, news workers must rely upon frames as a means to quickly bring order to complex and unexpected events and to make sure that audiences can easily understand and process what is being presented (Edelman, 1988; McCarthy, McPhail, & Smith, 1996; Snow et al., 1986).

News frames provide the foundation for how members of the news audience will begin to assess and talk about the issues and events that are depicted. Viewers, readers, and listeners are rarely left to their own devices to decipher the array of information and images provided by news media. Instead, news workers incorporate certain frames into the packaging and presentation of the news, and these frames promote particular interpretations or ways of thinking about the issues to news consumers (Gamson & Wolfsfeld, 1993). As sociologist Robert Stallings notes in his research on the social and political dimensions of risk (1990, p. 81): "Whether rejected, accepted, or modified… news accounts serve as points of departure for personal conversations." The capacity of news media to direct the attentions of their audiences and provide cues for how to think about the news content renders their productions as essential components in the creation and communication of a shared social reality. This, in turn, affords the news media tremendous power in shaping which issues are placed in the foreground of public consciousness and setting the parameters of public debate.

23.2.1 The Structure and Culture of the News Industry

Developing a critical awareness of news media – generally, but also in terms of how it intersects with disaster and mass emergencies – requires that we consider the structure and cultural aspects of how news gets made and how audiences engage with news products. For instance, it is not possible to truly understand news without considering the importance of *profitability* within media corporations. In the 1970s a variety of economic and social changes helped those in and around the media industry to recognize that news offered great economic value (Hallin, 1992). This may seem obvious today, but when such ideas were first introduced they stood in stark contrast to how news had previously been seen. For much of its history news was viewed primarily as a public service, to be offered without regard for

whether it generated a profit (it often did not); net revenue losses were simply seen as the cost of making news (Hamilton, 2004). In today's media marketplace the push for profitability now trumps public service aims in most media organizations (Monahan, 2010). News divisions are increasingly being counted on to not only operate at a profit, but deliver sizeable margins to shareholders and executives.

Profit has now become a chief calculation in determining what is to be considered newsworthy and how it is to be organized and presented to audiences. This of course has had tremendous implications for the nature and content of news in recent years. For instance, news became more and more oriented toward *infotainment* through the 1980s and 1990s (Bird, 1992; Grabe, Zhou, Lang, & Bolls, 2000; Thussu, 2007), a style of news that placed a premium on things like dramatic visuals and video, human suffering, spectacle and sensationalism (Monahan, 2010). And this is not just a matter of news having to now be created in a way that will make it profitable. It also means that news is increasingly being produced by people whose first responsibility is to their corporate bosses and shareholders, as opposed to aiming to satisfy a journalistic ethos or some standard of public good. The emphasis on profitability has further increased in the twenty first century as more and more news agencies have become embedded in corporations (e.g., NBC in GE, CBS in Viacom and so on) and many of those corporations have merged into conglomerates (Croteau et al., 2012). News is very rarely ever discussed as a public good in the way that it once was; instead it is a commodity that is packaged and sold expressly for the consumption of media audiences (Mullainathan & Shleifer, 2005). To understand disasters – or any issue or event that becomes transformed into news – it is crucial that we understand profitability as a core feature of the context in which news gets identified, packaged, and presented to audiences.

In addition to the importance of profitability in the modern media environment there are other aspects of media that disaster practitioners or social scientists must consider when assessing how the media-disaster relationship intersects with their own work. Much like the economic shifts toward profitability as a key metric of what makes "good" news, technological changes have also fundamentally altered the production and consumption of news. For instance, communication technologies have introduced an unprecedented level of speed and accessibility into mass communications; this has, in turn, drastically altered our capacity to identify potential news content, organize information, and disseminate and receive it rapidly across the globe. Recent decades have not only brought the advent and growth of the Internet and cable/satellite television, they have also seen tremendous advances in the speed with which news and information can be created and disseminated to audiences, which has fundamentally altered the way we share information and communicate with one another. The ever-increasing collection of news outlets on cable television and the Internet has given rise to a 24-hour news culture that produces an unyielding stream of images, facts, figures, warnings, breaking news, live look-ins, news crawls, and dramatizations. This can make it difficult for those who need to use media to reach an at-risk public because it can be hard to connect with audiences amidst a constant deluge of media content (Pantti & Sumiala, 2009).

23.2.2 A Brief Overview of the News-Making Process

Transformations in the technological and financial foundations of the media industry have wrought fundamental changes in the economic, political, and cultural contexts in which news gets made. News workers have had to shift their ideas about what constitutes news along with their roles and responsibilities in making it and bringing it to the public. Making news can be an exceedingly challenging task that requires people to navigate a complicated web of goals and constraints in a fast-paced and highly competitive public sphere. News organizations develop an

internal culture over time in response to these broader economic and cultural conditions and the focal concerns of the news environment in which they operate. In other words, those embedded in this culture of news work (reporters, editors, anchors, producers, photojournalists, graphic artists, video technicians, and so on) cultivate a shared understanding of how news can and should be made and communicated. Sociologists David Altheide and Robert Snow studied this shared understanding—which they have termed *media logic*—to better understand how it takes shape and how it influences the processes of making news (Altheide & Snow, 1979). Media logic encompasses the various habits, strategies, informal routines, and journalistic norms that affect how news is collected, shaped, and presented to the audience. News workers rely on the dominant media logic for guidance when determining the potential news value of a news item and to guide their efforts in gathering, interpreting, and disseminating the selected news items to their audience (Altheide, 2006; Molotch & Lester, 1974).

All news, whether it involves disasters, terrorism, crime, health care, the environment, or any other issue, begins with certain core elements. That is, all news is built upon a collection of basic components – what we might call *raw materials*, a list that includes factual information, still photographs and video, official statements, eyewitness accounts, statistics and figures, and other forms of information. How these elements get pieced together is what distinguishes one form of news from another. This idea – that news can be pieced together in a variety of different ways – reflects what sociologists refer to as the social constructionist perspective on news media. *Social construction* refers to how people engage in communication – words, images, symbols, and actions – to create or "socially construct" a shared set of meanings that we can use to understand the world around us. Applying this perspective to media helps us to see that something becomes news not because it is inherently important or deserving of attention but because it has been defined as "newsworthy" by those whose job it is to identify potential news content and transform it into actual news content. This means that what we see as news is the outcome of a series of choices made by those tasked with making news (reporters, anchors, editors, producers, and so on). The actions of these individuals not only determine what will become news, but how that news will be organized and presented to the public. Thus, a constructionist view of news suggests that the products that are delivered to audiences as "news" are but a tangible reflection of media decision-making about how to frame and present the who, what, when, where, why, and how of a particular issue or event.

Examining news from a social constructionist perspective is valuable because it allows us to see news in context, to understand the processes involved in news work (i.e., the strategies and techniques news workers employ), and to gain a sense for the organizational and cultural contexts in which this work occurs. What this means is that journalists make choices about what to cover and how to cover it, but their choices are not made in a vacuum. Instead, they must grapple with certain challenges (e.g., budgets, deadlines, time and space limitations, competition from other news organizations) and strive toward certain goals (e.g., maximizing profits for media corporations, which prioritizes things like news that will have broad, mass appeal and orienting content to the needs of advertisers and other commercial interests). The challenges associated with these issues are further compounded by the fact that most news organizations face constrictive shortages in terms of staff and other resources.

23.2.3 Examining the Media-Disasters Relationship

Disasters are sudden and spontaneous events that can bring devastating damage, loss, or destruction to life and property (Dwivedi, 2010; Iqbal, Ali, Khursheed, & Saleem, 2014). A disaster can happen as a natural occurrence, such as a tornado, earthquake, hurricane, or volcanic eruption; they can happen as technological mishaps,

such as nuclear power plant accidents, oil spills, or chemical leaks; or they can be man-made, such as terrorist attacks or acts of mass violence (Houston, Pfefferbaum, & Rosenholtz, 2012). When disaster strikes, media rapidly attempt to obtain material about the crisis, often by dispatching field analysts and reporting back anything they are informed of (Scanlon & McMahon, 2011). And public attention, too, often turns toward the disaster as people seek out media sources to gather information about the developing events. Public interest in breaking emergencies often spikes after initial media coverage and can sustain for weeks and even months on end (Monahan, 2010) as news channels, newspapers and online outlets chronicle the events and the emergency response and recovery efforts (Miller & Goidel, 2009).

Research shows that media can serve an indispensable role before, during, and after an emergency event – through effective warning, delivering timely information to those affected, supporting the emergency response, and directing public attention and outreach toward affected communities. However, all too often media coverage of disasters proves to be just as problematic as it is helpful. This is because news media routinely promote misinformation and myths, spread rumors, and generally favor sensationalism and spectacle over serious investigative reporting. In this section we offer an overview of media-disaster research to uncover the many challenges and opportunities often found in media coverage of disasters and mass emergencies.

23.2.4 Advantages of Media Involvement in Disasters

Media organizations are distinctively equipped in their abilities to disseminate information quickly and have proved to be resourceful in collecting crucial material to help aid local residents, practitioners, responders, and public officials in recognizing the scope and magnitude of a disaster (Perez-Lugo, 2004; Quarantelli, 1999; Scanlon, 2007). Prior to a disaster, media act as a medium between officials and citizens to rapidly transmit information, evacuation procedures, and absorb and reflect current public needs to policy makers (Miller & Goidel, 2009). Quarantelli (1996) found that media are often utilized before a disaster to broadcast alert warnings, coordinate emergency management strategies, and educate citizens about potential cautions, serve as conduits for government officials to provide instructions and guidance, cultivate risk reduction plans, and exhibit the effectiveness of an emergency response organization. Dwivedi (2010) explored the role media outlets played in the time period leading to the devastating tsunami that struck India's coast in 2004 and discovered that media sources acted as an early warning system, coordinating and transmitting an array of disaster messages to the general public. Due to this media involvement, the national press was able to rapidly alert the rest of the world and effectively prompt immediate action from the Prime Minister and other government officials. The government was able to collect vast amounts of money, set up emergency centers, and put in place evacuation plans at great speed. The media is one of the most critical tools people use to learn about disasters, acting as a guidance for those who may be affected by such a situation.

In the midst of a disaster, news media messages can bring a deeper awareness of the unfolding crisis to audiences (Miller & Goidel, 2009; Quarantelli, 1996; Scanlon, 2011). Media organizations have a framework that allows for rapid communication by affiliate and local networks, circulating information to one another, allowing them to extensively magnify their audience count. Their very structure makes them uniquely situated to collect and provide up-to-the-minute alerts for those in impacted communities as well as people who have not been directly affected but nonetheless wish to follow the unfolding drama through television, Internet, or radio updates. These outlets are often the voice of disaster assistance, coordinating efforts by government and emergency responders (Iqbal et al., 2014). During a disaster, the media provide a bridge for victims and the general public by depicting devastating visuals to the rest

of the world, soliciting assistance from the domestic and international community, and motivating national outreach to disaster zones (Scanlon, 2011). Media coverage can serve as a catalyst for obtaining assistance for local communities and increase allocations for disaster response programs. Media channels provide audiences with current disaster relief efforts, rescue missions, and locations of potential victims. Media can be vital in alerting communities about risks and helping to identify or reach out to those who need rescue or assistance during or after a disaster event (Drabek & McEntire, 2003).

Stewart and Wilson (2016) explored media involvement during Hurricane Sandy in 2012 and the immense onsite coverage that attracted a frenzy of reporters to cover one of the worst storms in U.S. history. It was found that the extent of onsite media involvement was massive and even small rural communities received constant documentation of the devastating consequences this storm was having on the local population. While the public can use the media in a number of ways during a disaster, news outlets are mainly utilized to determine whether a crisis will affect a viewer directly, how one should think, and what actions should be employed if needed (Littlefield & Quenette, 2007; Seeger, Sellnow, & Ulmer, 2003). For example, those in the path of a hurricane or flood zone can use the media to obtain evacuation orders and preparations needed to stay safe throughout the crisis.

Along with broadcasting alerts, advisory updates, and public warnings, media are a channel for decision makers to learn what supplies are needed, and act as a prompt and somewhat reliable vehicle to convey facts and possible consequences while catastrophe strikes. Public officials and responders can utilize this stream of information to effectively distribute goods and materials to help aid local citizens, and while there is a great deal of stress that many are forced to adapt to in the middle of a disaster, this is a period where the media excels, viewing this time as an opportunity to provide a valuable service, increase broadcast ratings, and augment circulations (Sood, Stockdale, & Rogers, 1987). When disaster strikes, the media will rapidly attempt to obtain material about the crisis, dispatching field analysts, and reporting back anything they are informed of (Scanlon & McMahon, 2011).

Following a disaster, the desire for information dramatically increases in crisis areas, and media can disseminate a variety of information to aid officials, practitioners, responders, and local residents. In addition to providing this crucial information, the media can act as a trigger for obtaining assistance for affected populations and increase allocations for disaster response programs. Media channels provide audiences with current relief efforts, rescue missions, and locations of potential victims. Following the aftermath of Hurricane Gustav in 2008, media outlets established communication channels that response teams used to transmit messages to responders, allowing people to view disaster sights where residents were trapped and in need of rescue (Stewart & Wilson, 2016). Disasters and the crisis's that stems from these conflicts are pivotal moments in which the media can be used to attract the world's attention and put certain geographical areas in the middle of the global spotlight (Moeller, 2010).

23.2.5 Challenges of Media Involvement in Disasters

While media can provide many prosocial benefits in their involvement and coverage of disasters, there are a number of challenges that such involvement presents. For example, media can act as an undue hindrance, impede effective communication and rescue efforts, limit government responses, and promulgate false and inaccurate information during a crisis. There is a pattern in existing literature which shows a vested interest by the media to attract the "biggest" stories, even if those stories expose the public to false messages and narratives (Ali, 2013; Houston et al., 2012; Moeller, 2006; Scanlon & McMahon, 2011). The mass media will often disseminate "evidence" based on fabricated truth,

situational misunderstandings, and fears that are expensed as facts. Many of these problems can be traced directly to media organizations' emphasis on profitability and prevailing media logic among news personnel who seek content that meets their needs (e.g., captivating visuals, human interest, tragedy, and simple storylines that are accessible to mass audiences) and which can be quickly packaged and disseminated to the public.

One recurring theme in research on media coverage of disasters is the fact that media tend to devote a great attention and detail to unusual or violent accounts while giving much less or no attention to the mundane (Moeller, 2006; Recuber, 2016; Scanlon, 2011; Scanlon and McCullum, 2011; Stock, 2007). The fascination with destruction is rooted in prevailing media logic, but it also draws its form and force from wider, deeply rooted disaster myths, which Horlick-Jones (1995, p. 310) refers to as "widespread (largely mistaken) beliefs that the public will panic and behave uncontrollably following a disaster, and that looting and other antisocial behaviors will occur." Repetitive images of destruction and disorder seen in mass media accounts appear to affirm the presence of chaos, unrest, and horror that is present in post-disaster reality. These distorted depictions have been found to influence individual and organizational decisions during disasters in ways that can limit the effectiveness of response efforts by government and public officials (Fisher, 1998).

The prevalence and persistence of these beliefs – that the public will act with panic or social unrest – have repeatedly been found to be inaccurate by those who study public reactions to mass emergencies. In fact, Scanlon suggests that "panic is so rare; it is difficult to study" (2011, p. 18). Nonetheless, a "panic frame" once in place, becomes part of the story in ways that tend to shape the content of any updates that follow. If an early broadcast shapes a disaster in terms of panic and disaster, this framework is generally reinforced by other mass media outlets, resulting in a narrow perspective that is not factually representative of the situation, but rather perpetuates false myths. The idea that community residents turn their alleged panic and uncertainty into outwardly aggressive behavior—often, we are told, in the form of looting and rioting—can be found in the disaster literature. This was a prevailing theme in analysis of media coverage of Hurricane Katrina in New Orleans. Tierney, Bevc, & Kuligowski (2006) studied media framings of Katrina, where they found that media coverage quickly become dominated by reporting that "characterized disaster victims as opportunistic looters and violent criminals," "presented individual and group behavior following the Katrina disaster through the lens of civil unrest" and generally depicted New Orleans as a "war zone" (2006, pp. 60–61). Similarly, Berger (2009) revealed how news conventions criminalized much of the New Orleans population and disseminated rumors and helped create a racialized "looter class" which allocated high portions of disaster funding to maintain order over assistance.

Rather than panic and chaos ensuing in the midst and wake of a disaster, researchers have found that people usually get straight to work in search and rescue missions, and rather than violent disintegration of the social order, we see that people tend to engage in prosocial behavior, and that there are often great displays of solidarity and unity from others who have undergone similar disruptive experiences (Tierney et al., 2006; Sommers, Apfelbaum, Dukes, Toosi, & Wang, 2006; Scanlon, 2011). While the media often depicts these situations as a time of panic, research shows that individual and collective responses to disasters are usually rational and organized among an affected population (Quarantelli, 1989; Tierney, 2003; Wenger, Dykes, Sebok, & Neff, 1975). When mass media outlets create a shared misconception through their reporting, organizations can be led to misappropriate their resources. For instance, if mass media accounts are portraying civil unrest in the form of looting and rioting, resources may be allocated to maintaining order rather than assisting those who actually need help (Arnold, 2006; Friedman & Wenger, 1986; Goltz, 1984).

Another media-related challenge for public officials and emergency responders is the

tendency for news workers to frame coverage in ways that assign blame to something or someone (Davis and French, 2008; Littlefield & Quenette, 2007; Rowland, 2012). This need for blame may be more prevalent in different types of disasters as well. For instance, some have noted a more earnest effort to assign fault in the wake of technological disasters (e.g., Chernobyl and Three Mile Island) because these can be more easily framed as a product of human error (Baum, Fleming, and Davidson, 1983). Though there is also evidence to see that blame narratives can become attached to natural disasters as well, as numerous studies noted in the aftermath of Hurricane Katrina (c.f., Maestas, Atkeson, Croom, and Bryant, 2008; Malhotra and Kuo, 2008; Napier, Mandisodza, Andersen, & Jost, 2006). Media and public narratives centered on blame reinforce the perceived need to assign culpability as part of the larger response to a disaster event, which can in turn be a hindrance by diverting media and public focus from other aspects of the response that might benefit from additional attention and other resources.

Another troubling recurring theme found in research on media coverage of disasters is a tendency to present racial minority groups in distorted out-of-context fashion (Elliot and Pais, 2006; Haider-Markel, Delehanty, & Beverlin, 2007; Hartman, 2006; Tierney et al., 2006). For instance, Sommers et al. (2006) found in their research that during Hurricane Katrina, African-Americans, the group most affected by the traumatic effects of this storm, were found to be labeled "refugees" by the media rather than the more oft-used and appropriate term "evacuee" (p. 3). Refugee carries a connotation of one fleeing a country and seeking asylum in another country. This use of language created a context which operated outside of mainstream society. Furthermore, in depth research found that when "refugee" was used to describe survivors of Katrina, most often it was used in direct relation to the mention of "poor" or "black" citizens (Sommers et al., 2006).

We mentioned earlier the importance of framing to both news workers and their audiences, and that has implications for how information about disasters is gathered, presented, and received by the public. The way the media shows images and scenes will create meaning and shape reactions to certain situations. Sommers et al., (2006) cites another important example in which there are two very similar pictures of people wading through water to get food from a grocery store; in one picture, there is a Black male, and the caption mentions "looting a grocery store," while in the other picture there is a white couple with a caption that suggests that they are "finding bread and soda from a local grocery store" (p. 4). Clearly the meaning captured in these two similar photographs creates a very different operational context. In the former, the Black male falls within an accepted social narrative of minorities performing violence and illegal acts, while the white couple, performing the same act, are given the benefit of the doubt, and are seen as survivors. The media often labels certain races and ethnicities, causing divisiveness in disaster response and management efforts (Napier et al., 2006; Voorhees, Vick, & Perkins, 2007).

To satisfy the public's demand for information about a disaster, the media is required to make choices about what information they will share and emphasize. This is the fundamental idea underlying the constructionist view of news discussed earlier: news workers do not just "present what happens;" they make choices about what to pay attention to, what information to gather, and how to organize and present that information to audiences. Mass media outlets act as "gatekeepers" to decide which information, issues, images, individuals, and events will be distributed to the general public, and in turn, the public's desire for certain aspects of a disaster will influence what enters and remains in the news cycle. Monahan (2010) found this in media coverage of 9/11 where news workers were faced with an unprecedented challenge: the decision had been made shortly after the second plane crashed into the World Trade Center that all other news would be cast aside; with this, they had a wide-open news hole but there was virtually no solid information that could be used to fill it. As the hours went by the notion that this was a

deliberate attack by Al Qaeda become more prominent in the coverage; as a result, the chaos and uncertainty of the day slowly came to be replaced by a dominant "terrorism" frame. This is important because, as Monahan (2010, p. 9) notes: "much of how we made sense of the attacks in those first days, weeks, and months and… how we have come to understand and act on '9/11' in the years since derives from how the media first constructed and told the tale."

Media coverage can affect large populations in ways that extend deeper than mere beliefs, by influencing how policies and agendas are developed and implemented. The media hold great power in shaping how the public will make sense of what happened, who should be responsible, and the manner in which officials should be responding. However, there is a theme seen in disaster literature showing many mass media accounts that are often inaccurate, exaggerated, prejudiced, and have proven to be harmful to evacuation and relief procedures (Arnold, 2006; Scanlon, 2011; Miller & Goidel, 2009; Sommers et al., 2006).

23.3 Discussion and Conclusion

Many readers have no doubt heard in recent years some variation of the message that "big media is dead," with such proclamations often directed at traditional media such as print and television news. It is true that mass media have changed considerably in the last twenty years, as seen most notably in the rapid decline of print media, the booming growth of web-based and digital content, and the ongoing revolution in mobile technologies (Greer & McLaughlin, 2011). These are all very impactful developments that no doubt have fundamentally altered both how information gets gathered and disseminated and how it is received by public audiences. But the traditional notion of "mass media" – i.e., using communication technologies to reach a large number of people – remains a vital component of how we experience and navigate social life. With respect to disasters, news media are well-positioned to be of great benefit before, during, and after mass emergencies. Media can convey information in a variety of formats – television, radio, digital and print, social media, and advertisements– and reach diverse audiences quickly, often in real time. This makes them crucial for effective warnings, timely updates, and post-event information regarding where response personnel and other resources can be best utilized. But as we have shown in this chapter the actual role played by media is often more problematic than helpful, propagating false information and myths, spreading panic and uncertainty throughout affected communities, and impeding the speed and efficiency of response efforts.

If news media are, in fact, to be useful prior to or in the aftermath of a disaster, it is crucial that public officials and community members understand what media are available to them and how to access that media (some media options can be incapacitated by an emergency event – such as with Internet and cellular phones after the September 11, 2001 terrorist attacks). It is also important that people have an understanding of the underlying factors and forces that shape how information gets packaged as news. This is why we provided so much detail in this chapter about the social contexts and processes involved in news work. Awareness of how and why news content is created and communicated is crucial to finding ways to effectively use the news media to promote mitigation, enhance public safety, and build support for ongoing preparedness and response efforts. For instance, those charged with planning effective warning systems and disseminating information to the public no doubt must be aware of how national and local media operate (each has different goals and needs, and these can further vary based on the format in which information is presented). Those who experience loss of life or property or are otherwise displaced in a disaster event need to know where to turn for information and they need to be able to do so with the confidence that the information they receive will be as accurate as possible. At the same time, media organizations and news workers must be reminded of the important roles they can play when covering mass emergencies.

More specifically, they should be encouraged to critically assess problematic patterns in how they cover disaster events (e.g., sensationalizing and myth-making) and take steps to maximize the prosocial effects of their coverage. With this in mind, what follows are a few considerations regarding ways to more effectively manage the media-disaster relationship before, during, and after emergency events.

23.3.1 Considerations for Disaster Practitioners

Those involved in disaster response at the local, state or federal levels need to be attuned to the underlying factors and forces that influence how media handle disasters. For instance, recognizing that news workers must adhere to certain routines, needs, and goals allows emergency managers to more effectively craft messages in ways that media are likely to understand and share with audiences. Thus, informed practitioners can provide information that aligns with media preferences (e.g., their preference for drama, emotion, widespread devastation, and captivating imagery) while still advancing their own interests in getting timely and accurate information out to the community. Sims (2007) highlights the importance for emergency management responders to utilize effective communications during a disaster. For example, as the eye of Hurricane Katrina passed on August 29, 2005, electric, telephones, and internet connections were destroyed, and floodwalls and levees began to break and flood New Orleans. Homes, hospitals, and police departments were underwater and inoperable. Infrastructure collapsed and the destruction of such made coordinating actions very difficult. The near collapse of local law enforcement was one of the most dismaying aspects of this storm.

One way to enhance message control is to build relationships with media personnel over time, so that they are not having to form those relationships quickly during the chaos and uncertainty of an emergency event. Message control strategies can perhaps be modeled on those that have been implemented with much success by police agencies: research reveals that police agencies have derived great benefits by cultivating symbiotic relationships with the press (Ericson, 1989; Fishman, 1980) and by professionalizing their communications with and through media (Chermak & Weis, 2005). Such relationships can increase the likelihood of media helping to spread messages and give practitioners greater control over the content of those messages.

Message control takes on added importance in the modern media age, where *audience segmentation* has increasingly come to guide how news workers organize and carry out their work. Audience segmentation refers to the fact that audiences should not be seen as some sort of singular homogenous mass, but as a set of "demographically specific groups" (Croteau et al., 2012, p. 70) that form around race, social class, religion, gender, interests and ideologies (Best, 2013). Audience segmentation means that media organizations today must rely more than ever on targeted advertising, which refers to an array of strategies media use to figure out who they are trying to reach and how to best connect with them. However, the manner in which audience demographics are categorized for marketing purposes may not be aligned with information needs before, during, or after a disaster event. And those demographics – which include things such as age, gender, occupation, marital status, presence of children in the household, whether one is a homeowner or a renter, native language, and so on – can greatly affect if and how preparedness or response communications are received and acted upon. Thus, disaster practitioners seeking to use media to reach particular audiences must know which outlets will be most effective (some technologies or programs are more likely to reach younger people than older persons, while others are better served to reach those who primarily speak a particular language) and have a general awareness of how to access them. Developing relationships with leaders and other key figures representing the various segments of a community can help improve awareness and preparedness while also facilitating

more effective communications during periods of heightened uncertainty. This can be especially important for reaching immigrant groups who do not speak English, as well as the elderly or rural poor who may not have access to social media, Internet, and other modern communication technologies (c.f., Fothergrill & Peek, 2004; Zickuhr & Smith, 2012).

Working closely with media personnel also may enable public officials to more effectively craft a common script, as opposed to a disparate stream of messages that can emerge when information is "crowdsourced" through other channels (Geo et al., 2011). Of course, this potential advantage may turn into a disadvantage if the information widely distributed is incorrect. Seeger (2006) argues that communication strategies should be fully integrated into the decision-making process. By doing so, communication issues are brought to bear more immediately and more fully in the process of planning for and responding to crisis. If communication issues are only considered after the fact, the effectiveness of crisis communication is typically reduced. Barnes et al. (2008) identified two critical subjects that mass media outlets can focus on with relation to disaster management that can have very different consequences in terms of how we react and respond to a crisis. The first subject is response and recovery and the second is mitigation and preparation. With Hurricane Katrina, it was found that 78% of 1590 articles studied showed a focus on response and recovery while only 8.9% focused on mitigation and preparation (Barnes et al., 2008). This is significant because mitigation and preparation, as one would expect, if given proper credence and allocation of energy, can severely minimize the harms experienced in disasters and thus can make disaster management and relief a much easier task during and after the episode.

23.3.2 Considerations for News Media

Media organizations and news workers also must be encouraged to reflect on their connections to disasters and mass emergencies and look for ways in which they can maximize the prosocial benefits of their coverage while also seeking to eliminate the problems often associated with how they cover disasters. One step that media organizations must take is to make sure that they have plans for covering major incidents, particularly those events that might compromise their facilities or equipment. Research has shown that media organizations rarely develop specific plans for covering mass emergencies (Qaurantelli, 1991), preferring instead to cover such events as they do most other issues (e.g., sending reporters to the scene to deliver live reports, gather first-person accounts, and transmit captivating images of the incident).

Critical self-analysis would also benefit media by requiring news makers to examine the processes they use to decide which events to cover and how to cover them. For instance, when unprecedented flooding ravaged a sizeable region of Louisiana in the summer of 2016, one of the most notable features of the media coverage of that event was the general absence of media coverage (similar observations can be made regarding the ongoing water crisis in Flint, Michigan, which existed for more than a year before national media took notice and continues – largely unabated – in the many months since media focus once again shifted toward other issues). Disaster coverage would also be strengthened if media were to deemphasize the importance of speed of communication when covering mass emergencies. The rush to be the first on the scene and get "exclusive" breaking reports is one of the chief sources of the rampant misinformation and myth-making so often found in media coverage of disasters. Moreover, immediate, live coverage could be unduly traumatic for those whose loved ones have been directly impacted by the unfolding events. Consider, for instance, the November 2016 incident involving a Brazilian soccer team whose plane crashed while landing in Columbia. Within hours of the crash we were reading about it on a popular news site; alongside the article were several detailed and graphic photos of the wreckage, including images of bodies strewn throughout the

impact area. This was at a point when information about the crash itself was still pouring in and many family and friends of the team's players and staff were unaware of who had perished and who might have survived (initial reports suggested that six of the plane's seventy-seven occupants had survived the crash, and those early reports also listed four people among the victims who had in fact not even been on the plane). The point here is that news workers need to be mindful of how their reliance on patterned media logic – emphasizing things such as speed of communication, the spectacle of devastation, compelling visuals, human interest, and tragedy – can place additional burdens on victims and their relatives.

Media must be particularly mindful about the ways in which they advance and legitimize disaster myths. As we have noted throughout this chapter, a staple feature in much media coverage of disasters is the idea that people engage in panic, looting, and other deviant behavior during a disaster. Research, however, has shown repeatedly that people very rarely exhibit panic, and the stereotypes portrayed in news organizations are inaccurate and exaggerated. The mass media is saturated with stories of ongoing terrorism, pandemics, and natural disaster events, and it is imperative for those concerned to consider what is known and what needs to be known that could inform efforts to prevent or mitigate the consequences of disaster occurrences (Masten & Obradovic, 2008). Quarantelli (1991) highlights many findings that practitioners, responders, and government officials need to be aware of. This includes that when disaster occurs, individuals react very well, and while there are differential short term psychological effects, there does not appear to be many long lasting behavior consequences. Social science literature has established that the media plays a key role in many aspects of crisis management and mass media participation is critical for effective warnings and may be the glue that binds societies in certain occasions (Scanlon, 2011).

Ideally, media will give attention to disasters before they strike, inviting disaster practitioners into their coverage cycles to spread messages about the value of mitigation and harm-reduction strategies. These messages could also be introduced into the coverage of a disaster after it happens, though this is perhaps unlikely given that media logic and production routines call for a primary focus on the spectacle and drama embedded in the events. But even a few messages in the aftermath of a disaster – when public attention and interest in such issues are at their peak – touting the long-term value of mitigation strategies could have great impacts on institutional, community, and individual awareness of the need to plan and prepare for emergency events. This of course is an area where emergency management professionals and public officials could more proactively engage with media to more effectively shape these messages and promote their spread through media channels, community events, public forums, and community policies. If the mass media focused more on mitigation there could be greater public awareness of the value of preparedness and disaster education.

Researchers, too, can draw upon ideas explored in this chapter to shape future directions for research and inquiry. For instance, we must continue to investigate patterned messages in disaster coverage because—as noted repeatedly in the literatures on framing and agenda-setting—what gets covered and how it gets presented are crucial determinants of public beliefs, policy, and political action. There is much to learn about how and why disasters are covered (or ignored) by media, so research that examines whether some types of disasters are more likely to be covered than others would be quite welcome (perhaps by cataloging all disaster events that occur and assessing if and how much each event draws local or national media attention). It would also be worthwhile to revisit the extent to which geography still plays a role in which events are covered (historically, an event's proximity to media organizations, often near urban centers, was found to be a key factor in coverage decisions) considering the fact that technological developments now make it possible to collect and transmit information and images from virtually anywhere. Research has consistently

shown that media coverage of disasters tends to be rife with misinformation and reinforces myths about race, social class, violence and criminal activity. There continues to be great need for studies that compare what media report in covering disasters to what actually happens in disaster events, so that we might better understand the nature and extent of media misrepresentations of the causes and consequences of disasters as well as perceptions of public behavior before, during and after periods of crisis.

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Social Media in Disaster Communication

24

Leysia Palen and Amanda L. Hughes

Contents

Social media[1] have changed the ways in which the public can participate in disaster and other mass emergencies. For instance, users of social media have demonstrated how broad and ready access to other people during a disaster event enables new forms of information seeking and sharing, as well as exchanges of assistance (Hughes, Palen, Sutton, Liu, & Vieweg, 2008; Palen & Liu, 2007). Through social media, a growing number of eyewitness texts, photos, videos, maps, and other information are available around disaster events, information that was hard to access before social media. Meanwhile, emergency management organizations seek to respond to the new content and these new communication platforms: the initial focus on developing and executing best practices for outward communications is now giving way to discussions about augmenting response efforts with inclusion of data from the public (Hughes & Palen, 2012; Latonero & Shklovski, 2011; Ludwig, Reuter, & Pipek, 2015). The research field of *crisis informatics* (Hagar & Haythornthwaite, 2005; Palen, Vieweg, Liu, & Hughes, 2009) has arisen in response. Researchers of crisis informatics investigate the nature of socio-behavioral phenomena in mass emergency mediated by social media environments and devise new methods for its investigation (Foot & Schneider, 2004; Foot, Warnick, & Schneider, 2005).

The chapter begins with a brief history of the emergence of social media activity in relation to disasters and other mass emergencies to help the reader to understand how crisis informatics research has evolved in scope and depth to address the changing socio-technical environment. We then survey the major themes that have emerged in the field of crisis informatics over the decade since

[1]Social media are Internet-based applications that promote high social interaction and user-content generation often at a one-to-many or a many-to-many scale. Most social media services are supported across multiple devices including smartphones, computers, and tablets. Examples of popular social networking applications include Facebook, Twitter, YouTube, and Flickr.

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its inception. After presenting these themes, we then aim to clarify an issue about the differences in social media behavior arising from natural hazards versus criminal events—an issue that has confused researchers and readers of the growing array of papers across a field comprised of many disciplines and audiences. We call this the *social media and crisis confound*, and we believe that foregrounding this issue will support better communication of crisis informatics knowledge to the interdisciplinary audiences that might engage with it. We conclude with a discussion of future directions for crisis informatics research.

24.1 A Brief History

As social media use began to take hold in about 2007, research on the phenomena in mass emergencies emerged soon after. Predating this period, however, interaction via the web (including web sites and blog sites) around mass emergencies events was gaining, portending that collective action would soon become commonplace across social media. In response to the September 11, 2001 attacks in the US, researchers examined how people expressed themselves on the web during disaster events (Foot & Schneider, 2004; Foot et al., 2005). In the aftermath of the December 2004 Indian Ocean Tsunami, researchers noted the use of Flickr, what could be considered the first "social media" image-sharing site even though "social media" was not a term in use at that time (Liu, Palen, Sutton, Hughes, & Vieweg, 2008). Additionally, the Sahana Software Foundation emerged as a result of the tsunami. Sahana employed *open source* disaster management software to enable rapid development and wide access, appealing to the same broad participation and self-organizing ideals that propelled social media development and adoption (Careem, De Silva, De Silva, Raschid, & Weerawarana, 2006; Currion, De Silva, & Van de Walle, 2007).

Hurricane Katrina in 2005 drew even more attention to the potential of peer-to-peer communication in response to a crisis event (Macias, Hilyard, & Freimuth, 2009; Palen & Liu, 2007; Procopio & Procopio, 2007; Robinson, 2009; Shklovski, Burke, Kiesler, & Kraut, 2010; Torrey et al., 2007). Blogs and online forums following Hurricane Katrina provided places where displaced citizens could connect with members of their geographically-based communities to exchange information and cope with their loss (Procopio & Procopio, 2007; Shklovski et al., 2010). Torrey et al. (2007) found that several citizens used online means to coordinate disaster relief, such as the donation of clothes, toys, and other items. Additional research discovered cases where citizens used social media to help find missing persons as well as housing for victims (Macias et al., 2009; Palen & Liu, 2007). These initial studies demonstrated that through social media, citizens could offer and obtain crisis-related information (Palen & Liu, 2007) as well as participate in disaster response and recovery efforts even when remotely-located from physical disaster sites (Heverin & Zach, 2010; Hughes et al., 2008; Qu, Huang, Zhang, & Zhang, 2011; Vieweg, Hughes, Starbird, & Palen, 2010).

After Hurricane Katrina, research continued to explore social media activity in times of mass emergency, expanding to a variety of hazards. College students took advantage of already established networks in social media, most notably on Facebook during the 2007 Virginia Tech shootings and the 2008 Northern Illinois University shooting (Palen & Vieweg, 2008). Students accessed Facebook but also instant and text messaging services to assess the impact of the event on their wide and diffuse social network, discovering who among their colleagues were safe or not (Palen et al., 2009; Vieweg, Palen, Liu, Hughes, & Sutton, 2008). Public participation during the 2007 Southern California wildfires demonstrated how social media could function as an important "backchannel," where members of the public could informally obtain, provide, and seek information that clarified and expanded upon the information they received from formal emergency response channels (Sutton et al., 2008). It was here, too, that the Twitter *hashtag* was invented by users in need of filtered information (Credited to Chris Messina, personal communication; Starbird et al., 2012b). Other

studies looked at the role that social media could play in repairing human infrastructure and creating a sense of normalcy amid on-going conflict and war (De Choudhury, Monroy-Hernández, & Mark, 2014; Mark, Al-Ani, & Semaan, 2009a; Mark & Semaan, 2008), and in supporting civic journalism in "urban warfare" (Monroy-Hernández, boyd, danah, Kiciman, De Choudhury, & Counts, 2013). Qu, Wu, & Wang (2009) studied a popular online forum in China —*Tianya*—following the 2008 Sichuan Earthquake and found that the forum provided a place for information sharing, seeking, gathering, and integrating as well as a place where community members could provide emotional support. These research findings demonstrated social media's range of use and captured the attention of emergency responders who were beginning to consider whether social media could benefit formal response efforts.

Emergency management groups attended to the rise of social media platforms and considered how they might be included in their communication activities. Public risk communications were largely imagined as one-way pathways that flowed from emergency response organizations to members of the public (Palen & Liu, 2007), and so adoption of social media challenged this frame. Members of the public made use of new opportunities for participating in crisis response and recovery efforts, which made newly visible the socio-behavioral phenomena that were always present—that of a public who informally participates in disaster response. Emergency managers had to consider not only the new role social media would play in outgoing communications, but how they would participate in the digital information ecosystem (Denef, Bayerl, & Kaptein, 2013; St. Denis, Hughes, & Palen, 2012). With readily-available ways for the public to communicate with peers, to generate information that could be tactically valuable to response, and to perform support functions that could complement emergency response strategies (Meraz, 2006; Palen & Liu, 2007), crisis informatics research launched investigations of these behaviors and how they could be shaped for future visions of emergency management.

24.2 Research Themes

The growth of the field of crisis informatics, like the growth of social media adoption, has been rapid and diverse. In the following sections, we distill a majority of the research literature into eight broad themes organized into three groups. First, we review the socio-technical innovations that arose with the advent of social media. Mirroring the first empirical observations of social media activity in mass emergencies, we describe activities by the public (citizen reporting, community-oriented computing, and collective intelligence and distributed problem solving) and demonstrate how social media have shaped—and continue to shape—perceptions around how members of the public can participate in emergencies. Next, we discuss how social media communications are being treated and explored as data sources, and specifically as a way to contribute to situational awareness, along with the then accompanying challenges in collecting, processing, and verifying large amounts of social media data around crisis events. Finally, we address applications to emergency management, considering how emergency response groups are reacting to the communicative shifts and adapting their policies and practices in response.

24.2.1 Part 1. Socio-Technical Innovations Afforded by Social Media

24.2.1.1 Citizen Reporting

The ability for people to report from on-the-ground during and after an event drives much of the attention to social media use, and is attached to ideas of citizens as "sensors" (Goodchild, 2007)—people who detect, measure, and report local emergency information—as well as journalists (Gillmor, 2006)—people who collect, report, analyze, and disseminate information

as news. In the world of emergency response, the idea of first-hand reporting—particularly in the form of visual documentation through the use of camera phones and photo-sharing sites—made an indelible early impression of what the future of public participation could bring to both the tactical aspects of response (Fontugne, Cho, Won, & Fukuda, 2011; Liu et al., 2008), as well as the longer-term aspects of a community's cultural heritage (Liu, 2011; Liu, Palen, & Giaccardi, 2012). The ability to broadcast messages to wide or selective audiences (Dabner, 2012; Palen & Vieweg, 2008; Sutton et al., 2008) and provide commentary on events through blogs and public forums continues to reinforce the idea of highly localized but widespread "journalism" and "sensing" (Al-Ani, Mark, & Semaan, 2010; Jin & Liu, 2010; Macias et al., 2009).

Studies of disaster events around the world have documented instances of citizen reporting, as well as the ubiquity of this kind of reporting. During a five-day media ban following a controversial election in Kenya, social media provided a means for citizens to act as on-the-ground reporters who provided and consolidated information (Mäkinen & Kuira, 2008). Meier and Brodock (2008) reported on this same Kenya election and found that citizen reports of protest activity and violence were published well before traditional media channels reported them, a behavior that gave rise to the Ushahidi platform, discussed later. Similarly, the first widely-available video footage of the 2008 Sichuan Earthquake was shot by a Sichuan University undergraduate student with his camera phone (Wang, 2010). Monroy-Hernandez and colleagues have examined the social media and blog responses to the drug wars in Mexico, showing how they have become an important part of the information ecosystem that affects people's interpretation of events (De Choudhury et al., 2014; Monroy-Hernández et al., 2013).

24.2.1.2 Community-Oriented Computing

Social media have been described as facilitating online communities where members share and seek information during times of crisis (Qu et al., 2009; Wang, 2010). An early instance followed Hurricane Katrina, when some New Orleans residents went online in an attempt to locate friends and neighbors—with the hope of reducing the geographical distance between their newly dispersed community (Macias et al., 2009; Procopio & Procopio, 2007). During the Southern California wildfires of 2007, the fires were so diffuse across the region that acquiring information about particular locations and neighborhoods from traditional media sources was difficult. In this environment, innovations around social media emerged that let some mountain communities share information specific to their concerns (Shklovski, Palen, & Sutton, 2008). They were in a sense able to "project" their geographical community activities to the digital sphere.

By providing community members with tools to engage in crisis preparedness, response, and recovery, social media may have a role to play in building community resilience—a measure of a community's ability to respond to, withstand, and recover from adverse situations (Belblidia, 2010; Dufty, 2012; Mark, Al-Ani, & Semaan, 2009b). Hjorth and Kim (2011) found instances, following the Great East Japan Earthquake of 2011, in which social media provided means for residents to express emotion and to grieve with their community. Several studies examined how members of the public create collective histories of crisis events by sharing photos, videos, and personal experiences over social media (Liu, 2010; Mark et al., 2012). Social media may also create a sense of solidarity and social support during political protests (Starbird & Palen, 2012; Tonkin, Pfeiffer, & Tourte, 2012), times of war (Mark et al., 2009b; Mark & Semaan, 2008), and acts of terror (Eriksson, 2016; Glasgow, Vitak, Tausczik, & Fink, 2016). In addition, studies have demonstrated that social media have a place in crisis recovery and the restoration of a sense of normalcy (De Choudhury et al., 2014; Mark et al., 2009a; Mark & Semaan, 2008).

Network analysis, which examines social media behavior in the large, concurs with qualitative examination, showing that people who

have a close relationship to the region where an event is taking place make use of social media differently than those who are global onlookers. In the 2009 Red River Flood threat, people who lived near the Red River or who came there to assist in flood mitigation were more likely to offer original tweets to the information sphere. They were also more likely to provide information that locals understood. Those more distant from the flood were more prone to retweet "the abstract" of the event, redistributing messages or images that communicated what was happening to the rest of the world more broadly (Starbird et al., 2010). Follow on work by Kogan, Palen, and Anderson (2015) examined social networks of social media communications before, during and after the 2012 Hurricane Sandy. This research also saw that in a high-volume event, locals were more likely to interact with locals. Finally, in an examination of image-sharing in the aftermath of the 2015 Nepal Earthquakes, people close to the region again showed differences in the images that they shared. People not from the region also seemed more likely to appropriate images from other events to describe the Nepal earthquakes (Bica et al., 2017).

24.2.1.3 Collective Intelligence and Distributed Problem Solving

Social media have been shown to facilitate collective intelligence—where large, distributed groups of people solve complex problems (Palen et al., 2009; Vivacqua & Borges, 2010). For example, students affected by the Virginia Tech shootings converged on popular social media sites to first report their own safety in the early, uncertain moments, and then from these data (and their absence) began compiling lists of those who had died as they learned how extensive the trauma was to their community. This happened across more than one group, and though no single list was complete, across all lists, every name was correctly identified before the names were publically released (Palen et al., 2009; Vieweg et al., 2008). Keegan and colleagues have studied the structure and dynamics of Wikipedia (an open content online encyclopedia) during crisis events (Keegan, 2015; Keegan, Gergle, & Contractor, 2013). They find that Wikipedia supports collective behavior where people come together to share and seek information and to make sense of the event as it unfolds. Starbird and Palen (2012) examined Twitter posts (or tweets) during the 2011 Egyptian uprisings and noted how members of the crowd recommended and filtered tweets by rebroadcasting (or retweeting) them. The most frequently retweeted messages among remote, world-wide observers tended to be those with broad appeal, such as high-level news reports and messages of solidarity with the Egyptian cause. In contrast, related subsequent work on the Occupy Wall Street movement suggests that those on the ground seek more particular kinds of information (Starbird, Muzny, & Palen, 2012a). Research on the use of Reddit (a social media discussion site) has found that users of the site play an important role in making information more or less visible during a crisis event, which in turns shapes the narrative surrounding the event (Leavitt & Clark, 2014; Leavitt & Robinson, 2017). Citizens may also provide geographically-tagged localized and distributed reports—known as volunteered geographic information—of crisis events through social media (DeLongueville, Luraschi, Smits, Peedell, & De Groeve, 2010; Goodchild, 2007). This geographic information can then be collated and mapped by volunteers who call themselves "crisis mappers" using open source mapping software that includes, Ushahidi[2] which pulls its base layer map from OpenStreetMap[3] (Goodchild & Glennon, 2010; Heipke, 2010; Meier, 2015; Norheim-Hagtun & Meier, 2010; Zook, Graham, Shelton, & Gorman, 2010). In addition, the OpenStreetMap community has grown to complete maps of regions that are affected by disaster, but do not have complete geospatial data, so that emergency responders have accurate maps from which to make decisions and plans (Palen, Soden, Anderson, & Barrenechea, 2015; Soden & Palen, 2014, 2016).

[2]http://www.ushahidi.com/ (accessed January 16, 2017).

[3]http://www.openstreetmap.org/ (accessed January 16, 2017).

24.2.1.4 Digital Volunteers

Members of the public, social media advocates, technologists, emergency managers, humanitarian activists, and researchers continue to experiment, design, question, and develop new ways to use social media during crises. A successful effort is Ushahidi—an open source application for collecting and analyzing citizen-generated information (Meier & Brodock, 2008). Ushahidi relies on both the public as well as "digital volunteers" to populate maps that are helpful to humanitarian efforts. Digital volunteers donate time to performing tasks that aid in crisis efforts and can be completed remotely with online applications like social media (Starbird & Palen, 2011). A spontaneous version of this activity was observed following the 2010 Haiti earthquake when remotely-located citizens self-organized over Twitter to collect and donate funds to those affected by the earthquake (Starbird & Palen, 2011). A group that had coalesced prior to the Haiti earthquake also converged to help Haiti. The OpenStreetMap (OSM) community created a base layer map for Port-Au-Prince in the aftermath of the earthquake, all by the work of volunteer "crisis mappers," the "neocartographers" (Liu & Palen, 2010; Shanley, Burns, Bastian, & Robson, 2013) of the humanitarian space. The Humanitarian OSM Team (HOT) evolved out of this effort to deploy on the ground to make maps usable to the international response, and later, to foster community mapping activity within post-earthquake Haiti (Soden & Palen, 2014) and in subsequent disasters around the world (Dittus, Quattrone, & Capra, 2016; Palen et al., 2015; Soden & Palen, 2016).

Digital volunteerism is related to grassroots efforts that develop applications or provide services to meet humanitarian needs. Some of the earliest groups included the Random Hacks of Kindness "barcamps" and the CrisisCommons[4] organization. These groups were composed of "technology volunteers" with software development and emergency management experience who donated their time to building tools and applications that help those affected by crisis (Boehmer, 2010). A global volunteer organization—HumanityRoad[5]—seeks to provide members of the public with crisis information by teaching people how to "crisis tweet," and by monitoring social media streams to collate information (Starbird & Palen, 2013). Similarly, the Standby Task Force[6] organizes digital volunteers in response to humanitarian needs with a focus on crisis mapping. Organizations like these help to sustain digital volunteer efforts across time and disaster responses.

Seeking to find ways to monitor and maintain social media streams and capitalize on the behaviors exhibited by these early digital volunteers, emergency managers experimented with groups of digital workers (who are pre-selected and trusted) to manage some of the social media communications responsibility (Cobb et al., 2014; St. Denis et al., 2012). These groups call themselves Virtual Operations Support Teams (VOSTs). A similar effort by Wickler, Potter, Tate, and Hansberger (2011) created a Virtual Collaboration Environment that leverages Web 2.0 technologies in support of virtual experts that can participate and assist in an emergency response remotely. Following the 2011 Libya Crisis, volunteer crisis mappers collaborated with the World Health Organization to map over 600 Libyan health facilities (Chan, Colombo, & Musani, 2012).

Many questions still remain around how digital volunteer efforts can work with emergency management effectively and sustainably (Hughes & Tapia, 2015). The American Red Cross has established the Digital Operations Center which employs trained digital volunteers to help with social media monitoring (Meier, 2012). Initiatives like this will be critical to follow as we think about the role of planned and spontaneous digital volunteers in disaster response. The Woodrow Wilson Center for International Scholars has sponsored legal research that examines this issue in the US, and reports that

[4] http://crisiscommons.org/ (accessed January 16, 2017).

[5] http://www.humanityroad.org/ (accessed January 16, 2017).

[6] http://www.standbytaskforce.org (accessed January 16, 2017).

digital volunteers are not covered under Good Samaritan laws because the volunteers seek situations in which to assist. Instead they need to reduce their liability by establishing standards of care against which they want to be evaluated (lest a court determine that after the fact) and other liability-limiting measures (Robson, 2012).

24.2.2 Part 2. Social Media Communications as Data Sources

24.2.2.1 Deluge of Data

Social media use has become so widespread that during a major crisis, the vast amount of information available becomes difficult to monitor and analyze (Castillo, 2016). For instance, during Hurricane Sandy (2012), the University of Colorado Boulder collected over 26 million publically available tweets in an attempt to comprehensively collect the world-wide tweet communications about the warning, onset, and two-week post period of the hurricane. Such representative data sets enable rigorous data analysis of how social media were used during the event using a specialized infrastructure designed to handle large data sets—itself a research project on its own (Anderson & Schram, 2011; Schram & Anderson, 2012). At this point in time, it is almost impossible to make sense of the large amount of socially-generated data for applications to emergency management without adequate tools to filter, analyze, and visualize the data (Palen & Anderson, 2016). The goal of doing real-time collection and analysis remains an open problem in the technology research community.

In response to this challenge, researchers have designed and built several systems that filter and analyze social media streams in times of crisis. The Enhanced Messaging for the Emergency Response Sector (EMERSE) system classifies and aggregates tweets and text messages using supervised learning techniques so that emergency responders and members of the public can more easily access them (Caragea et al., 2011). A research group from Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO) has developed a Twitter tool with burst detection, message summary, machine learning and classification, and history analysis (Yin, Lampert, Cameron, Robinson, & Power, 2012). Twitcident uses semantics techniques to filter tweets and provide better search capabilities to help people explore Twitter data, making use of the uniqueness of languages spoken in the Netherlands to do so (Abel, Hauff, Houben, & Stronkman, 2012). These systems demonstrate proof-of-concept of such ideas, but they are not deployable at scale.

An alternative approach to filtering large information sets is to shape the social media data itself, making it easier to parse and analyze. The Tweak the Tweet project proposes a prescriptive syntax using descriptive hashtags (e.g. #location, #status, #needs, #damage). Twitter users then insert these hashtags into their message as they compose their tweets to make them more machine-readable and allow for automatic analysis (Starbird et al., 2012b; Starbird & Stamberger, 2010). Several projects have developed methods for extracting and disambiguating location names from social media data, thus providing valuable contextual information that can allow the data to be visualized with mapping software (Intagorn & Lerman, 2011; Sultanik & Fink, 2012). "Ushahidi"[7] was originally developed during the 2008 post-election fallout in Kenya and allowed citizens to report and map accounts of violence online. Since that time, Ushahidi has become a computing platform that supports human-entered data and analysis in an array of humanitarian situations (Meier & Brodock, 2008; Morrow et al., 2011). The Artificial Intelligence for Disaster Response (AIDR) system combines crowdsourcing and machine learning to classify tweets (Imran, Castillo, Lucas, Meier, & Vieweg, 2014). During a crisis event, AIDR collects relevant tweets and asks members of a crowd to manually label a subset of these messages. These labeled messages are then used to train an automatic classifier. This approach improves classifier accuracy because it

[7] http://www.ushahidi.com/ (accessed January 16, 2017).

has been trained on messages specific to that particular crisis.

For those seeking more information on the topic, Imran, Castillo, Diaz, and Vieweg, (2015) offer a more complete survey of the tools, methods, and techniques that researchers have used to automatically process social media data.

24.2.2.2 Contributions to Situational Awareness

An important contribution social media offer in times of crisis is their potential to enhance situational awareness through the data that many users offer (Cameron et al., 2012; Ireson, 2009; Johnson, Zagorecki, Gelman, & Comfort, 2011; Vieweg, Hughes, Starbird, & Palen, 2010). *Situational awareness,* in the emergency domain, describes human perceptions of the multifaceted circumstances around a crisis event that allow for interpreting situations, making decisions, and predicting future outcomes. Obtaining situational awareness is vital for those dealing with crisis because these situations are unusually complex and poor decision-making may lead to adverse consequences (Johnson et al., 2011; Vieweg et al., 2010).

Examples of situational awareness research include the in-depth analysis of tweets sent during the 2009 Red River floods and the 2009 Oklahoma City fires, where tweets were found by searching on relevant keywords (e.g. #redriver and #okfires). Researchers analyzed tens of thousands of tweets by hand to identify and extract information that could enhance situational awareness such as flood level status and fire locations (Vieweg et al., 2010). Subsequent research has focused on developing natural language processing classifiers that analyzes text to help identify tweets contributing to situational awareness (Corvey, Verma, Vieweg, Palmer, & Martin, 2012; Verma et al., 2011), though in general the state-of-the-art of the field is such that automation behind situational awareness derivation is difficult to do dependably. Ireson (2009) assessed the extent to which public forum postings could add to situational awareness during the 2007 floods around Sheffield, UK and found extractable relevant event information despite the inconsistent quality and conversational nature of the posts.

Research has demonstrated that data from social media interactions can provide situational awareness for specific crisis-related tasks and domains. Using natural language processing (a field of study which enables computers to analyze and understand the human language), machine learning (techniques that provide computers with the ability to learn), and crowdsourcing (the process of accomplishing a task by dividing it into subtasks that can be performed by a large group of people), several research groups have developed methods and tools for detecting and monitoring epidemics through social media data analysis (Brennan, Sadilek, & Kautz, 2013; Chen, Hossain, Butler, Ramakrishnan, & Prakash, 2016; Munro, 2011; Olteanu, Vieweg, & Castillo, 2015). One study used Internet reports to create early estimates of the death toll for the Great East Japan Earthquake of 2011 (Yang, Wu, & Li, 2012). The estimate was correct within one order of magnitude—an improvement over early static estimation models that can be off by as much as 3 orders of magnitude—and it could be updated as more information became available. Another study augments standard evacuation models with evacuee sentiment obtained from social media with the aim of improving evacuation planning (Gottumukkala, Zachary, Kearfott, & Kolluru, 2012). Researchers at several institutions have used geographic information contained in social media reports to detect earthquakes and predict earthquake impact and damage (Avvenuti, Cresci, Marchetti, Meletti, & Tesconi, 2014; Earle, Bowden, & Guy, 2012; Sakaki, Okazaki, & Matsuo, 2012). Dashti et al. (2014) found that visual data contained in social media messages could be used to help experts digitally survey a disaster affected region.

24.2.2.3 Trustworthiness and Veracity of Citizen-Generated Data

When choosing to act—or to not act—on citizen-generated crisis data, emergency responders and citizens must assess information credibility. Despite the free, unregulated production of

information in this type of environment, researchers have found that much of the information provided over social media is self-regulated, meaning that members of the community will question and correct the information (Mendoza, Poblete, & Castillo, 2010; Palen et al., 2009; Qu et al., 2009). Building upon this finding, Starbird and Palen (2010) explored the role of retweeting (rebroadcasting) and found that retweeted messages tended to correspond with information that was accurate or contributed to situational awareness. Recognizing the value of a retweet, one research group has developed a fine-grained predictive model to predict what information will be retweeted (Zhu, Xiong, Piao, Liu, & Zhang, 2011). Tapia, Bajpai, Jansen, and Yen (2011) explored how Twitter could fit the information needs of NGOs in disaster and described methods to overcoming trust issues, such as using a private online environment where all users are known or using Twitter for ambient or contextual data only.

Relying on citizens to filter trustworthy information and restricting who can contribute information is not the only way of creating veracity; as an alternative, several researchers are developing computational methods that seek to automate the process of finding the most credible social media data. Xia, Yang, Wu, Li, and Bao (2012) have developed an unsupervised learning algorithm for detecting credible information on Twitter, while another research group (Gupta & Kumaraguru, 2012) adopted a supervised machine learning and relevance feedback approach to ranking tweets using a credibility score. Preliminary evidence suggests that social media users geographically closer to the physical disaster location tend to share more accurate information (Thomson & Ito, 2012). Consequently, several efforts have created computational methods which use social media features (e.g. profile information, social connectedness, recommendation data) to identify on-the-ground social media users (Schlieder & Yanenko, 2010; Starbird et al., 2012a).

Another approach to ensuring credible information is to identify the information that cannot be trusted. To this end, Starbird and colleagues have employed computational and qualitative methods to identify false rumors and misinformation in social media streams and examine how they spread during crisis events (Arif et al., 2016; Starbird, Maddock, Orand, Achterman, & Mason, 2014, Starbird et al., 2016). This line of research has found recent evidence that "official" accounts (such as those of formal emergency responders) can help to slow the flow of misinformation during a crisis event through their social media posting behavior (Andrews, Fichet, Ding, Spiro, & Starbird, 2016).

24.2.3 Part 3: Applications to Emergency Management

Research had shown that social media channels allow for two-way communication between members of the public and emergency response organizations (Artman, Brynielsson, Johansson, & Trnka, 2011; Hughes & Palen, 2012; Latonero & Shklovski, 2011; Palen & Liu, 2007). Through these channels emergency responders can both distribute important information and make themselves available for dialogue, questions, and feedback (Hughes, St. Denis, Palen, & Anderson, 2014; Hughes & Chauhan, 2015). Furthermore, the information contained in citizen-generated data shows potential for contributing to situational awareness (Cameron et al., 2012; Ireson, 2009; Vieweg et al., 2010) which could benefit emergency response operations (Hughes & Palen, 2012).

However social media adoption in formal emergency response has lagged behind that of public uptake (Hughes & Palen, 2012; Latonero & Shklovski, 2011; Plotnick, Hiltz, Kushma, & Tapia, 2015; Tapia & Moore, 2014). Latonero and Shklovski (2011) investigated the use of social media by the Los Angeles Fire Department (LAFD) in 2009. At the time, the LAFD's active use of social media (monitoring, message distribution and response) was unusual for an emergency response organization and Latonero and Shklovski (2011) suggest that much of the LAFD's advanced adoption could be attributed

to having a single social media evangelist in the department. Around this same time (in 2009), Hughes and Palen (2012) interviewed 25 Colorado public information officers (PIOs) and reported that PIOs wanted to use social media but did not have permission or support from their management to do so. In addition, many of the participants reported that they lacked training as well as the resources to commit to maintaining a social media presence between emergency events. For those PIOs who had managed to obtain permission and resources to use social media, social media were most often used for one-way message distribution. More recently, Plotnick et al. (2015) conducted a survey of 241 U.S. emergency managers at the county level in 2014. In addition to finding many of the same barriers to social media use, they found that only about half of the surveyed agencies reported using social media in their work. Reuter et al. (2016) report that 44% of European emergency services reported using social media based on a 2014 survey of 761 emergency service staff across 32 European countries.

A growing body of empirical research documents innovative on-line behaviors that enlighten what contributions of social media could be. A number of policy and research visioning meetings have been held (Burns & Shanley, 2013; Committee on Public Response to Alerts and Warnings Using Social Media, Computer Science and Telecommunications Board, Division on Engineering and Physical Sciences, & National Research Council, 2013; Computing Community Consortium, 2012). Emergency managers continue to face mounting pressure from members of the public to use social media (Hughes & Palen, 2012); if emergency managers do not provide adequate social media information around a crisis event, citizens may obtain their information elsewhere (Stephens & Malone, 2009). These factors made emergency responders more likely to support and incorporate social media in their practice.

In this changing environment, several empirical research efforts have studied emergency management social media use. One study looked at whether international medical response teams and organizations coordinated through Twitter during the 2010 Haiti Earthquake (Sarcevic et al., 2012). Though there was little evidence of direct coordination between these international groups distributed across Haiti, the researchers identified an important pre-condition to coordination: that of on-line "beaconing behavior," where responders broadcast messages hoping that the message would be heard by a large audience. This is taken as a sign that groups are anxious to assist, to make themselves known, and to coordinate in a highly-decentralized activity. They perceive the digital sphere as important in this regard but it does not automatically provide the social connections that are needed (Sarcevic et al., 2012). Another study looked at social media use by two different police organizations during the August 2011 UK riots. Each organization took a different approach to their Twitter communications ("instrumental" and "expressive"), each which yielded advantages and disadvantages in terms of relationships with the public and the abilities to sustain communications over a period of time when internal resources were taxed (Denef et al., 2013). Briones, Kuch, Liu, and Yin (2011) interviewed 40 members of the American Red Cross to understand how they use social media to build relationships with their public and found that members perceived social media as both an effective and necessary public relations tool. Research around the 2013 Boston Bombings discovered that with the wide-spread attention focused on the event, emergency officials needed to tailor their Twitter communications to both a local audience seeking help and guidance as well as a remote audience wanting to know more about the attacks (Sutton et al., 2014). Research by Hughes et al. (2014) offers insight about the on-line communication behaviors of 840 fire and police departments within a 100 mile radius of where Hurricane Sandy made landfall in 2012. They found that even though use of Facebook, Twitter, websites and Nixle was relatively low overall, the ways in which departments employed the technology varied widely. Creative uses by some departments suggest new possibilities for public engagement in the future, and such variance suggests that a social media practice

remains highly emergent as groups experiment with different styles of engagement. In addition, Potter (2016) conducted a two-year ethnography of the Queensland Fire and Emergency Services (QFES) and their social media use. Despite evidence that social media supports more interaction with the public, the QFES primarily used them to distribute information. Frictions with internal processes often kept QFES from sharing information through social media in a timely manner, such as difficulty in getting information from responders on-the-ground and a culture of prioritizing operational duties over public information tasks.

24.3 Reflections on the Field: Social Media Behavior Is Tied to the Hazard

The research on social media use in disaster warning, response and mitigation has grown rapidly in the last decade, extending and contributing to the social science research in this space. However, we advise that researchers read this new literature knowing that lessons learned from one kind of emergency may not apply to others kinds of emergencies, even when the medium of social media is the same. The review offered in this chapter focuses on research from natural hazards, though selectively draws insights from other kinds of hazards to address additional socio-behavioral phenomena. We explain why a careful reading of the interpretation of socio-behavioral phenomena is important vis a vis the kind of emergency event being studied.

Social science research of mass emergency response has sought to investigate and represent the human behavior that arises in response to hazards threat, onset, and aftermath (Dynes, 1970; Mileti, Drabek, & Haas, 1975; Stallings, 1971; Tierney, Lindell, & Perry, 2001). This research makes distinctions between hazards and the resulting social-behavioral phenomena, and in so doing, has systematically portrayed the nature of those phenomena. It makes distinctions between local and mass emergencies, which give rise to different consequences socially and societally. In addition, social science attends to differences in emergencies that arise from natural hazards, and those that arise from criminal behavior because the nature of the response and mitigation of these two different sets of hazards differ. For example, mass emergencies arising from natural hazards might, first, be mitigated through better policies and practices of development. Gilbert White famously warned against the building of structures in the flood plain (White, 1945) to reduce flooding disasters. Improved detection and prediction of weather-based hazards can mitigate risk (Gillespie, Chu, Frankenberg, & Thomas, 2007; Mileti, 1999; Morss, Wilhelmi, Meehl, & Dilling, 2011), as can risk communication to the public (Fitzpatrick & Mileti, 1994; Morss, Demuth, & Lazo, 2008; Reynolds & Seeger, 2005). However, natural hazards themselves cannot easily be eliminated: rivers rise and lighting-born wildfires burn. In contrast, criminal activity is managed by a set of circumstances that are psychologically and socially complex and systemic; we seek to take control of crime to preserve the basic workings of civil society.

In social media studies of emergency, the literature reports on all kinds of emergency events, sometimes without these important distinctions that readers of this volume care about. Social media studies of collective action of bombings and hurricanes are reported side-by-side, and so it is up to the reader to consider the differences such hazards give rise to in the social media sphere. We make this point because we worry that the very idea of "social media" flattens the many meanings of "crisis" and "emergency" for which social science fields have worked to provide insight. For example, because Twitter or Facebook are available for use in any kind of crises, it is easy to make these applications the salient concern, and ask "Is Twitter or Facebook better in emergency response?," rather than question how the very nature of emergency response might beg for different forms of information seeking and reporting. We refer to this flattening of communication medium and hazard as the *social media and crisis confound.*

We find *endogeneity* and *exogeneity* of hazards to be a meaningful distinction in social media in mass emergencies research, one that readily clarifies for a range of researchers and readers who are outside the social science discipline. Just as events that arise from exogenous and endogenous hazards differently impact legal, political, health, and other societal systems, so do they differently impact social media behavior.[8] With exogenous events, the culprit is beyond reach, and unstoppable. With endogenous agents, the suspect lies within. Therefore, organizing features of the communication are distinctly different, because the source(s) of the problem(s), the nature of their solutions, *and the ability for the perception of the collective control of the outcome* are different. Online participation focuses on in-common salient problems when they are present; when the problems are less in-common and must be addressed in parallel, the crowd organizes in many smaller groupings and, often endogeneity and exogeneity of hazards predicts this (Palen & Anderson, 2016).

Here we offer a brief illustration of the distinction for the social media world. The 2012 Hurricane Sandy and the 2013 Boston Bombings were events that affected major US cities. Though the investigations of social media behavior are many and nuanced (Hughes et al., 2014; Leavitt & Clark, 2014; Starbird et al., 2014; Sutton et al., 2014; White, Palen, & Anderson, 2014), for the point of this chapter, we can broadly characterize the nature of those interactions in the immediate aftermaths. As with other exogenous hazards, the social media response to Hurricane Sandy can be characterized as a set of many simultaneous social interactions that sought to ask questions and provide information about the status of a range of issues (e.g., transportation, utilities, flooding, public service assistance, evacuation directions). In contrast, after the bombings during the Boston Marathon (an endogenous hazards event), the social media behavior is better characterized as addressing matters of safety from criminal activity and forensics: who is the culprit? Has the person been found? Famously, a community on the popular social media discussion site Reddit fingered several innocent people as the culprit before the community was shut down (Potts & Harrison, 2013).

This distinction enlightens the reading of the growing social media and mass emergency literature for three reasons. First, without it, this new literature risks undoing decades of work by social scientists who have dismantled the myths of disaster, with a dominant discourse that includes panic and unlawful behavior by victims. But in disasters arising from natural hazards, we know such behaviors are not typical. Mass emergencies arising from criminal behavior can have a much wider range of collective behavior because the source of the hazard is unknown, unpredictable and perhaps more imminently dangerous. Therefore, when events like gun shootings and bombings are examined as "crises," they are collapsed with other events that are also considered to be "crises" without distinction, even though the behaviors exhibited online will parallel the behaviors we see in the physical world. The curiosity of social media as an element of the behavior seems to override these important hazard-based differences. Though social media brings an interesting new means by which people interact and perhaps coordinate, we must not lose sight of the natural phenomena that first influences socio-behavioral phenomena.

Second, lessons for practitioners out of the new social media literature become clouded. Whereas criminal events might require a law-based response with limited participation by members of the public, natural hazards events do not require a law-based response (even though police and fire resources are used for both), and may in fact benefit from broad participation of residents helping each other with many localized problems that tax public services.

This ties to a third point, which is that the dangers of misinformation might not be the same in different kinds of disaster events. Misinformation diffused in an endogenous hazard event—

[8]Furthermore, beyond the natural versus criminal hazard divide, the term "crisis" encompasses war and other political unrest. It also encompasses long-ranging environmental hazards arising from global warming, including sea level rise and drought.

where the social media communication might dwell on matters of forensics—could put safety and security at risk. Innocent people might be unfairly pursued; would-be victims could experience greater risk if they evacuate to the wrong area. Activity tends to be concentrated and faster moving, and so the implications for misinformation are also intensified. One must also question if the misinformation is being propagated as part of the criminal activity itself. Misinformation arising from natural hazards or exogenous events might be greater in kind, but less in impact, with fewer in-common readers as it traverses a network that can move a little slower than it might in criminal mass emergency events. Because the problem-solving tends to be more diffuse in exogenous events, the same message might not reach enough people; in other words, the misinformation might also be thinly diffused. Misinformation in such events is more likely to age out, or not be relevant to enough locations to pose a big threat—in other words, all information in the first place is less likely to be categorically correct or incorrect, and as such, it is hard to find as much value in pursuing the threat of misinformation in such situations.

Social media research on mass emergency events is burgeoning. A range of practitioners, application developers, researchers are considering social media as both a site of social interaction worthy of study, and as a source of information that can reveal a lot about what is happening on-the-ground across many people. The potential that such investigations have for examining and supporting socio-behavioral phenomena in the large is high. We encourage a wide reading of this rapidly expanding interdisciplinary literature, but with the precaution that lessons that follow mass emergencies from endogenous and exogenous hazards might differ, and should be a knowing part of the synthesis of that literature.

24.4 Future Directions

Future directions for crisis informatics research are exciting and promising. One important turn is examination of the role of social media participation in resilience, rather than in only warning and response. As social computing platforms expand into new areas of interaction, the immediacy that characterizes the platforms of today—a characteristic that favors the rapid response aspects of disasters—might give way to longer horizon engagement with people and data. This engagement is what characterizes the hope of some working in the geospatial data space (Soden, 2017).

Furthermore, little research has focused on the needs of the disadvantaged with respect to social media and crisis (Bricout & Baker, 2010; Cinnamon & Schuurman, 2012). The majority of the literature discussed in this chapter has studied populations with widespread access to social media and the hardware technology to use it. In the United States, Crutcher and Zook (2009) observed how access to Google Earth following Hurricane Katrina fell strongly along disadvantaged economic and racial lines. Majid and Spiro (2016) examined Twitter messaging from formal emergency responders in the US and noted a lack of cross-language messaging despite evidence that many communities contain a significant number of non-English speakers. Elwood (2008) looked at how citizen-generated data is shaped during a crisis, and observed that what information is available as well and who it empowers or disempowers is a function of access. However, some also suggest that social media has the potential to provide crisis communications in places where emergency response infrastructure is poor (White & Fu, 2012). The need to create a trajectory of research that combines the study of the vulnerable with the increasingly necessary tools for large-scale social media analysis is essential.

Another direction is the ever-sharpening precision around understanding information diffusion, as well as the changing socio-political landscape that is changing our assumptions in 2017 about what constitutes "fact." It could well be that the ideas of misinformation are going to be challenged definitionally with the rise of "fake news" and its possible encroachment into the disaster space. In this way, the overlap of news reporting on any number of kinds of hazards

events is going to change the information landscape in ways that are currently unpredictable. We look to the work of Starbird and colleagues on the examination of fake news (Starbird, 2017) and its possible intersections with disaster reporting.

Network analysis of social media communications will improve as researchers develop new data science techniques for wrangling with units of analysis in discourse and other forms of on-line interaction (Kogan, Anderson, Palen, Anderson, & Soden, 2016). Such advances are crucial to move beyond the observation that people are interacting on-line in interesting ways to explain in what ways they are coordinating that propagates solutions or idea diffusion. It will also be an important contributing method for understanding how people react to weather forecast information and other information artifacts that attempt to communicate uncertainty to affected populations. Similarly, it is important to expand existing research that mostly focuses on Twitter, to include other social media platforms; people do not confine their online activity to one platform during a crisis event. Thus, Hughes, Starbird, Leavitt, Keegan, and Semaan (2016) propose a new research agenda to explore how information is moved and propagated across multiple social media platforms.

Efforts to parse, filter, and make sense of "crisis big data" (Castillo, 2016) using machine learning learning methods will continue. Natural language processing methods are essential, but so will be methods for image diffusion. This research combined with service-side application development will help make hypertemporal and hyperlocal data accessible (Palen & Anderson, 2016) in a real-time fashion that is not currently possible.

Finally, the application of all this knowledge to practical response, recovery and mitigation efforts is the reason such research is important. As public participation continues to grow, questions regarding how the social media efforts of the public fit with formal response agencies will continue to be explored. What is the best way to leverage the collective knowledge of the public and the emergency experts? How do members of the public and emergency responders work together and what roles should each play? How can disasters be mitigated or even averted? These are the essential questions that drive the social media and crisis research agenda.

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Part VII

From Coordination to Recovery: Managing Disasters

Community Processes: Coordination 25

Thomas E. Drabek

Contents

25.1 Introduction

When community coordination processes fail during disaster responses, people suffer. And that includes both those directly impacted and secondary victims ranging from relatives to first responders to elected officials. Historically, coordination was central to the practice of emergency management. In recent years, however, a new paradigm for this profession has emerged. No longer is the vision limited to past notions of multi-agency coordination, rather concepts of vulnerability and resilience define the mission—one of community change agents focused on the whole community. Consequently, the concept of coordination has been expanded and made even more central within this profession. In this chapter, research relevant to these key concepts is summarized. The analysis comprises six topics: (1) introduction, (2) problem identification: fragmentation, (3) objects of study, (4) basic principles, (5) change agent strategies, and (6) future research agendas.

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While numerous studies have documented that preparedness actions and exercises increase interagency coordination during disaster responses (e.g., Benini, 1998; Berlin & Carlström, 2015; Drabek, 2005; Phillips, 2013), communication gaps and coordination difficulties continue to be highlighted after mass shootings like the Aurora, Colorado theater event (July 20, 2012) (Tri Data Division, 2014), Hurricane Katrina (Fink, 2013), the 2010 earthquake in Haiti (McEntire, Sadig, & Gupta, 2012) and many others (Drabek, 2013). These juxtapositions illustrate the public policy relevance and theoretical importance of a fundamental concept—coordination.

25.1.1 Structure Versus Process

Like many other sociological concepts, coordination has been defined differently by scholars with diverse objectives (Drabek & McEntire, 2002, pp. 204–205). As such it parallels many other constructs such as decision making or conflict, which also have been defined differently. Some have found each of these concepts to best fit their purposes when they were conceptualized as *structural* characteristics of social systems. In contrast, others have focused on the *processes* whereby decisions have been made regarding critical organizational, community, and societal policies (Janis, 1982).

So it is with *coordination.* When conceptualized as a quality of social structure various types of social systems can be compared (Hall, 1987). Consequences of the degree or level coordination can thereby be assessed. Similarly, the *processes* whereby system coordination might be enhanced or undermined may also be examined (Haas & Drabek, 1973). While structural interpretations, and research reflective of such, will be noted within this chapter, the primary focus is on process.

25.1.2 Definition

Haas and Drabek (1973) defined coordination as "…those sets of behaviors through which the complex network of interrelated events are maintained." (p. 103). They proposed that many business texts were oversimplified. That is, administrators should not be viewed as *the* organizational coordinator. Their perspective was reinforced over the years as other analysts documented the inherent shortcomings in perspectives rooted in the articulation of "coordination principles" such as "the unity of command principle" that specified "…that no organizational participants should receive orders from more than one superior…" (Scott, 1981, p. 65) (see also Hall, 1987, pp. 66–70).

Building on such insights as these, Rogers, Whetten, and Associates (1982) synthesized a large number of studies and perspectives focused on alternative approaches to coordination among organizations. Hence, they defined coordination "…as a legitimating mechanism used by those involved to divide up the territory and mutually work to prevent the entry of competition, and to dampen costly innovation." (p. vii). While similar to the definitions offered by these and other scholars, the formulation created by Gillespie (1991) is most relevant to the focus of this chapter and disaster research generally.

Gillespie proposed that "…coordination is the cooperation of independent units for the purpose of eliminating fragmentation, gap in service delivery, and unnecessary (as opposed to strategic) duplication of services." (Gillespie, 1991, p. 57). Unlike other alternatives, this definition is most relevant to human service systems and disaster responses in particular. Although it reflects a managerial perspective, both in purpose and desired outcome, it pushes the profession of emergency management into a framework, orientation, and vision that reflect the turbulence, diversity, and scope of the social systems that comprise disaster responses.

In contrast, Petrescu-Prahova and Butts (2008) used a more narrow definition in their analysis of radio communication networks following the World Trade Center attacks, i.e., coordination is "…the process of relaying information so task interference is prevented and individuals' efforts can come together in a coherent response." (p. 140). As such, it parallels concepts like "information transfer," i.e., the process of relaying information so task interference is prevented. Given their data base—transcripts of radio communications among Port Authority of New York

and New Jersey responders for over three hours after the first plane crashed into the North Tower (8:46 a.m.)—this more specialized definition of coordination was appropriate and useful (p. 145). As always, sociological concepts must be adapted to fit the research questions under study.

25.1.3 Enter the Emergency Manager

American society has been characterized in many ways, but all analysts agree that it reflects high levels of vertical and horizontal differentiation (McEntire & Dawson, 2007). Indeed, as Waugh (2000) emphasized: "The horizontal and vertical fragmentation of the federal system creates jurisdictional confusion and leads to coordination problems" (p. 52). And he was referring only to one sector. When the community and state layers of government are added to the mix along with the myriad of voluntary and private sector units, the scope of the managerial task becomes much clearer.

Increasingly, however, the profession of emergency management has staked out this processual turf as its niche (Drabek & McEntire, 2003; McEntire & Dawson, 2007). As reflected in the studies completed at Iowa State University (1962-1975), the post-World War II environment brought a fundamental shift in civil defense policy and especially local government priorities (see Drabek, 1987b for a summary of these studies, pp. 52–57). No longer confined to an agency name, i.e., Office of Civil Defense, local directors shifted agency mission and identity by relabeling their unit, i.e., Office of Disaster Preparedness. They propagated their role as being the community coordinator for all disaster preparedness activities, both peace-time and war related. In numerous publications, the Iowa State teams documented perceptions of local publics and local government officials that indicated these shifts. For example, "…preparedness for nuclear attack is not salient for most coordinators. One clear implication for DCPA is that appeals made to local coordinators on the basis of things a coordinator should do or be able to do in terms of the all-hazard approach are likely to be more readily acted upon than others" (Mulford, Klonglan, & Kopachevsky, 1973, p. 2). Indeed, during this era, in addition to more widespread adoption of an all-hazard approach, local government officials spoke in terms of "the coordinator" whenever disaster preparedness or response was discussed. The seminal work completed by staff of the National Governor's Association (1979) proved to be paradigm changing. No longer was emergency management limited to response actions, now preparedness, recovery, and mitigation were included (Perry, 1982). The *necessity* of intergovernmental and interorganizational coordination became recognized explicitly, and emergency managers within local, state, and federal agencies increasingly gained *legitimacy* in the eyes of their counterparts. They were viewed as "the coordinator" and their occupational role became increasingly professionalized including internal certification procedures and requirements (e.g., see Drabek, 1991a; Wilson and Oyola-Yemaiel, 2000, 2002). This transformation, like the specific principles and strategies of coordination, provides the basis for understanding the failures in agency action following the 9/11 attacks.

After the WTC attacks, the Bush Administration initiated major reforms, most importantly the creation of the Department of Homeland Security. Many of these were designed to detect, prevent and respond to potential terrorist attacks. These policy changes briefly deflected the evolution of emergency management at all levels of government, especially the federal (Kapucu, 2006). Hence, the Homeland Security Act of 2002 and Homeland Security Presidential Directive 5 complemented the earlier (1988) Stafford Act (Waugh, 2007). These priority shifts contrasted sharply to scholarly criticism of the 9/11 Commission conclusions (NCOTAUTUS, 2004) by Perrow (2005, 2007), Tierney (2005) and others (e.g., Drabek, 2008).

Prior to the 9/11 attacks and subsequent priority shifts within emergency management, the Federal Emergency Management Agency (FEMA) had initiated a project to encourage faculty at colleges and universities to explore and design degree programs focused on emergency management and aspects of homeland security.

The rational was that these programs would accelerate the professionalization process that was elevating the legitimacy of emergency managers within community coordination processes (Drabek, 2007). As these were developed (Cwiak, 2014)—over 200 to date—Hurricane Katrina left catastrophic damages along the Gulf Coast. Numerous researchers documented impacts especially on women (David & Enarson, 2012; Weber & Peek, 2012) and children (Fothergill & Peek, 2015). Not only did these studies, like the university based curricula, document key vulnerabilities within the US population, they also deflected the vision of emergency management.

While the FEMA Higher Education Program was continued under the Bush Administration, the initiative was accelerated following the election of President Barack Obama. Drabek (2013, p. 285–295), for example, proposed that a new paradigm was required, one wherein the concept of "community coordinator" was expanded and made more proactive. Thus the imagery of "community change agents" was proposed as a more appropriate model for reduction of community vulnerabilities and increases in resilience (Springer, 2009).

As system strains and interagency conflicts were exposed, professional emergency managers were encouraged to implement conflict resolution strategies among all stakeholders. This imagery paralleled both Aldrich's (2012) analyses of social capital theory and "the whole community approach" introduced by the Obama Administration through such actions as "Presidential Policy Directive (PPD) 8: National Preparedness" (see Drabek, 2013, pp. 282–289; FEMA, 2011). The social problem of disaster (Kreps & Drabek, 1996) was placed into a much broader context as so-called "coordination processes" now reflect the "bottoms-up" approaches advocated by Edwards (2009) and others who emphasized that if community resilience was a key goal of emergency management, the approach must be based "…on institutions and organizations letting go, creating the necessary framework for action, rather than developing specific plans…" (Edwards, 2009, p. 80). The implications of this paradigm shift for prior notions of "community coordination" are profound.

25.2 Problem Identification: Fragmentation

To understand how coordination, both in its early "life" and more recent paradigms, gradually evolved as a key responsibility of emergency managers, it is necessary to explore three interrelated streams of literature: (1) organizational theory, (2) disaster response assessments, and (3) studies of local disaster preparedness directors.

25.2.1 Organizational Theory

Thompson and Hawkes (1962) explored the implications of disaster for administrative theory. Conceptualizing disaster as a type of social system stress, they observed that "…the contemporary American community normally relies on pluralistic processes for allocating resources among its parts and for attaining integration of those parts." (p. 274). Furthermore, "…disaster interrupts normal relationships among these units, requiring them to operate more autonomously than before." (p. 274). And finally, "… the system's processes of allocation and integration are *fragmented*…" (p. 274) (italics in original).

During disaster responses, these community qualities, i.e., increases in unit autonomy, preexisting levels of fragmentation, and pluralism give rise to the emergence of *synthetic* organizations. Through these emergent systems interorganizational communications can be established and/or enhanced and the information bases on which executive decisions can be made become expanded. In his now classic work, *Organizations in Action*, Thompson (1967) elaborated on these processes and adapted them into a general theory of organizational behavior. Quarantelli, for example, (1984a, b) picked up on these themes and specified with greater precision

the processes whereby the environment created by disaster redefined the managerial challenges confronting local decision makers (Kreps, 1991). Analyses of these shifts in task environments, and the managerial models most appropriate for them, paved the way for the articulation of the range of strategies and tactics that came to define "comprehensive emergency management" (Lindell & Perry, 1992). Others (e.g., Denis, 1997) proceeded to amplify these conceptual foundations through a series of elaborations including the paradigm shift wherein emergency managers are viewed as "community change agents" (Drabek, 2013, pp. 291–298).

25.2.2 Disaster Response Assessments

As Scanlon (1988, 1997) has highlighted so effectively, the *first* empirical study of disaster documented system fragmentation, conflict, and poor coordination among responders. In his seminal study of the Halifax ship collision on December 6, 1917, Prince (1920) laid the first stone in the foundation. As Scanlon put it, Prince described "…emergent organization, both homegrown and imported" (p. 221). Quoting Prince (p. 84), Scanlon hammered the point home. "There was also lack of cooperation among official committees themselves. Friction and crises arose from time to time, which were only stopped short of scandal" (Scanlon, 1988, p. 222).

Years later, individual disaster case studies continued to display organizational personnel tripping over each other as they mobilized to reduce the trauma brought by floods (e.g., Clifford, 1956), tornadoes (e.g., Form & Nosow, 1958), and hurricanes (e.g., Moore, Bates, Layman, & Parenton, 1963). These studies enabled Fritz's (1961) multidisaster analyses whereby the detail of the specific could give way to the generalization based on the many. Reading between the lines of dozens of single-community disaster studies, Barton (1969) expanded on his earlier (1962) more limited analysis of "the emergency social system" and created elaborate networks of hypotheses that linked hundreds of variables into more unified wholes. One such cluster of 71 hypotheticals sought to define the rise of the post-disaster "altruistic community" wherein some would put the pain and experience of disaster into redefinitions of deprivation that might neutralize the hurt and also reinforce their sense of self-worth and individual autonomy (Barton, 1969, pp. 216–279).

In contrast, Dynes (1970) stuck to realities that, while less abstract than Barton's models, were more rooted in empirically based observations. He emphasized that the post-disaster problem of coordination was exacerbated by numerous factors such as the sequential interdependence of tasks. This, in turn, required "… some overall view of the tasks and their relative priority" (Dynes, 1970, p. 207). Lacking mechanisms to accomplish this, some proposed that the coordination task could best be accomplished by strong leaders who could implement the classic principles of bureaucracy (e.g., Weber, 1946). "This myth tends to be perpetuated by those who assume military analogies are applicable and who speak in terms of commanding and controlling a disaster situation." (p. 207). Paralleling Thompson's (1967) analysis, Dynes (1970) concluded that such "commanders" rarely were successful at accomplishing the coordination required to adequately cope with such fragmented responses. Rather, the search for and eventual supply of information gradually leads to an emergent coordinating body. "Such a group is usually composed of officials of legitimate organizations plus individuals with special competence and knowledge and individuals who participate in many different institutional segments of the community" (Dynes, 1970, p. 208).

Organized disaster responses were not limited to the core emergency organizational executives that had become the primary units of analysis focused on by Thompson or Barton. Rather Dynes demonstrated the full scope of the community response and illustrated its various forms. What came to be known as "the DRC Typology" had its roots in this and other reports of its day (e.g., Quarantelli, 1966). Thus, the fragmentation of response was best understood, as emergency

managers later came to realize, through the identification of at least four very different types of systems. These reflected two dimensions, that is, tasks (regular or nonregular) and structure (old or new). Cross-tabulation identified the four types of systems that comprised community responses to disaster: type I (established, regular tasks accomplished through old structures); type II (expanding, regular, new); type III (extending, nonregular, old), and type IV (emergent, nonregular, new). It is this mix of systems, with very different life histories and cultures, that defines the coordination task of emergency managers.

Numerous scholars documented the importance and usefulness of the DRC typology (e.g., Forrest, 1978; Stallings, 1978). While other examples could be noted, the long-term program of research directed by Kreps (1989) and his associates provides the best work to date that has tried to unravel the post-disaster structures described by Dynes and others using the DRC typology (e.g., Kreps, Bosworth, Mooney, Russell, & Myers, 1994). After extensive analysis of hundreds of interviews conducted by DRC staff, they concluded: "The DRC typology will continue to be a very efficient and effective analytical tool…" in part because it "…specifies nicely a micro-macro link between the individual and social structure" (Kreps et al., 1994, p. 191).

Recent disaster events continue to reflect coordination difficulties. For example, when a mentally deranged shooter fired into the audience attending the Aurora Century 16 Theater (July 20, 2012), 70 people were shot, 12 died (TriData Division, 2014, p. x). Both police, fire and ambulances arrived quickly, but neither a joint command center nor overall commander was established until late in the first hour of the incident. (TriData Division, 2014, p. xiii). Furthermore, EMS responders "…were delayed and overloaded before getting to some of the critically injured victims because they were intercepted by the wounded streaming away from the theater." (p. xiv). "Police did not inform fire on how to reach some patients, despite one police car making multiple round trips to hospital." (p. xiv). While the overall response was found to be effective as a result of past training, these and many other shortcomings were documented. Unfortunately, the research literature continues to reflect these types of failings.

25.2.3 Studies of Local Disaster Preparedness Directors

The third stream of research that helped define the problem of fragmentation was assessments of local emergency manager activities and programs (Stehr, 2007). As noted earlier, this stream of research had its origins in studies conducted at Iowa State University between 1962 and 1975 (e.g., Mulford et al., 1973). After identifying a series of strategies used by local civil defense directors to improve coordination, that is, reduce program fragmentation within their communities, senior team members began to examine other human service agencies (e.g., Mulford & Klonglan, 1981; Mulford & Mulford, 1977). They documented that more effective civil defense coordinators more frequently used such strategies as cooptation and resource building. Educating the public and local organizations also improved agency legitimacy. They labeled this process "audience strategy". Inviting key local leaders to serve as an advisory board was labeled "elite representation strategy" (Mulford et al., 1973, p. 304). These studies provided a foundation for our understanding of the dynamics of interagency coordination processes.

Numerous studies of disaster response were conducted, and continue to be completed, by staff of the Disaster Research Center (DRC) since its creation in 1963. Most relevant to coordination processes and explication of the key problem of fragmentation, of course, was the creation of the DRC typology. Beyond this, however, are specific assessments of local civil defense offices and qualities related to their effectiveness which frequently was defined as their capacity to coordinate. For example, Dynes (1994) has emphasized that local managers would be better served by implementing an "emergent human resources model" (later referred to as a "problem solving model") than the prevailing "command and control" approach. His wise understanding

of the importance of legitimacy echoed the earlier observations of Anderson (1969), who had highlighted issues of authority and acceptance in interagency contacts. Later comparative assessments (e.g., Wenger, Quarantelli, & Dynes, 1987) documented a typology comprised of eight types of local emergency management agencies that reflected: (1) extensiveness of response activities; (2) extensiveness of planning activities; and (3) agency structure, that is, autonomous or integrated (p. 60). Hence, local offices were found to vary from type 1 (traditional) agencies, that reflected an autonomous structure used to accomplish a very narrowly defined set of planning and response activities, to type 8 (established, i.e., broad response and planning activities implemented within an integrated structure). These analyses documented the utility of definitions of coordination paralleling that noted above by Gillespie (1991) and the limited applicability of "top-down" management structures (Wenger, Quarantelli & Dynes, 1990).

More recently, assessments by Jensen (2009) have documented the continuing pattern of implementation failure. For example, after five years of attempts to encourage adoption of the National Incident Management System (NIMS), face-to-face interviews with county emergency managers in three states revealed limited compliance. Indeed, her study documented that: "most emergency managers said that all, or parts, of NIMS were based on a series of false assumptions about the nature of emergency management and local settings." (Jensen, 2009, p. 228). In short, while a "…majority of emergency managers in this study interpreted NIMS in a generally positive manner; however, they did so with numerous reservations." (p. 243). Their perception "…appeared to be related to an approach to NIMS that sometimes involved game playing, a minimal compliance, and selective implementation." (p. 244). These results paralleled those Jensen and Yoon (2011) reported following their interviews with volunteer fire personnel regarding the implementation of the Incident Command System (ICS) and NIMS. Clearly, there frequently are gaps between policies written to improve community coordination and actual practice.

25.3 Objects of Study

Researchers have examined coordination processes, and failures, from a variety of vantage points. This diversity is important and best understood by clustering studies into a typology comprised of two dimensions: (1) system complexity and (2) disaster phase. Given the brevity of this chapter, however, illustrations for each analytic cell are not specified, rather, a simple twofold break is made, that is, system level and disaster phase.

25.3.1 System Level

In highly complex disasters, such as the WTC attacks, some researchers have identified important sub-systems for focused analysis. As noted above, Petreseu-Prahova and Butts (2008) focused on interactions within radio communication networks. They documented that the great majority of coordinators occupied emergent roles. "At the same time, where agents with institutionalized coordinative roles are present, they are substantially more likely to become actual coordinators." (p. 133). These emergent coordinating roles paralleled those documented by Drabek and Haas (1969) in their laboratory simulation of police communication systems under stress. Similarly, Kendra and Wachtendorf (2016) documented the emergent water based evacuation from Manhattan after the attacks. Thus, system level selected for study can be both segmental and emergent.

The outstanding detail provided by Wachtendorf and Kendra (2012) on the emergent reconstruction of the New York City Emergency Operations Center after the 9/11 attacks is a unique work. Once the office location was destroyed, they documented with precision how staff rapidly tackled the reconstruction process. Remembering key task qualities and procedures,

their behavior exhibited what these researchers aptly named "reproductive improvisation." This important finding should be built into future emergency management exercises as no facility is disaster proof. For example, Drabek (1991b) documented this in Charleston, South Carolina, following Hurricane Hugo. Extensive damages to the EOC required office relocation which was complicated further by staff shortages among those who knew how to use their computer after it was moved (p. 145).

At the community system level, Sorensen, Mileti, and Copenhaver (1985) identified key factors that prompted cohesion within systems both at the intra- and intersystem levels. This work paralleled the earlier assessment by Dynes (1978). Focusing on the tornadoes that struck Ft. Worth, Texas in March, 2000, McEntire (2001b) documented the major factors that facilitated coordination, for example, program acceptance, preparedness activities, networking, technology, etc. (see p. 10–12) and those that reduced it, for example, lack of information, blocked access, language barriers, and so forth (see p. 9–10). Denis's (1995) detailed assessment of the response to a PCB fire in Quebec, Canada demonstrated that "…coordination is negotiated by those who must respond to a disaster" (p. 25). Her work was extended to other events, for example, a used-tire dump fire, to dissect the dynamics of the types of "mega-organizations" that parallel the processes first described by Barton (1969) and Dynes (1970) and later by Drabek et al. (1981). All of this work underscored the imagery of emergent systems being the key structures that emergency managers must first conceptualize and then develop strategies if their coordination efforts are to be effective (see also Denis, 1997).

Relatively few have examined state level emergency management agencies, although Drabek (1991b) did assess the adoption and implementation of microcomputers in several. As will be explored later, these were but one of several technologies that managers have used to improve their capacity for coordination.

Federal system level analyses have been completed in the United States that are both of a generic nature, for example, Kreps (1990) or Schneider (1992) and event focused, for example, FEMA's response during Hurricane Andrew by Carley and Harrald (1997). Sylves and Cumming (2004) documented the adaptations required by FEMA staff as they turned more attention to terrorist attacks, both actual and threatened. Hence the drift toward a homeland security perspective has brought new problems and new organizational culture contacts that require additional coordination strategies (Bullock et al., 2005; McEntire, 2009). Aspects of the complex federal level coordination requirements were highlighted by Weaver (2014). Focusing on Hurricanes Katrina and Irene, he assessed the collaboration of departments of Defense, specifically the U.S. Northern Command (NORTHCOM) and Homeland Security, specifically FEMA, with regards to impacted state governments. His exploratory study revealed the complexities inherent in building theoretical models designed to predict relative effectiveness as reflected in how long it takes state government units to spend in the preparation and response phases of a hurricane (p. 381). In contrast, researchers such as Scanlon (1995) have provided insight into the Canadian federal system. McEntire and Lindsay (2012) contrasted the USA federal system with the Canadian emergency management intergovernmental system. Their key conclusion identifies a complex research agenda with profound policy and educational implications: "…even similar sociopolitical contexts may result in very different emergency management approaches, and emergency managers should understand how this impacts their work." (p. 93). Britton (1991) has provided a counterpoint with the Australian experience and Danielsson, Johansson, and Neal (2015) have described the research base in Sweden. As highlighted below, what the future requires is multinational comparative study.

Wachtendorf's (2000) analysis of the Red River flooding that crossed from Canada into the United States is reminiscent of Clifford's (1956) border study of flooding in Eagle Pass, Texas and the nearby Mexican town of Piedras Negras. Here, the cross-national issues of disaster

highlight the coordination difficulties nation-states confront. Clearly the complexities exposed by the earthquake that struck the northern section of Japan (March 11, 2011) illustrate this point (Kiyota, Tanaka, Arnold, & Aldrich, 2015). As debris continues to wash up on the western coasts of the U.S.A., many will wonder about the levels of contamination released from the earthquake and tsunami, especially that near the damaged Fukushima nuclear power plant (Companion, 2015). Others like Scanlon (2008) and McEntire et al. (2012) have focused on the processes used and problems encountered with unidentified bodies in mass-fatality events like the 2004 tsunami that struck several nations, especially Thailand and Sri Lanka and the 2010 earthquake in Haiti.

The dynamics of intergovernmental boundary-spanning processes were dissected by May and Williams (1986) and have been scrutinized further in studies such as those of Kory (1998) and Toulmin, Givans, and Steel (1998). From Kory's assessment, we learn of the reality of multiple local governments in a community such as Miami-Dade County, Florida. Regional, as opposed to local, planning for hurricane evacuation and recovery is but one approach to seek improved coordination. Deficiencies of a different type were documented by Toulmin et al. (1998), who applied Sanford's (1967) portrait of "picket fence federalism" to disaster communications. Their theory of "intergovernmental distance" (p. 120–130) highlighted structural sources for weak and highly problematic interagency communication under non-disaster conditions. Indeed such poor communication, and consequently weak coordination, "…is not occasional, anecdotal or unique to particular disasters, but is endemic to all the intergovernmental disaster responses" (p. 130). In view of the conclusions reached by the members of the 9/11 Commission (NCOTAUTUS, 2004) regarding "the wall" that hindered the "connection of the dots" by intelligence analysts operating within multiple agencies (pp. 254–277, 424), the conclusion offered by Toulmin et al. (1998) has a chilling relevance. "The theory of intergovernmental distance points to the complexity and difficulty—and yet the necessity—of planning for 'the big one'" (p. 131). Unfortunately, their wisdom has yet to be fully implemented, thereby leaving the nation at risk.

25.3.2 Disaster Phase

Since the idea of disaster life cycles was first introduced by Carr (1932), dozens of researchers have discovered its utility although critics such as Neal (1997, 2013) have underscored a variety of limitations. Like the generic, rather than the agent-specific, approach to disaster preparedness, the concept of disaster phase has provided a useful framework for many researchers. Wolensky and Wolensky's (1990) literature review is a case in point. For example, they documented "local government performance across four disaster phases" (pp. 704–708) and thereby demonstrated that within each phase actions by local officials emerged as "problematic." After dissecting strains within the intergovernmental system (pp. 708–710), vertical and horizontal fragmentation (p. 711), they concluded that "… the historic development of power relationships within the American community has supported a custodially oriented, limited-resourced government sphere and an influential, well-resourced private sphere" (p. 714). And in turn, "…we expect that disaster management will remain a low priority within a generally under-resourced local government" (p. 717).

Presumably, interagency, coordination can be enhanced through a series of disaster preparedness actions (Perry & Lindell, 2003, 2004). Empirical assessment of such a claim, however, has revealed many challenges. For example, Gillespie and Streeter (1987) unveiled a host of methodological issues when they attacked the first piece of the puzzle, that is, measures of disaster preparedness. Later, Gillespie and Colignon (1993) reported on their effort to carefully measure network shifts before and after a major table-top drill involving an earthquake scenario. Validating the research of the past, but this time with far more precision, they concluded that shifts in the task environments of responding

disaster organizations were met with changes in interagency relationships that reflected both elaborations in structure and increases in concentration (p. 159). These and related assessments reflecting network coordination processes were documented in detail in their book length presentation (Gillespie, Colignon, Banerjee, Murty, & Rogge, 1993). To date, their work remains the most rigorous measurement and quantitative exploration of disaster preparedness networks. Regardless of the precision or sophistication of the measurements used, however, one theme is underscored by all who have examined such social networks: preparedness activities frequently enhance, but do not insure, effective interagency coordination.

Studies of disaster response frequently have concluded that the coordination processes used during routine emergencies do not fit the task environment created by disaster (Drabek, 2013; Dynes, 1970). As Auf der Heide (1989) states, "…the reasons disaster response is difficult to coordinate is because disasters are different from routine, daily emergencies" (p. 49). As summarized by Auf der Heide (1989), numerous studies, especially those completed by DRC staff members, have documented various reasons why disaster responses require, and frequently produce, alternative coordination mechanisms, for example, unfamiliar tasks crossing of jurisdictional boundaries, effects on equipment and/or personnel, large number of responders and responding organizations, urgent nature of demands, and so forth (see Drabek, 2004; Drabek & McEntire, 2002).

These realities were dissected in detail as the 9/11 Commission took testimony from those who sought to coordinate rescue efforts. Despite the guidance provided in a July 2001 directive by Mayor Guiliani titled "Direction and Control of Emergencies in the City of New York," "…the response operations lacked the kind of integrated communications and unified command contemplated in the directive" (NCOTAUTUS, 2004, p. 319). There were many reasons why the behavioral reality of the response did not match the framework spelled out on paper. Aside from the unique and massive quantity of attack-generated demands, the Commission documented that "…the FDNY and NYPD each considered itself operationally autonomous. As of September 22, they were not prepared to comprehensively coordinate their efforts in responding to a major incident" (p. 285). Intrasystem coordination processes were lacking as well, for example, "…the FDNY as an institution proved incapable of coordinating the number of units dispatched to different points within the 16-acre complex" (p. 319). Further, "information that was critical to informed decision making was not shared among agencies" (p. 321).

When Hurricane Katrina left Memorial Hospital damaged and flooded, staff finally realized that critically ill patients including infants and elderly had to be evacuated. Issues of triage were guided initially by protocol, but as time progressed some began to focus on evacuation of those most likely to survive rather than the most ill. Fink's (2013) detailed analysis of this decision process, the numerous improvisations implemented by staff are most insightful including her documentation of the lack of planning in the event of flooding (p. 71) and evacuation priorities among DNR patients (p. 92). And then on October 29, 2012, as Hurricane Sandy was striking the east coast, Fink found herself at the command center for Long Island's North-LIJ Health System (p. 463). In contrast to evacuating and confronting all of the ethical triage decisions that Memorial Hospital staff faced during Katrina, volunteers at Bellevue Hospital in New York "…formed a chain and passed fuel up thirteen flights of stairs to feed the generators manually. Swift improvisation prevented the backup power from cutting out, which prevented horrible choices from having to be made." (p. 485).

Further validating the importance of improvisation in most, if not all, disaster responses, Kendra and Wachtendorf (2003) carefully documented three significant developments following the 9/11 attacks. These "creative" responses partially reflected the destruction of the NYC EOC which had been housed within the facility at 7 WTC. So a new "…geographic

information system (GIS) and map-distribution function, amounting virtually to a cartography factory" emerged (p. 130). The "waterborne evacuation" quickly moved approximately 500,000 people out of Manhattan (p. 132) and an improvised "credentialing" system was implemented through a series of phases to help control area access (p. 134). These and other examples of improvisation were required given the new task environment within which emergency responders functioned. Further analyses by Wachtendorf (2004) identified three very different forms of improvisations that represented an acute structural strain or tension, especially among officers who wanted to work within prearranged plans that did not fit the disaster reality, see Kendra and Wachtendorf (2003, pp. 136–138) and Kendra and Wachtendorf (2016).

In short, despite the research of the past and the exceptional heroism exhibited by first responders and hundreds of civilians within or near the WTC on that fateful day, the multiorganizational networks that emerged during this response were found to be lacking in coordination at multiple system levels. As such, despite the complexity and the uniqueness of this event the coordination failures were reminiscent of past times and past events. As Drabek (1968) documented in the first monograph published by the DRC, the response to the explosion within the coliseum at the Indiana state fairgrounds (October 31, 1963) was characterized by inadequate interorganizational coordination (pp. 162–165). What he later termed "organized disorganization" (Drabek, 2013, pp. 175–199).

Emergent responses among those in a disaster impacted area, especially confined spaces like subways or trains, reflect survivor behaviors and at times considerable acts of altruism. Scanlon's (2005) early personal observations at the time of the London subway bombings (July 2005) were confirmed and greatly extended by Drury, Cocking, and Reicher (2009). Such responses must be anticipated by emergency officials whose coordination efforts will require both time and appreciation of the actions of victims and survivors.

In contrast, when preparedness actions have been implemented successfully and the event allows forewarning, far more extensive coordination actions are possible. This was documented by Hoekstra, Nichols, and Gruntfest (2014) in their analysis of school district and university officials who directed protective actions following National Weather Service tornado warnings. While unique circumstances always will leave some areas uncovered in preparedness training, it is clear that community investments in such activities will save lives and reduce trauma for those at risk. Active shooter programs implemented after the Columbine school massacre in April 1999 have been implemented widely with results that clearly are positive (Cullen, 2009; Mears, 2012). Unfortunately, the numbers of such incidents has continued to increase both in frequency and scope (Blair, Nichols, Burns, & Curnutt, 2013; Drabek 2013, pp. 56–57). Their sudden and expected nature will continue to challenge officials responsible for coordinated responses.

Recovery operations often involve complex coordination issues. As noted earlier, these reflect the fragmented nature of the intergovernmental system and the rich resource bases located within voluntary relief agencies such as the Red Cross and private sector organizations (Auf der Heide, 1989, p. 113, Drabek, 1986, p. 225). Neal's (1994) documentation of the difficulties surrounding donated items provides a starting point (see also Auf der Heide, 1989, p. 113). More complex events, such as the bombing of the Alfred P. Murrah building in Oklahoma City, Oklahoma (1995), give rise to even larger numbers of emergent systems as officials seek to cope with actions initiated by thousands of well-intentioned people (Wedel & Baker, 1998).

Using semi-structured telephone interviews with 54 county emergency managers in nine states, Jensen, Bundy, Thomas, & Yakubu (2014), documented many gaps in the recovery role envisioned and that actually performed (pp. 168–176). While the value of emergency management appeared to be on the rise within their data set, "…these data show that the respondents perceive a generic and limited role

for themselves in recovery that is largely focused on the completion of paperwork." (p. 177).

These results contrast sharply with the conclusions reached by Richardson, Siebeneck, Shaunfield, & Kaszynski (2014). They interviewed 32 residents and five community leaders of a small Texas town, after general recovery from Hurricane Ike (2008). They used Turner's (1974) concept of "communitas," that is, "… times in which status and roles are temporarily suspended and a sense of equality and freedom pervades in a group or society…" (p 186). Hence, by emphasizing emergent structures, especially those reflective of altruism, they documented that the community appeared to recover through three stages, i.e., separation, margin, and re-aggregation. "…the community re-invented itself, which may be a necessary condition for recovery." (p. 211). Appreciation of such processes may aid community leaders who can "… recognize the emergence and existence of communitas and use it as a resource to aid the recovery process." (p. 212).

These themes are reflected in the extensive literature review of 202 articles focused on disaster recovery completed by Jordan and Javernick-Will (2014). They concluded that 34 factors reflecting aspects of community resilience and vulnerability could be classified into five categories: 1) pre-disaster economic, 2) institutional, 3) infrastructure, 4) social and 5) post-disaster recovery strategy (p. 423). So too, issues of re-entry that were documented by Siebeneck and Cova (2008) after Hurricane Rita in 2005, reinforced both the essentiality and complexity of issues that confront local officials. Always they must juxtapose assessments of risk to returning evacuees with powerful political and sentimental forces. As they seek to coordinate this aspect of recovery, it is essential to recognize the strong desire for returning home so that some semblance of "normalcy" can be achieved. Emergent and highly creative actions by residents can be expected when local officials error through policies reflective of excessive caution and delay.

Longer term recovery often involves coordination requirements pertaining to memorials. In the short term, those who died in a disaster will be grieved and memorialized through a series of family and extended kin rituals. Eyre and Dix (2014) have emphasized that aside from a few exceptions like their work on the permanent monument erected at Dryfesdale Cemetary following the Lockerbie Air Disaster in December of 1988, the coordination processes that guide such recovery activities remain undocumented. Clearly these elements of "popular culture" are important aspects of recovery that both local officials and researchers must seek to understand better (Quarantelli & Davis, 2011).

Finally, coordination processes during the mitigation phase may be the most difficult to implement. For example, Godschalk, Beatley, Berke, Brower, and Kaiser (1998) documented the coordination complexities confronting those who seek to reduce community vulnerabilities through such strategies as land-use planning, flood zone usage procedures, and the like. Such pleas to "cooperate with nature" have been advocated for decades (Burton, Kates & White, 1978). This viewpoint culminated in Mileti's (1999) statement wherein he articulated the strategies and tactics of a "sustainability perspective" and the underlying values it reflected (e.g., see pp. 17–35). Such values, however, may clash with those of others, especially those representing development, community growth, tourism, and other interests. And as Jensen and Chavet (2014) documented, many local emergency managers have only vague notions at best of the complexities and implications inherent in the concept of "sustainability". Hence, the question of "who is in charge?" may severely neutralize, or at the very least complicate, coordination efforts. For example, wildfire mitigation policy proposals have been resisted by sectors of mountain communities who perceive their economic interests being trampled by "excessive" or "illegitimate" government regulation.

This too is true for even such basic provisions as housing as Delaney (2015) documented after the 2011 Japan earthquake and tsunami. Following Hurricane Katrina, Evans-Crowley and Kitchen (2011) examined the processes whereby officials in several Gulf Coast states explored

temporary housing needs. They implemented a "cottage" system designed to provide low cost temporary housing as an alternative to FEMA trailers. As the implementation processes proceeded, they documented a key impediment—lack of local zoning decisions appropriate for temporary housing. As time went on, higher percentages of the cottage residents (68.5%) indicated a desire to remain in the cottage, although some described a desire to build an addition (p. 118–120). The researchers concluded that "…FEMA should evaluate the pilot alternative housing programs in Gulf States to determine the feasibility of replacing the FEMA trailers with Cottages as a temporary-to-permanent post-disaster solution." (p. 124).

With a much broader focus, Smith, Lyles, & Berke (2013) explored the consequences of the Disaster Mitigation Act (DMA) of 2000 which "…created a new intergovernmental policy framework for hazard mitigation that formalize and strengthens states' role as a coordinator between local and federal mitigation efforts." (p. 179). While this act provided state hazard mitigation staffing designed to provide technical assistance and encouragement of awareness and commitment to hazard mitigation and local land use planning, the research team documented a mixed picture of implementation. In short, "…more than 10 years after the passage of the DMA, several important issues continue to affect the ability of states to assist local governments in building robust hazard mitigation plans and integrated risk reduction policies." (p. 193). For example, the team documented that state agencies "…tend to emphasize building local governments' capacities to gain access to project funding rather than focusing on helping them identify and establish a comprehensive, proactive, and sustained risk reduction strategy grounded in land use policy." (p. 194).

Regardless of the hazard, those seeking to coordinate proposed mitigation programs confront a myriad of complexities not encountered during other phases of the disaster life cycle, not the least of which are fundamental potential value clashes that may preclude, or at least make very difficult, attainment of a consensus that becomes defined as legitimate.

25.4 Basic Principles

The summaries in the preceding text identify numerous principles and insights pertaining to coordination processes. There are five themes in the literature, however, that should be highlighted: (1) facilitators, (2) barriers, (3) managerial orientations, (4) role of emergency operations centers, and (5) information technologies.

25.4.1 Facilitators

As noted earlier, Iowa State researchers, for example, Mulford and Klonglan (1981), first documented various strategies whereby interagency coordination could be enhanced. Auf der Heide (1989) expanded on their work by incorporating numerous post-disaster response studies from DRC staff, both continuing (e.g., Dynes, 1970; Quarantelli, 1966) and former (e.g., Drabek, 1986). He emphasized such factors as dispute resolutions, be they jurisdictional, personnel, or what have you; development of trust among organizational staff at all levels; and increasing knowledge of expectations, resources, and operating procedures used by other organizational personnel. Numerous studies have documented that various preparedness actions have facilitated more coordinated responses, for example, Carley and Harrald (1997), Paton and Johnson (2001), Perry (2004), and Quarantelli (1997b). At the household level, these themes parallel those documented by McCaffrey, Velez, and Briefel (2013) in their study of information needs of wildfire evacuees. They used a mail survey to obtain data from 274 people threatened during two wildfires in 2010—Fourmile Canyon, Colorado and Schultz Fire in Arizona. Their results clearly demonstrated that access to both more timely and more interactive information sources, will enhance evacuation compliance.

Improved coordination of the flow of such information is essential.

Drawing upon a careful review of the literature, e.g., McEntire (1998), syntheses by Gillespie (1991) and others, Drabek and McEntire (2002) highlighted three facilitators of agency coordination: 1) contact; 2) communication, and 3) cooperation (p. 211). Later, McEntire and Dawson (2007) restated these themes as follows. "Coordination is most likely to be achieved when organizations have (1) pre-disaster ties (which generate familiarity with others' knowledge, skills, and abilities), (2) a means of sharing disaster information easily and quickly, and (3) a willingness to work together to meet emergency management needs." (p. 61).

25.4.2 Barriers

Numerous studies have documented a variety of factors that at times can be barriers to interagency coordination. For example, Drabek (1986) stressed that inadequate communication flows among the multiorganizational search and rescue networks he studied prevented adequate coordination. He (1968) had stressed this factor previously in his case study of the Indianapolis coliseum explosion. However, he emphasized that other factors operated as well. Many of these have been documented further by others (e.g., Gillespie, 1991, p. 58). These include interagency conflicts and jurisdictional ambiguity (e.g., Kouzmin, Jarman, & Rosenthal, 1995); lack of experience and/or knowledge among EOC personnel (e.g., Auf der Heide, 1989); and lack of consensus regarding the nature of and need for coordination (Quarantelli, 1984a, b).

McEntire's (1998) literature reviews confirmed earlier syntheses by Gillespie (1991), and reaffirmed the importance of several barriers to coordination including: 1) lack of organizational awareness, i.e., do agency personnel even know of the existence of another organization, or some level of professional association; 2) shared standards of conduct or agreements to operate in unison; 3) lack of forums or communication channels to share information and discuss policy options; 4) failure to overcome various disincentives to cooperate such as competition for funds or publicity; and 5) failure to understand how another agency can complement their actions to assist disaster victims (McEntire, 1998, p. 3). Each of these factors has been documented by case study writers and those conducting comparative cross-event assessments.

25.4.3 Managerial Orientations

In 1983, Dynes first delineated the contrasts between a command and control managerial orientation that had become the prevailing orientation among civil defense directors. Reflecting in many cases their prior military training, they sought to apply the principles of coordination that they had learned within these bureaucratic systems. Unfortunately, both in everyday activities with the diverse array of organizational cultures they confronted, and especially in the turbulent environments of disaster response, this orientation failed them. Dynes (1983) explicated why the bureaucratic model was inappropriate to the task environment of the emergency manager. After the 9/11 attacks, he (2003) applied this analysis to response failures.

Others, such as Drabek (1987a, b), Neal and Phillips (1995), and Schneider (1992) have developed parallel analyses. Waugh (2007) has stated the position well in several of his texts for emergency managers. "Effective emergency management requires *collaboration* rather than a command and control approach." (p. 18). In short, regardless of the label used to identify the orientation, for example, "human resources model" (Dynes, 1983), "problem solving model" (Dynes, 1994); "participative model" (Waugh, 2007), "collaborative model" (Paton & Johnson, 2001), the coordination function increasingly is implemented by emergency managers who have come to realize the limited usefulness, indeed outright inappropriateness, of older managerial paradigms rooted within the rhetoric and orientation of "command and control."

25.4.4 Role of Emergency Operations Centers (EOCs)

During the past three decades, one structural creation has emerged in many communities that, apart from disaster drills and simulations, has done more to improve the quality of interagency coordination than anything else. But while the EOC concept has been around much longer, today it is a living, functioning unit in most communities (Drabek, 2013, pp. 192–199). In the past the so-called EOC might house only the emergency manager and other agency staff during an emergency response. Others just did not show up, or if they did, they did not stay long. Numerous field studies (e.g., Drabek, 1987b, 2003; Scanlon, 1994, 1997, 2002) have documented the widespread presence of these facilities and their centrality within the multiorganizational network (Perry, 1991; Rotanz, 2007). And as Wachtendorf and Kendra (2012) documented after the 9/11 attacks, the key priority of emergency management staff was the improvised reconstitution of their EOC.

25.4.5 Role of Information Technology

Drabek (1991b) prepared a social history of the initial adoption and implementation of microcomputers into state and local emergency management offices. While there were barriers, these technologies enhanced the information processing and mobilization of resources, thereby facilitating interagency coordination. Since then, the revolution in information technology is hard to describe. For example, Beaven et al. (2014) documented extensive use of Facebook following the September 4, 2010 Darfield, New Zealand earthquake. Extensive popularization and use of smart phones is but one to aspect of this technological revolution. Numerous types of decision making tools have been developed (e.g., Belardo, Karwan, & Wallace, 1984) as have geographic information systems (e.g., Gruntfest & Weber, 1998) that have increased the visibility, reputation, and legitimacy of local emergency management agencies. Documentation of the GIS used in Hurricane Katrina recovery operations is but one example of the widespread adoption and application (Curtis, Mills, Blackburn, Pine, & Kennedy, 2006). Stephenson and Anderson's (1997) analysis of additional technologies is most insightful and underscores the impacts of variety of new technologies (e.g., digital libraries, ultra-broadband networks) on the evolving profession of emergency management. Thomas's chapter in this book provides an excellent overview and elaboration of GIS and remote sensing applications, "The Role of Geographic Information Science and Technology in Disaster Management." Each of these technologies has enormous potential for enhancing coordination although there are important issues that wise scholars such as Quarantelli (1997a) have identified.

25.5 Change Agent Strategies

Wolensky and Miller (1981) first documented important differences in the everyday, as opposed to the disaster response, role of emergency managers. Everyday activities of emergency managers reflected preparedness and planning activities ranging from equipment purchases and implementation to exercise construction, conduct and critique. In sharp contrast to the skills useful in maintaining a bureaucratic unit, emergency responses required capacities for rapid decision making, stress management, and multiunit communication. Drabek (1987b) integrated this analysis with insights about managing environmental uncertainty from organizational theorists such as Thompson (1967) and Pennings (1981). Through detailed community case studies and a multidimensional stratified randomly selected telephone survey, he documented 15 strategies used by effective emergency managers to nurture interagency relationships and maintain agency integrity. Thus, he built upon and extended the earlier pioneering studies conducted at Iowa State, the DRC, and elsewhere. These 15 strategies (Drabek, 1990) have been integrated into courses and seminars for emergency managers

throughout the United States and elsewhere. These strategies include: (1) constituency support; (2) committees; (3) cooptation; (4) joint ventures; (5) coalitions; (6) agenda control and nine others. Drabek's data documented that those emergency managers who implemented the largest number of these 15 strategies also ranked highest on a variety of effectiveness measures.

The response function was assessed years later in a complementary project (Drabek, 2003). In total, 62 local emergency managers were interviewed (10 within community case studies and 52 through a telephone survey). By adapting a typology formulated by Osborne and Plastrik (1998), Drabek documented five broad types of coordination strategies that were used to varying degrees during disaster responses. Within these five categories, 26 more specific strategies were identified: (1) core strategies (domain clarification, jurisdictional negotiation, and resource familiarization); (2) consequence strategies (display of decisions; use of information technologies; and maintenance of a hospitable EOC social climate); (3) customer strategies (communication of citizen expectations and requests, facilitation of media relations; documentation of damage assessments; and documentation of disaster repairs and restoration); (4) control strategies (appeals to prior legitimacy; reference to planning documents; reference to prior experiences; decentralization of decision making; use of self-managed work teams; emergent collaborative planning; and emergent community—government partnerships; and implementation of mutual aid agreements); and (5) cultural strategies (enhance awareness of cultural differences among responding agencies; enhance awareness of vulnerable populations; enhance awareness of community diversity; promote interagency cross-talking; build a shared vision; develop an in-house schoolhouse; celebrate success; and monitor stress symptoms).

Using an assessment of effectiveness criteria proposed by Quarantelli (1997b), Drabek discovered that both the implementation of the 15 managerial strategies (pre-disaster) and the 26 coordination strategies were important factors in a prediction model. That is, those emergency managers who scored highest on the effectiveness index also reported using more of both sets of strategies (see Drabek, 2003, pp. 143–146). Of course, other social factors also constrained effectiveness. Drabek's multivariate model also comprised one event characteristic, that is, length of forewarning; certain agency qualities, namely participating in disaster training exercises; and higher levels of both domain consensus and prior agency contacts. Each of these, reflected, in turn, more extensive use of the strategies identified that helped to maintain agency integrity (Drabek, 2005, 2010).

These ideas were endorsed by emergency managers at all levels of government, although some viewed the implied image with suspect. "What does this have to say about terrorism?" some asked. As Drabek responded to these and other challenges (2009a, 2014a), his analysis revealed that his earlier social problems perspective (2008, 2009b) held an answer. And so, consistent with views expressed by a few others, e.g., Springer (2009), he eventually proposed that emergency managers needed to adopt a new vision for their profession—one of a community change agent (Drabek, 2013, 2014b). Urby and McEntire (2015) expanded on this perspective and proposed specific implementation strategies drawing upon literature focused on general management, leadership, and strategic management. Encouraged to develop his transformative paradigm even further, he explored the approach announced in the Obama Administration's *Presidential Policy Directive/PPD-8: National Preparedness* and in FEMA's (2011) "whole community" initiative. At the 2016 annual meeting of the International Emergency Managers Association, Feinman (2016) assembled a wide ranging panel of experts who offered opinions regarding progress made. Following the insights of Edwards (2009), the key insight of this perspective is that a bottoms-up approach is required; a "one-size fits all" approach is unacceptable and unworkable. Empirical documentation of early implementation was summarized by Sobelson, Wigington, Harp, & Bronson (2015) in their study of seven communities wherein the whole community model was used. They

articulated three principles from FEMA documents that comprise the core of this approach: 1) "understand and meet the actual needs of the whole community"; 2) "engage and empower all parts of the community"; and 3) "strengthen what works well in communities on a daily basis" (p. 350).

The relevance of this approach was demonstrated in the difficulties encountered during the evacuations triggered by Hurricane Isabel (2003) in North Carolina (Horney, MacDonald, Willigen, Berke, & Kaufman, 2010). The research team offered two conclusions that are relevant to the whole community approach: 1) "…social cohesion, makers of territoriality, civic engagement, and volunteerism were associated with a decrease in hurricane evacuation"; and 2) "… educational programs evacuation planning targeted to civic groups, churches and volunteers—could be developed by policy makers and planners to take advantage of neighborhood ties, civic engagement, and peer influence to encourage protective behavior and empower local residents." (p. 53). The rich resources of volunteers who can be empowered to assist in times of need continue to appear in post-disaster assessments ranging from Anderson's (2014) description of the tornado response in Tuscaloosa, Alabama (April 27, 2011) to Camp's (2015) descriptions of a community "PrepareAthon" or Lazo's (2015) depiction of social media use for volunteer recruitment for Rose parade float construction.

Drawing on social capital theory (e.g., Aldrich 2012; Putnam, 1993, 2000) has developed parallel ideas regarding community vulnerability and resilience. Documentation of the decisions made by survivors of the massive earthquake in Japan (2011) to initiate a café whereby social cohesion could be strengthened is an excellent example of an application of the whole community perspective (Kiyota et al., 2015). This paralleled the emergence of the foot bath practices documented by Atsumi and Goltz (2014) following the earthquake that struck Niigata, Japan, July 16, 2007. These emergent groups reflect an emphasis on recognizing that ordinary people can be integrated into emergency responses as Scanlon, Helsloot, and Groenendaal have argued (2014). Such "grassroots models", to use Gardner's (2015) term, reflect the core principle of the whole community perspective. These conclusions parallel those of Pierce, Lovrich, and Budd (2016) who contrasted Putnam's data from Italy with more recent (2013) surveys from identical regions (pp. 275–277). In addition to demonstrating continuity with Putnam's original findings with newer data sets, they noted that "Social capital has been linked to a myriad of social and political outcomes including among others, emergency management collaboration…" (p. 273). In short, as Phillips (2013) has emphasized all stakeholders must be empowered and involved in both pre-disaster planning and post-event responses. These are among the themes that will guide the next decade of research on community coordination. More specific dimensions of the agenda follow.

25.6 Future Agenda

In a world of increased interdependency, turbulence, and both economic and political instability, the next few decades will provide enormous opportunities for researchers of coordination efforts at all social system levels. *Most important of these will be those documenting coordination processes and problems stemming from mitigative efforts and social adaptations to the enormous human consequences of climate change.* It is first among six other critical research needs: (1) development of a theory of disaster response effectiveness; (2) development of a theory of emergency management and homeland security; (3) impacts and limitations of information technologies; (4) gender issues; (5) vulnerable populations; and (6) cross-national studies of complex catastrophes.

25.6.1 Climate Change Adaptations and Impacts

As Fisher, Waggle, and Jasny (2015) point out, climate change has been politicized more so than

most other recent scientific conclusions. Hence, the few scientists who question the assessments and conclusions of nearly all expects on the topic have been "showboated" by a small but politically powerful network of politicians who represent corporate interests invested in oil, gas, and coal production. Coordination processes, both emergent and continuing, among the networks of agencies designing and implementing policy innovations related to mitigation of climate change impacts should be at the top of the future research agenda (Dunlap & Brulle, 2015). Sharing this priority should be studies of the coordination among organizations—both governmental and non-governmental—focused on designing and implementing adaptations that may lessen climate change impacts (Klinenberg, 2013; Phua, 2015). As oceanic warming continues and terrorist attacks attract new converts, communities around the planet may reflect the types of trauma documented by researchers like Erikson (1976, 1994). As future events like these occur, new research on community coordination processes will remain a top priority. Mercer and her colleagues have elaborated on these issues in their chapter within this book, "Climate Change and Disasters."

25.6.2 Development of a Theory of Disaster Response Effectiveness

At the conclusion of his study of coordination strategies, Drabek (2003, pp. 147–150) proposed a preliminary theoretical model whereby comparative study of response effectiveness might by conducted. Thus, he placed coordination processes within the broader context of disaster responses and the network of social constraints they reflect ranging from community, nation-state, and worldwide social trends and emergency management policies. While the event and response networks he examined were limited to "natural," and in a few cases technological, agents, responses to terrorist attacks such as those that occurred on 9/11 specify logical next steps. Although the matrix of agencies that comprise such multiorganizational networks will differ significantly, the basic logic of the model may apply. Such explorations, however, must be guided by greater sensitivity to the fundamental epistemological question posed by Quarantelli and others on several occasions, that is, "What is a disaster?" (Perry, 2006; Quarantelli, 1998; Perry & Quarantelli, 2005). Through such work, expanded and more predictive models could be derived and subjected to further empirical exploration. Perry's chapter within this book outlines the most recent thinking on these matters, "What Is a Disaster."

25.6.3 Development of a Theory of Emergency Management and Homeland Security

All societies confront vulnerabilities and changing levels and distributions of risk. Using models of disaster response effectiveness, with coordination processes at the very core, work should be undertaken to expand into other phases of the disaster lifecycle. Thus, the networks—conceptualized as nonlinear, mutually inclusive activity sets—through which recovery, mitigation, and preparedness programs are implemented should be studied. As these are completed and multivariate predictive models are tested with cross-national data sets, a true theory of emergency management and homeland security may evolve (Drabek, 2007). Such a theory must take into account the observations of those working within a wide variety of theoretical orientations including sustainability (Mileti, 1999) and social vulnerability (e.g., David & Enarson, 2012; Thomas, Fothergill, Phillips, & Lovekamp, 2013; Wisner, Blaikie, Cannon, & Davis, 2005). In contrast to normative prescriptions about how to "coordinate," this model, or models, should seek to be predictive of alternative forms of emergency management and homeland security programs and activities that exist behaviorally in societies throughout the world. Such a vision will bring the study of coordination processes and emergency management into the broader realm

of sociological theory and scholarship, thereby strengthening both the discipline of sociology and the profession of emergency management (Drabek, 2007).

As terrorists attacks (e.g., San Bernadino, December 2, 2015 and Belgium, March 22, 2016) demonstrate, both radicalized and home grown terrorists can do much harm with minimal resource or coordination requirements. Detection and prevention of such terrorist units challenge the balance between security and liberty (Rothkopf, 2014; Stampnitsky, 2013). Even routine technologies like smart phones can suddenly become centerpieces in these inherent strains. Future terror attacks, policy controversies and vulnerabilities reflected in the information age of a globalized planet (Friedman, 2007), will continue to create challenges and opportunities for researchers attempting to study these coordination processes, both successes and failures.

An important segment of this research must be directed at assessing the implementation of alternative administrative models, especially the National Response Plan (NRP) and the National Incident Management System (NIMS) (Kapucu, 2006). Clearly, administrative edict does not necessarily translate into immediate or complete compliance. Rarely does the law on the books equate to the law in action. Haddow and Bullock (2003) stated the case well when they described the adoption of the ICS among fire departments. While it assisted in defining lines of authority, a more flexible "coordination model" was more appropriate for emergency managers. "…[T]he coordination model is becoming more popular than the traditional command and control structure (p. 88)… the new breed of emergency management is typically more of a recovery coordinator than a field general" (p. 88). "The coordination model is also often better for negotiating turf battles among agencies and nongovernmental organizations providing overlapping services" (p. 88).

These views are more consistent with the definition of coordination that was presented at the outset of this chapter. They also are more consistent with the critiques of the bureaucratic managerial model—an assumption base implicit within the ICS—summarized by Drabek (2013), Dynes (1994) and Neal and Phillips (1995). Hence, it is highly likely that future researchers studying post-disaster communities wherein ICS and NIMS were implemented by emergency managers—at least to some degree—will document the costs of inadequate interagency coordination (Fennell, 2002). Efforts to implement managerial prescriptions that are inappropriate for the task environment created by disaster are destined to fail. In short, the very structures some are trying to impose on their community to enhance subsequent levels of coordination may severely constrain the effectiveness of a post-disaster response (Drabek, 2014a, c).

Finally, as "the whole community" approach and the paradigm shift wherein emergency managers understand and implement a "community change agent" perspective, additional linkages to social science theory will be made, especially expansions of Aldrich's (2012) social capital adaptations (see also Aldrich & Yasuyuk, 2014; Kiyota et al., 2015). Research reflecting these themes is of highest priority.

25.6.4 Impacts and Limitations of Information Technologies

Drabek's (1991b) work demonstrated, microcomputers provided local emergency managers with a powerful tool that could enhance interagency coordination. But they were just another episode in the increasingly rapid speed of technological innovation. As Gruntfest and Weber (1998), like Dash (2002), demonstrate so clearly, additional technologies ranging from digital libraries to the Internet to multilayered geographic information systems are transforming the profession of emergency management. All of these tools have enormous potential for enhancing interagency coordination (Curtis et al., 2006). But as the 9/11 Commission documented so well, the fundamental problem is *social, not technological*, in nature (e.g., see NCOTAUTUS, 2004, pp. 297–300). Indeed, just the single issue of interoperability among response agency radio

systems requires systematic and continuing assessments. As Randell (2004) stated: "the fact remains that interoperability needs to be actively managed to avoid the chaos of everybody talking to everyone on the same radio frequency…" (p. 29).

As new innovations, like the mobile device application developed by the Johns Hopkins University/Applied Physics Laboratory (JHU/APL) for multiple agencies in the National Capital Region are implemented, research on multiagency coordination must be completed both on uses, security breaches, and civil liberties issues. As described by Contestabile, Patrone, and Babin (2016), this application integrated images streaming simultaneously from thousands of fixed cameras throughout Washington, DC and nearby counties in Maryland and Virginia. By overcoming multiple issues of interoperability among the separate systems, this application permits "…government users to view the shared video on their mobile devices." (p. 40).

It is clear that these new information processing technologies can offer enormous assistance to emergency managers ranging from Facebook and other social media platforms to text messaging (Renda-Tanalli, 2014; Wukich, 2015). Indeed recent research has documented the near addictive behaviors among most millennials who now start using smart phones on a daily basis as early as four years of age (Crosswhite, Rice, & Asay 2014; Harrison, Bealing, & Salley, 2015). Following Hurricane Sandy (October, 2012), Ferris et al. (2016) mailed questionnaires to a sample of threatened households (16% return rate; n = 177 of which 36 actually evacuated) to document mobile technology usage (p. 211). Over two-thirds (68%) reported ownership of a laptop or iPad/tablet and every one (100%) owned at least one mobile technology device (p. 212). Reflecting high usage prior to Sandy, "…text messaging and social networking are go-to modes of communication during hurricane conditions…" (p. 214). Among those who left their homes, nearly all (92%) took one mobile device with them and slightly over one-half (57%) took more than one (p. 216). Given that more extensive use was reported by younger respondents, Ferris et al. (2016) concluded that "…we can expect that mobile technology will be a more relied upon source to provide timely, personal, and credible evacuation information in the near future" (p. 226). Knowing that during disaster responses people will use their routine resources, during community evacuations, for example, the coordination challenges these use patterns reflect await documentation.

25.6.5 Gender Issues

There has been a seismic shift in the increased awareness of gender issues related to emergency management. This has been accelerated because of work completed by early researchers like Enarson, Peek, Fothergill, and Phillips. Hence, the demographics and opportunity structures have changed dramatically in the past decade as processes like "redoing gender" (Pacholak, 2013) have become better understood and specific policy recommendations have been proposed whereby recruitment and promotion decisions reflect greater awareness of the sexism that defined the professions of emergency management and related areas like law enforcement, fire services, emergency medical, and the military (Thorpe, 2015; Weshinskey-Price, 2015). How sexism, in its many manifestations, impacts coordination processes awaits documentation.

Beyond occupational issues, however, the consequences of disaster impacts for female survivors have been documented and the picture isn't pretty. But future researchers must go beyond the documentation of sexism after disaster and assess new models of recovery so that the future can differ from the past. Concepts of empowerment, pathways to greater independence, and alternative models of family life must be developed not only within traditional gender designations, i.e., male vs. female, but also to the lesbian, gay, bisexual and transgendered (LGBT) community. Documentation of bureaucratic relief agency failures in coordination during post-disaster recovery must be followed with policy recommendations and implementation

studies so that every person, regardless of their gender identity is afforded opportunity to envision and develop their human potential to the fullest. These issues and many others are articulated by Enarson within her chapter in this book, "Gender and Disaster: Foundations and Directions."

25.6.6 Vulnerable Populations

Sexism is only one of the dimensions of vulnerability that must be addressed in future research and reform (Cripps, Cooper, & Austin, 2016; Fothergill & Peek, 2015; Peek, 2006). As Drabek's (2013) social problems perspective highlights, disasters are but one of a number of community issues. Racism, ageism, economic inequality, and other forms of vulnerability plague all communities to varying degrees. People who die from tornadoes, floods, or what have you, do so differentially because of the community patterns of risk. As research documents these "root causes" of disaster, local professionals can better understand how their efforts to implement comprehensive emergency management reflects broader issues of resilience, community well-being and social justice (Berke, Cooper, Salvesen, Spurlock, & Rausch, 2010; Drabek, 2016; Kroll-Smith, Baxter, & Jenkins, 2015; Xin, Aronson, Lovelace, Strack, & Villalba 2014). Bolin has elaborated on these issues within his chapter in this book, "Race, Class, Ethnicity and Disaster Vulnerability."

25.6.7 Cross-National Studies of Complex Catastrophes

Like the 9/11 attacks, the Boxing Day tsunami in Southeast Asia presented emergency managers with unique coordination challenges. Fortunately, such events have remained rare, but every effort should be made to learn from these and those of the past. While historical records present unique methodological challenges, much has been learned by scholars like Oliver-Smith and Hoffman (1999). Their pioneering anthropological research provides an important counterpoint to the quick response tradition. Regardless of the events selected, however, theoretical models of coordination processes for such complex events must occupy a critical sector of the future agenda (McEntire, 2001a; McEntire & Lindsay, 2012; Peacock, 1997).

Reflecting the earliest days of Quarantelli's effort to encourage cross national research with pioneers like Danielsson et al. (2015), Trost and Hultåker (1983) published a special issue of International Disaster Research Committee's journal focused on Nordic studies. Mass fatality tragedies like the 2004 tsunami and the resulting coordination failures were documented by Scanlon (2008) as did McEntire et al. (2012) following the 2010 Hati earthquake. Chen (2015) examined housing reconstruction coordination issues following the 2004 tsunami in Sri Lanka and Hamerton, Sargisson, Smith, & Hunt (2015) documented the importance of coordinating volunteers following the Rena oil spill in New Zealand. These, like Ganapati's (2009) examination of emergent multiorganizational networks ($EMON_s$) following the 1999 earthquake in Turkey which left 17,480 dead, point toward the rich research opportunities awaiting future researchers who should further explore key study conclusions. "Decision makers could promote such arrangements as federation of networks or $EMON_s$." (p. 156). And as Beal (2015) documented, the roles and resources from military units are especially difficult to coordinate in large-scale humanitarian responses.

The above agenda would be expanded by many and reprioritized by others. This is as it should be. Regardless of the shape and contour proposed, however, coordination processes should be at the top of research funding agency concerns and budgetary allocations. Assessments of training impacts must also be part of the future effort. For clearly, even with these processes, that is, coordination, far more is known than is being implemented on a daily basis throughout the United States and especially throughout the world (Drabek, 2014c).

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Governmental Response to Disasters: Key Attributes, Expectations, and Implications

26

Saundra K. Schneider

Contents

Disaster relief has become an integral component of the government's responsibilities in contemporary political systems. When disaster strikes, citizens expect government agencies to mobilize necessary resources and distribute essential services to those in need. Yet, the incidence and severity of disasters have put serious strains on governmental operations. More and more situations are occurring, and they are happening in a wider variety of forms. In turn, citizens are placing greater demands on governmental institutions to respond more quickly and effectively to an increasing array of emergency situations. At the same time, widespread economic problems are making it difficult for governments to devote adequate resources to emergency response operations, as well as to the vast array of other societal problems that they must address. As a result, there are considerable variations and inconsistencies in the ability of governmental systems to respond quickly, responsibly, and appropriately when disasters strike.

This chapter examines the role of governmental institutions during disaster situations. It describes the political and policy context in which governments become involved in disasters, identifying key attributes of the governmental

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approach to disasters. The importance of the intergovernmental framework underlying a governmental response systems is highlighted along with the possibility that different intergovernmental structures can be established and utilized. Regardless of the official arrangement of organizations and personnel in a response system, it is clear that intergovernmental processes have a significant impact on the performance of disaster response systems. And, in turn, crisis response efforts can have broader repercussions, shaping more general assessments of governmental performance in contemporary societies.

26.1 The Role of Government in Disaster Response

Disasters, by definition, are severe events (Fischer, 2008; Quarantelli, 1995; Silverstein, 1992). They can cause extensive physical damage to homes, farms, and businesses, leading to large financial losses. Disasters can be very disruptive in their impact, requiring people to alter their everyday routines, relocate to new locations, or seek assistance from outside their families, immediate contacts, and local communities. They can also be responsible for major physical injuries, mental trauma, psychological stress, and death. Thus, it is not surprising that disasters are extremely significant issues for affected populations and highly visible events that attract the attention of the general public (Hodgkinson & Stewart, 1990; Quarentelli, 1991).

Disasters are also salient events for governmental institutions and public officials. People often turn to government when disaster strikes because governmental organizations have the necessary resources and the authority to address them (Kettl, 2004; National Research Council of the National Academies, 2006; Schneider, 2011). Similarly, people look to political leaders to help them comprehend disasters situations and provide guidance so that they can deal with these circumstances more effectively (Boin, Hart, Stern, & Sundelius, 2005; Smith, 2007). Consequently, the actions (or inactions) of political officials and governmental institutions play a critical role in helping citizens prepare for, respond to, and recover from disasters (Platt, 1999; Rubin, 2012; Tierney, Lindell, & Perry, 2001).

26.1.1 The Impact of Disasters on the Public Agenda

Disasters play a significant role in the agenda-setting process. Indeed, they are major forces that can shake up existing policy environments. Disasters are dramatic events for affected communities and populations. But, even when their impacts are fairly localized, they can attract the attention of much larger segments of society. This may occur because of the severity or scope of the situation, the unexpected nature of the event, the particular populations groups that are affected, or the degree of attention that disasters receive. When information about a disaster reaches a broader audience, it can push the event to a more prominent place on the public agenda. This signifies that the public has become more aware of a particular disaster and views it as an important situation for broader discussion. The rise of a disaster on the public's agenda does not automatically mean that subsequent governmental action will follow, but it does provide a tangible indicator that citizens consider the disaster to be an important situation to discuss and potentially address (Cobb & Elder, 1983).

Indeed, the agenda-setting or agenda-building research contains numerous accounts of how disasters affect the public's perception of major issues. Crises are depicted as "triggering," "focusing," or "signaling" events, forcing people beyond the affected populations to acknowledge their existence, to follow their developments, and to push for some type of response (Bauer & Gergen, 1968; Eyestone, 1978; Peters, 2015). Disasters are often identified as one of the key factors determining the focus of public attention and the scope of public discourse (Kingdon, 2010). Yet, most scholars also indicate that disaster situations are unable to sustain the public's

attention for long periods of time. Their impact on the public's psyche is short-lived as other issues arise to crowd out their importance and relevance (Downs, 1972). This can occur even though the scope, magnitude, and severity of a disaster may be extremely large. Thus, the attention of the public shifts to other problems and issues, and the prominence of the event diminishes or even disappears from their immediate realm of consideration (Kingdon, 2010).

The media plays a key role in this process. The media can help elevate a crisis event to a more prominent position (relative to other problems and issues) on the public's agenda (Baumgartner & Jones, 2009). This can occur because of the type of media overage that occurs (i.e., selecting dramatic, emotional, or controversial situations), the symbolic nature of media images and stories (Iyengar & McGrady, 2007; Stone, 2011), or the connections that are made to broader societal problems, such as racial inequalities or economic disparities (Barsky, Trainor, & Torres, 2006; Dynes & Quarantelli, 1968, 2007; Goltz, 1984; Horsley, 2016; Imhof, 2016). The impact of the media in this process has been widely discussed and documented across a fairly extensive array of events around the world (Hannigan, 2012). Many scholars portray the media as an important conduit for communicating and disseminating information about disasters to a wider audience (Quarentelli, 1991). However, others imply that the media's influence goes beyond that of serving as a vehicle for communicating important events to one of shaping, even determining the public's understanding of a disaster (Adams, 1986; Barsky et al., 2006; Benthall, 1993; Maestas, Atkeson, Croom, & Bryant, 2008; Nimmo & Combs, 1985; Rodriguez & Dynes, 2006; Scanlon, 2008). Regardless, it is clear that the media exert a significant impact on the public's perception and understanding of disasters (Benthall, 1993; Rodriguez & Dynes, 2006; Tierney, Bevc, & Kuligowski, 2006).

26.1.2 The Political and Policy Implications of Disasters

Disasters are also significant *political* events. Not only are they likely to rise to prominence on the public's list of important agenda issues, but they are also exactly the type of events that attract, even require, the attention of political leaders. Some disasters may be so massive or severe that they cannot be dismissed or ignored. Other situations get connected to specific proposals or perspectives that coincide with the broader motivations and aspirations of political figures (Edelman, 1964, 1977; Stone, 2011). This occurs across a wide variety of crisis situations, from unpredictable, sudden events like tornadoes and terrorist attacks, to more persistent, lasting problems, such as poverty, environmental pollution, and food shortages. Thus, disasters can and do play an important role in shaping what issues are raised, emphasized, and addressed by prominent officials within a political system as well as across political jurisdictions (Birkland, 1997, 2007; Butler, 2012a, b).

Disasters can and do affect the nature of political discourse and the outcome of political contests. They can become the focus of discussion and deliberation among political leaders; they affect the type of proposals and alternatives that are presented; and they can be used as the basis for pursuing certain policy objectives. Disasters also can have significant consequences on electoral outcomes, internally within a political system, as well as the relationships that emerge and continue across political jurisdictions. Political leaders who are able to provide guidance and direction to affected populations when disaster strikes, are more likely to acquire and sustain public support. This can lead to advantageous political outcomes, such as claiming electoral success, increasing public support, or quieting political opposition (Boin, Hart, Stern, & Sundelius, 2005).

However, the reverse scenario is also possible: Political figures who do not acknowledge or address disaster-related problems may

lose public support and political influence. The political repercussions of disasters have been described in many different types of situations, such as militarized disputes, humanitarian crises, and natural disasters (Beardsley, 2012; Gilboa, 2005;
Healy & Malhotra, 2009; Malhotra & Kuo, 2008; Schneider, 2005; Sylves, 2006, 2008), as well as across a wide range of disaster-related situations, ranging from outbreaks of violence or instability within a country to broader regional or international incidents (Fearon, 1994; Jervis, 2002; Powell, 2002).

26.1.3 Governmental Involvement and Its Evolving Focus

The importance of disasters in public and political discussions has had a direct impact on the level and type of governmental involvement. Governments around the world are often seen as having the necessary capabilities and authority to help affected populations respond to disasters and provide the resources that can facilitate recovery. Moreover, as the number and type of disaster situations have increased, this has contributed to even greater public-sector involvement. Modern day governments are now expected to handle a myriad of situations– from internal conflicts, infrastructure breakdowns, and the outbreak of major natural disasters to regional, international, and global incidents of aggression, terrorism, genocide, starvation and environmental pollution. As a result, governmental activity has expanded dramatically as the frequency and incidence of disasters have themselves increased (Schneider, 2005; Sylves, 2008; Tierney et al., 2001).

The focus of government's disaster activities has also clearly evolved and grown. Governments are now expected to handle a wide and diverse mix of situations, no matter when, how, or where they occur. Consequently, since the mid part of the 21st century, governmental systems around the world have developed larger and more extensive response frameworks, designed to address almost any type of contingency or emergency. This general approach to emergency management– referred to as the "all hazards" approach– has become a central tenet of governmental disaster response systems, as well as those of many private and non-profit/charity organizations (Rubin, 2012; Sylves, 2008).

The emphasis of a nation's disaster system also reflects its own experiences with specific types of crises. So, the Canadian government's response system emphasizes preparedness activities related to severe weather events like blizzards and avalanches (Emergency Management Policy Directorate, 2016), while the response process in the Netherlands stresses operations that can help address conditions of extreme flooding (Kuipers & Boin, 2014). In both nations, these are the most frequently encountered and often the most devastating types of disaster situations.

The focus of a governmental response system can also change and evolve. The U.S. governmental disaster response process is a clear example of how the priorities and emphasis of governmental policies shifted over time. During the late 1950s and 1960s, the U.S. government emphasized measures to prevent the outbreak of nuclear confrontation which was believed to be the major threat to the country at the time (Bea, 2012). However, following the September 11, 2001 attacks on the World Trade Center and the Pentagon, U.S. disaster response system re-directed its priorities toward strategies aimed at anti-terrorism (Schneider, 2011; Trebilcock & Daniels, 2006; Waugh & Sylves, 2002).

Yet, the common thread running through the development of government response systems is the close tie that exists between public-sector involvement and disaster situations. Stated differently, governmental response frameworks are manifestations of the underlying context in which they occur. Political systems which have experienced particular types of severe emergencies are more likely to have governmental response policies that focus more directly on these situations. Similarly, governments that have had to confront a wider variety of different

types of disasters have been more likely to establish more comprehensive response programs and protocols (Schneider, 2011).

Regardless of the focus or scope of a governmental disaster system, it is clear that public-sector organizations and institutions have become more engaged in emergency preparedness and response (Rubin, 2012; Sylves, 2008). And, it is also the case that national-level organizations have become more prominent actors in this process (Butler, 2012b). They now play a greater role in preparing societies for potential hazards, providing guidance and leadership when crises occur, and allocating resources to help disaster-stricken areas respond to and recovery from disasters (Harrald 2012). These trends have not eliminated or supplanted the need for governmental response systems to rely upon the input and participation of subnational public jurisdictions, private organizations, non-profit/charity associations, or the general public (Fugate, 2009, 2013). But, they do represent a clear trend toward more involvement by national-level organizations that, at least in theory, are able to handle a wider array of events, across large geographic areas and political jurisdictions, in a more consistent manner (Roberts, Ward, & Wamsley, 2012a, b).

Still another international trend in the way governmental systems approach disasters involves an emphasis on emergency preparedness and hazard mitigation. In general, this means that governmental emergency management organizations promote activities that will encourage citizens, private companies, and local communities to take steps *before* an event occurs to lessen the potential disruptions, dislocations, and damages of a disaster (Col, 2007; Carson & MacManus, 2006). Hazard mitigation measures can involve the distribution of information to disaster-prone populations about the likelihood of an event developing and the subsequent actions they can adopt to be better prepared. Or, it can entail providing guidance and assistance to communities in order to help them strengthen their physical infrastructures, emergency warning procedures, and evacuation protocols. Hazard mitigation measures can also be incorporated into policies and regulations that encourage or require subnational governments and private organizations to establish emergency management plans, procedures, and operations that are known and utilized on a regular basis (Bea, 2012; Sylves, 2008, 2012). Overall, hazard mitigation and emergency preparedness is aimed at directing more attention and resources to efforts that might prevent (or at least lessen) some of the most devastating impacts of a disaster situation.

26.2 Governmental Response Systems

Governments around the world are now called upon, more and more, to handle an ever expanding array of disaster situations. In order to address the multiplicity and complexity of events that occur, governments have developed plans, protocols, and procedures which identify when and how they will respond. These policies make up an overall system which delineates the basic framework that is used to organize, mobilize, and guide public-sector activity.

26.2.1 The Prominence of Intergovernmental Structure

In theory, governmental disaster response systems are organized so that all those who are involved have a sense of how the overall process is supposed to work. Within this organizational framework, the roles and responsibilities of public-sector organizations across and within levels of government are identified, as well as how they are to interact with one another. The disaster response system should also specify those activities and operations involving the public-sector with private-sector and non-profit/charity actors. And, there should be some sense of how all of these activities "fit together" to comprise an entire response system.

The organization of a governmental response system is a reflection of the broader structure of a political system. More specifically, the degree to

which political power is concentrated at the central level versus divided up (or shared) across various levels of government has a significant impact on the structure a governmental response system. In unitary political systems with centralized forms of government, the governmental response process is more likely to conform to a "top-down" structure. Here, the national government plays a dominant role in emergency management, assuming most of the responsibility for determining, guiding, and implementing disaster relief. Subnational governmental units and private entities can be, and often are, involved in these efforts. But, their activities and operations are more limited and likely to be determined by national-level directives and policies.

At the other end of the organizational continuum, the response frameworks in countries with federal forms of government are quite decentralized in form. Unlike centralized frameworks, decentralized systems are based on the premise that the governmental response process should work from the "bottom-up." Governments that are located in the closest proximity to citizens should be the first to respond to a disaster situation (Schneider, 1990). Higher levels of government may become involved, but they should supplement, not supplant the actions of local-level officials and organizations. In such designs, the flow of a response is often pictured as an organic process that moves up from one governmental jurisdiction to the next based upon the magnitude of a disaster situation (Schneider, 1992, 2011).

Regardless of the exact structure of a disaster response system, the intergovernmental disaster framework is extremely important. It provides the basic blueprint identifying the functions and operations of various governmental actors, as well as those of others who are expected to be involved in a nation's response efforts. The intergovernmental disaster framework guides how emergency preparedness and relief operations are supposed to work (Comfort, 2007; Schneider, 2011).

26.3 A Brief Glimpse of the Evolution of the Intergovernmental Response System in the U.S.

The evolution of emergency management in the United States provides an excellent example of the importance of the intergovernmental framework. Over the years, governmental involvement in emergency management has steadily grown in the United States as public-sector organizations have become more and more involved in a wider range of emergencies and crisis situations. Coincident with this trend, the locus of decision-making has shifted from local and state governments to national-level organizations and individuals. Yet, the basic intergovernmental framework remains as the central facet of the American disaster response system.

Public organizations in the United States have long been involved in helping people deal with emergency situations. Yet, for most of the early years of the nation's development, governmental involvement in disaster relief was quite limited and performed by local-level agencies (Bourgin, 1983; Popkin, 1990). If a disaster occurred, citizens turned to city and county officials for assistance. These efforts were often supplemented by those of private relief and charity organizations. But, there was little (if any) expectation that national-level institutions would become involved in disaster response. Emergency management was primarily a local responsibility (Schneider, 2011). Only during extremely unusual situations, did the national government become involved in disaster response. And, when it did so, national-level assistance was very focused and limited to specific emergency situations. There were no guidelines or protocols to indicate if the national government would become involved or the level of assistance that it might provide. As a result, the governmental response to disasters was primarily a reaction to each particular event (May, 1985). The response was also quite inconsistent and variable across the country; it was heavily

dependent upon the capabilities and efforts of local-level institutions.

This situation changed quite markedly during the middle part of the 20th century. Part of this shift in the nature and scope of governmental involvement in disasters reflected broader trends in public-sector activities. Governmental agencies become more involved in helping citizens deal with economic distress (following the Great Depression of the 1930s) and international conflicts (the Second World War). The Disaster Relief Act of 1950 signaled a major shift in public-sector involvement. It identified when federal resources could be employed to help disaster-stricken communities, and it established a general process to guide the flow of assistance from the local level up to the national government (May, 1985).

The 1950 Disaster Response Act was the basis of the U.S. intergovernmental emergency management process for several decades. A series of additional laws were passed during the 1950s, 1960s, and 1970s which expanded the responsibilities of the national government even further. But, despite the growth in governmental involvement, the U.S. disaster response system was quite disjointed, uncoordinated, and unpredictable. A number of agencies across levels of government were given some responsibilities for various aspects of emergency management. But, there was no cohesive, uniform process to guide the implementation of emergency assistance across the nation's intergovernmental system (Stratton, 1989).

This situation changed in 1978 with the creation of a new administrative body, the Federal Emergency Management Agency (FEMA), at the national level. FEMA was placed in charge of mobilizing national-level resources and coordinating the entire complex web of public and private actors across the entire intergovernmental system. Then, in 1988, the U.S. Congress passed the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The Stafford Act provided further elaboration and clarification of how emergency relief would flow through the intergovernmental framework: It specified the role of local, state, and national actors in the process, and it shifted the focus away from reactive measures toward an emphasis on emergency preparedness and mitigation activities (Schneider, 2011). In the late 1980s, the national government developed a new set of guidelines and policies to facilitate the implementation of emergency management actions across the intergovernmental system. The guidelines were presented in the Federal Response Plan of 1992 as a cooperative set of relationships across twenty-six federal agencies and the American Red Cross. The 1992 Federal Response Plan described the roles and responsibilities of national-level public organizations during different types of emergency situations, and it designated a lead agency for each disaster category or area.

Two other more recent events have helped to shape the U.S. intergovernmental disaster response system: the terrorist attacks of September 11, 2001 and a natural disaster named Hurricane Katrina in 2005. In response to the September 11, 2001 terrorist attacks, a number of changes were made in the nation's disaster emergency management framework. Steps were taken to strengthen the level of intergovernmental coordination and communication across agencies, establish a more unified framework, and create a system that could handle any type of emergency, no matter where, when, or how it occurred (Birkland, 1997, 2007; Harrald, 2007; Sylves, 2008).

One of the most significant aspects of the post-9/11 events was the creation of a new national cabinet-level Department of Homeland Security to mobilize, coordinate, and lead the governmental response efforts (Kettl, 2004; Rubin, 2012; Sylves, 2008). During the next several years, the national government issued a series of guidelines and plans to clarify the roles of the newly-created Department of Homeland Security and organize the myriad of twenty-six federal agencies that now fell under its jurisdiction (U.S. Department of Homeland Security, 2004; White House, 2003). Among these guidelines was a plan to guide the governmental response during extraordinarily severe, catastrophic events—referred to as incidents of

"national significance." During such situations, the national government could respond *proactively* to mitigate the situation even before it occurred.

However, the nation's disaster response system encountered major problems when Hurricane Katrina hit the Gulf Coast region of the United States. Hurricane Katrina demonstrated quite vividly that there were still major problems in the U.S. disaster response process. Hurricane Katrina was one of the most destructive, deadliest, and costly storms to ever hit the United States (Blake, Rappaport, & Landsea, 2007; Kettl, 2006). Unfortunately, the nation's intergovernmental emergency management system was ill-equipped and unprepared to handle the situation. The framework reacted too slowly in an uncoordinated, haphazard fashion. Consequently, changes were once again made to the U.S. response process to facilitate stronger coordination and cooperation between public and private efforts throughout the entire intergovernmental system. Provisions were established to clarify the direct intervention of the federal government during unusually severe emergency situations without going through the standard intergovernmental process. In addition, the role of the Federal Emergency Management Agency in the response process was once again modified: FEMA was put in charge of providing leadership and support to address all types of hazards, though it was not made responsible for communications and inoperability services (Rubin, 2012). However, for the vast majority of disasters, the intergovernmental response process was to be followed. The response would start at the local level, and move to the state if events exceeded local-level capabilities; the national government would become involved if additional resources and assistance were requested and needed (U.S. Department of Homeland Security, 2008).

Clearly, the U.S. governmental response system has evolved over the years. Specific domestic and international events have affected its development. But, the intergovernmental framework of the American political system remains the dominant feature of the U.S. disaster response process. Although the balance between national versus sub-national responsibilities has shifted over time toward more involvement by the national government, the U.S. emergency management system is still organized around intergovernmental components, operations, and dynamics. Responsibilities are assigned to local, state, and national-level organizations and a set of protocols are identified to organize, mobilize, and coordinate the various components of this complicated web of actors.

26.4 General Features of the Intergovernmental Framework in Emergency Management

Each nation's intergovernmental framework is, to some extent, a reflection of its own particular history, culture, geography, demographics, and politics. For example, the intergovernmental disaster response process in the United States has been affected by broader changes which have occurred in the country: Population movements from one region of the country to another, economic fluctuations between periods of prosperity to harsher economic times, and partisan/ideological re-alignments from eras of governmental expansion to those of governmental retrenchment (Rubin, 2012; Sylves, 2008). Yet, it is possible to identify several key characteristics of all governmental disaster response frameworks (Schneider, 1992, 2005). Not every intergovernmental response system possesses these characteristics to the same degree or with the same level of consistency. But, it is quite clear from numerous accounts of disaster situations, that these features have a noticeable effect on public-sector emergency preparedness and relief activities (see, for example Burby, 2006; Harrald, 2006, 2012). Indeed, the extent to which an intergovernmental emergency management system possesses and exhibits these attributes, the more successful and effective will be its disaster response efforts (Schneider, 2011).

26.4.1 Preparation and Expertise

One of the fundamental tenets of governmental activity during crisis situations is based on the idea that those who are involved in establishing and administering policy should have adequate training and preparation in emergency management (Comfort, 1988; Sylves, 2008; Waugh, 2000). This also implies that they have an understanding of their own roles and responsibilities, as well as those of others who are a part of the system (Schneider, 1992). Public-sector officials with emergency management responsibilities should have appropriate backgrounds and experiences that enable them to handle a mix of different types of disaster situations in a smooth and effective manner.

26.4.2 Resources

Governmental response organizations should have sufficient resources which enable them to perform their disaster-related duties and functions. They must have the finances, personnel, equipment, and supplies to provide necessary assistance to disaster-stricken populations, affected communities, and public/private jurisdictions (Sylves, 2008). They should also possess the resources (i.e., access and authority) that allow them to activate and guide the activities of others who are involved in the system (Schneider, 2005).

26.4.3 Communication and Coordination

Those involved in governmental response activities must be able to communicate with others in a clear, consistent, and effective manner. Communication is an important factor within a governmental system– it facilitates more coordinated and responsive activities by public-sector actors. Communication is also an essential element for connecting and synchronizing the actions of governmental actors with private organizations, non-profit agencies, and the general public. In addition, it plays a significant role in facilitating better coordination and cooperation between various governmental systems, regional entities, and international relief organizations (Ulmer, Sellnow, & Seeger, 2011; Waugh & Streig, 2006). Indeed, miscommunications and disorganization are often identified as the key reasons why governmental disaster relief efforts encounter difficulties (Schneider, 2011, 2005).

26.4.4 Decision-Making Protocols and Processes

Governmental response systems should have a clear set of objectives to guide their operations. These objectives should be reflected in the policies and plans that public-agencies develop, as well as the subsequent actions that they follow when a disaster unfolds. Such protocols and guidelines enable public officials to assess the benefits/costs of possible alternatives, prioritize certain courses of action, and executive governmental operations. Response systems that do not possess or follow-through on these protocols encounter difficulties in their ability to implement coordinated and successful responses (Comfort, 2007; Herek, Janis, & Huth, 1987; Hermann, 1979).

26.4.5 Leadership

Leadership is a somewhat difficult factor to describe. It involves the ability of political leaders, public officials, and government agencies to provide guidance and direction for governmental activity. This can involve the ability to draw to, and sustain attention on, a disaster situation (Edelman 1964, 1977). It can entail prioritizing the types of actions that should be taken and the order in which they should be pursued (Harff & Gurr, 1998; Schneider & Jordan, 2016). Or, it can relate to how public officials and political leaders describe events, as well as the actions and behavior they exhibit towards the affected populations and communities (Schneider, 2011; Sylves, 2008).

The role of political leadership varies in different political contexts (Bankoff, 2001; Gelpi & Griesdorf, 2001; Hannigan, 2006). And, it can also differ according to the nature and type of a disaster situation itself—such as a natural disaster versus a terrorist attack (Sylves, 2008). Regardless, it is clear that leadership is an important element of governmental disaster response operations (Waugh & Streig, 2006). For example, President George W. Bush and the entire U.S. federal government were widely criticized because of the many problems that unfolded during the 2015 Hurricane Katrina disaster in the United States (Birkland, 2007; Schneider, 2005, 2008a, 2011). Similarly, Japan's Prime Minister Naoto Kan was criticized for his inability to take appropriate actions to address the series of events that occurred in 2011—a massive earthquake, followed by a tsunami, and then the meltdown of the Fukushima Daiichi nuclear plant (Biello, 2013; Suzuki, 2017; Wharton School, 2013). The impact of political leadership on governmental emergency response efforts is well documented (Arceneaux & Stein, 2006; Gasper & Reeves, 2011; Healy & Malhotra, 2009; Hetherington, 2005; Malhotra & Kuo, 2008).

Thus, the intergovernmental features identified above play a crucial role in helping to organize and guide a nation's disaster response system. Moreover, they are important factors that influence the responsiveness and effectiveness of governmental activities during emergency situations. Yet, it is also the case that other factors—external to intergovernmental systems—can and do have impact on the ability of governmental response systems to address disasters in a swift and appropriate manner. Some of these external factors are tied to the size, scope, and magnitudes of a given disaster situation. Extremely large disasters place extraordinary strains on governmental processes which require the mobilization of a multitude or resources that may not have been deployed before. Similarly, events that are not anticipated because they occur quite suddenly or because they are highly unusual occurrences, are also likely to present more problems for disaster response organizations. In addition, the attitudes, expectations, and behaviors of citizens are extremely important factors which affect governmental performance during emergency situations.

26.5 Citizens' Views, Impressions, and Expectations of Intergovernmental Disaster Response

Citizens perceptions of governmental activity play a significant role in shaping the success or failure of governmental operations in any policy areas (Delli Carpini & Keeter, 1996). Not only must citizens think that some form of governmental action is warranted, but they must express that opinion to appropriate political actors and public institutions (Hetherington & Nugent, 2001; Putnam, 1993). Governmental operations that are broken down across and within different jurisdictions add another layer of complexity to the relationship between the public and government. Citizens must believe that the government should act, but they should also have an idea of which level of government is responsible for different types of actions and operations. This is precisely the situation that confronts intergovernmental disaster response efforts. So, what do we know about citizens' perceptions of this process?

26.5.1 Citizens Pay Close Attention to Disasters

Disasters are often highly visible occurrences which can receive an intensive amount of media attention. They are precisely the type of events that attract public attention and engender public discussions (Scanlon, 1977). In fact, citizens may be more likely to follow disasters than other types of societal problems or issues. This seems to be particularly true in the case of large-scale, catastrophic situations which are extensively covered in traditional media outlets and communicated widely through social media channels (Birkland, 1997, 2007). For example, over 70%

of respondents to a Pew Public Interest Survey conducted in the United States during October 2005 indicated that they paid close attention to media reporting during the Hurricane Katrina and Rita disasters (Pew Research Center, 2005). Similar findings have been reported about the public's monitoring of social media communications during more recent disasters, such as the Superstorm Sandy disaster in the United States in the fall of 2012 (Pew Research Center, 2013).

There is no assurance that the degree to which citizens pay attention to disasters affects their subsequent behavior. Similarly, there is no guarantee that the degree to which citizens monitor disaster situations has a direct impact on subsequent governmental actions. But, it is the case that increased public attention can give rise to more intense calls for changes in governmental policy and/or at least renewed discussions among decision-making bodies about the importance of addressing disaster conditions.

26.5.2 Citizens' Understanding of the Intergovernmental Response Process

Citizens not only follow disaster events, but they also have expectations of what they want various governmental actors to do when disaster strikes. In particular, they have a general idea of how the intergovernmental response process is structured, as well as the different responsibilities of various jurisdictional levels within the system. Survey data collected from the American public in 2006 reveals that a sizable majority of Americans (over 80%) believe that governmental action is warranted when disaster strikes (Schneider, 2008b). And, most Americans indicate a good understanding of what they want different levels of government to do throughout the process: They believe local and state governments should be responsible before and during a disaster, but over 70% want the national and state governments to assume the leadership role after a natural disaster has occurred (Schneider, 2008b).

These survey data were collected on the American population only a few months following Hurricane Katrina's devastation of the U.S. coastal area. So, they may have been influenced by the scope of this specific event, as well as the degree of media attention and public discussion that Hurricane Katrina received. These data may also not be indicative of the way that citizens in other nations view the operations of an intergovernmental disaster response process. But, they do suggest a surprising degree of knowledge about the intergovernmental response system within the broader American population.

26.5.3 Citizens' Behavior During Disasters

But, how do the people and communities directly affected by a disaster react when an emergency occurs? Clearly, disasters disrupt usual patterns of individual behavior and social interactions (Fritz, 1961). They create conditions that require people to adjust their normal daily routines to new or different circumstances. These new circumstances can be extremely disruptive and disorienting. In such situations, people naturally try to find out what has happened to them and how to cope with circumstances that may be unfamiliar and confusing to them. They may engage in behaviors that are not typical or familiar in order to comprehend their circumstances. And, they look to others for guidance and reassurance. If direction and assistance are not available or accessible, those affected by a disaster can become more frustrated, upset, and disoriented (Barton, 1969; Drabek, 1986; Turner & Killian, 1972).

This phenomenon has been documented quite frequently in the research on disaster-stricken populations and communities (Harvey & Bahr, 1980; Kreps, 1989; McPhail, 1991; Mileti, 1999; Perry & Mushkatel, 1984; Quarantelli & Dynes, 1977; Stallings & Quarantelli, 1985; Tierney et al., 2001; Turner & Killian, 1987). Although the media tend to focus on the rare instances where this behavior results in unconventional forms of actions (i.e., instances of looting, civil disobedience, etc.), it is much more likely for disaster victims to engage in helpful and

constructive forms of behavior—such as reaching out to assist others who have been affected by the disaster, contacting and working with neighbors to find ways of getting relief for the most pressing conditions (Barton, 1969; Fritz, 1961; Kartez & Lindell, 1990; McEntire, 2007; Tierney et al., 2001; Wilmer, 1958).

Disaster-stricken populations search for information that can explain their conditions and provide them with the necessary direction to help them cope (Drabek, 1970, 1984; Dynes, 1970; Dynes & Quarentelli, 1968; Quarantelli, 1966). So, it is quite logical for them to look to governmental officials and organizations for such guidance. After all, the government should know what is happening and it should be able to relay this information to the public. In addition, the government organizations should have the necessary resources and capabilities to administer assistance and relief to affected populations.

In turn, the information and leadership that is actually provided by governmental actors is a critical factor in this process. When the government communicates immediately, clearly, and consistently about an emergency, this helps those affected by the disaster to cope with the situation more calmly and effectively. When government officials do not provide guidance or when they present information in a confusing or contradictory manner, this leads to greater uncertainty and instability among disaster victims. It can also contribute to negative impressions about the ability of governmental leaders and public institutions to help citizens in need. These negative feelings can be targeted at specific political figures, administrative officials, public agencies, or levels of government, as well as the entire governmental process. There have been numerous examples of this happening in a number of disaster situations particularly in the United States (see Schneider, 2011 for an account of the criticisms aimed at government officials, political leaders, government agencies, and the entire U.S. government during a series of disasters from 1989 to 2010 and Flint (2012) and Schneider and Jordan (2015) for a discussion of the concerns raised following 2012 Superstorm Sandy along the U.S. East Coast). Similar accounts are reported about public criticism of public-sector actions during disasters in other nations—e.g., Japan during the 2011 earthquake-tsunami/Fukushima Daiichi nuclear meltdown (Funabashi & Kitazawa, 2012; Schneider & Jordan, 2015; Shinoda, 2013; Suzuki & Kaneko, 2013); the Australian government's ability to address persistent droughts (Anderson, 2014); and the Philippine government's response to Typhoon Haiyan in 2011 (McDonnell, 2013).

26.6 The Broader Impact of Intergovernmental Dynamics in Disaster Response

So, what are the implications of the research presented in this chapter? First, it is important to reiterate the political aspects of governmental activity during disaster situations. Governmental actions are prompted by the attention that disaster receive in the political system. In turn, political pressures have prompted governmental involvement, as well as the focus, content, and range of public-sector activity. This is particularly evident in the way that response systems have developed around the intergovernmental structure of public policymaking worldwide.

Second, problems or breakdowns that occur in disaster response are often tied directly to intergovernmental confusion, miscommunication, miscoordination, and disarray. This is evident in the accounts of what happened during the Soviet Union's 1986 response to the Chernobyl Nuclear Power Plant incident in the Ukraine, the U.S. government's handling of Hurricane Katrina in 2005 and Superstorm Sandy in 2010, the ability of the Nigerian government to address the abduction of female students by Islamist extremists in 2014, and the Japanese government's response to the 2011 earthquake-tsunami-nuclear meltdown in 2011 (Birkland & Waterman, 2008; Schneider, 2011; Schneider & Jordan, 2015; Willacy, 2013). In fact, most accounts of governmental activity during crisis situations focus directly on how various levels of government mobilize, coordinate, and implement

emergency preparedness, response, and relief. The "success" or "failure" of governmental actions are presented as a direct consequence of how well or how poorly various levels of government work together to prepare for, and respond to, disaster circumstances (Bier, 2006; Walters & Kettl, 2006).

Third, breakdowns in the intergovernmental response process can have negative impacts on government's ability to help citizens deal with the *next* disaster situation. When the response process works fairly smoothly and effectively, there are fewer complaints about intergovernmental capabilities and operations (Schneider, 2011). However, when the intergovernmental response process encounters decision-making errors, misguided initiatives, leadership failures, coordination difficulties, or communication breakdowns this can lead to accusations across a political system about the viability of the governmental approach (Forgette, King, & Dettrey, 2008; Gomez & Wilson, 2008; Maestas et al., 2008; Malhotra, 2008). People are also more inclined to be skeptical about the government's ability to address subsequent situations and less willing to accept the information and guidance that it provides (Roberts et al., 2012a, b; Schneider, 2008b).

Finally, governmental efforts during crisis situations highlight both the general strengths and limitations of public-sector operations. They indicate situations where intergovernmental operations work smoothly and effectively, as well those where their activities falter or fail completely. Governmental performance during disasters demonstrates quite clearly the extent to which public-sector policies, programs, institutions, and systems can address pressing societal issues. Thus, they have broader implications for our understanding governmental performance during extremely stressful, politically-charged situations.

26.7 Directions for Future Research

Governmental efforts during disasters have become critically important in nations throughout the world. Although there have certainly been instances when governmental response activities have been slow to activate and difficult to implement, it is almost impossible to imagine how some emergencies, particularly large-scale, catastrophic events, would have been addressed without governmental involvement. Clearly, governmental response systems have played major roles in helping citizens and communities deal with a wide variety of crisis situations around.

Governmental involvement in disasters is likely to increase even more as we are confronted with new environmental problems, lingering societal issues, and additional weather-related events. Thus, we need to be able to identify the strengths and limitations of current governmental systems, so that stronger disaster response processes can be developed. There are several areas of research that should be pursued to help us meet this challenge.

First, more work needs to be done which compares governmental response systems across countries. Although a number of studies and reports have been produced on the activities and efforts of the governmental response within specific nations, there has been much less research that compares governmental involvement in disasters across different countries or across different types of disaster situation. There are a number of ways that this could be done. For example, by selecting several nations that have different administrative frameworks, comparisons could made in order to identify those governmental responses that work fairly well, versus ones that encounter problems. Alternatively, by comparing governmental responses across different types of disasters would highlight the types of disasters where governmental actions work better than others. Overall, such work could yield valuable information into how and why government efforts are so variable.

Similarly, more comparative studies should be conducted on different governmental responses within the same country. Research could focus on governmental involvement in similar types of events (i.e., hurricane/typhoons, chemical mishaps, etc.) either during a given time period (perhaps, where there were changes to the

governmental response process) or across time to highlight changes in public-sector involvement. It would be quite beneficial to have more information on the governmental responses that are conducted quickly and smoothly, versus those that encounter delays, complications, or even serious breakdowns. Again, comparing disaster response efforts—over time, during specific time periods, or across different types of events—would reveal useful insights into aspects of governmental systems that should be maintained, as well as the more problematic components that ought to be modified or eliminated.

Finally, future research needs to analyze the consequences of governmental disaster response efforts. This may sound like a relatively straightforward process. But, it requires going beyond describing the findings of past studies to examining key elements of public-sector involvement that affect governmental performance in this important policy area. It would be particularly useful if we could determine why one governmental effort is said to be a "success," while another is labeled as a "failure," even though by many objective indicators (such as number of people assisted or the amount of money distributed) both efforts are quite similar. This would enable us to demonstrate more clearly the advantages of studying disasters, not only to improve our preparation and response to crisis situations, but also as an avenue to shed light more broadly on the connections between what government does and how governmental efforts affect people.

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Post-Disaster Sheltering, Temporary Housing and Permanent Housing Recovery

27

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Contents

27.1 Introduction

Reestablishing housing is critical for recovery processes whether addressing recovery at the individual, household, business, or community level. Research examining individual or household recovery suggests reestablishing permanent housing is critical for the ability of individuals and households to carry out normal activities, domestic functions, and reestablish routines (Bates & Peacock, 1987, 1992, 2008; Bolin & Trainer, 1978; Quarantelli, 1982). Delays in reestablishing permanent housing in turn delay all other dimensions of individual and household recovery (Bolin, 1976, 1986, 1993a; Fothergill & Peek, 2015; Browne, 2015; Kroll-Smith, Baxter, & Jenkins, 2015). Communities, as complex networks of social systems, require a multidimensional perspective when considering recovery (Dynes, 1970; Wenger, 1978; Bates & Pelanda, 1994; Peacock & Ragsdale, 1997; Lindell & Prater, 2003; Chang & Miles, 2004; Lindell, Perry, & Prater, 2006; Miles & Chang, 2006; Phillips, 2016; Sapat & Esnard, 2017), and yet fundamental is the reestablishing of housing for the social actors that populate this complex network of systems. Furthermore, it will be critical to consider housing recovery in all of its various forms – single and multi-family, renter and owner occupied, and the full spectrum from high-end to affordable – when considering broad-based community recovery. And finally, without housing, employees leave and consumers are lost; hence, housing recovery is fundamental to community economic and business recovery (Xiao & Van Zandt, 2012). Despite its centrality for understanding recovery processes, it has only been relatively recently that housing has become a critical focus in the disaster literature.

As late as 2001, Tierney, Lindell & Perry (2001, p. 100) noted that much of what is known about post-disaster sheltering and housing was undertaken during the late 1980s and 1990s, and that the entire "process remains significantly understudied, and little research has looked at

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post disaster housing patterns across social classes, racial/ethnic groups, and family types…." Much of that research emerged from events such as the Guatemalan, Northridge, and Loma Prieta earthquakes, and Hurricane Andrew, as well as the profoundly important work, *At Risk* (Blaikie, Cannon, Davis, & Wisner, 1994; Blaikie, Cannon, Davis, & Wisner, 2003), which addressed lessons from disaster events in Africa, Asia, and Latin America. Unfortunately, a host of major and minor disasters in the fifteen years since Tierney, Lindell and Perry's assessment have provided opportunities for many researchers to re-assess housing and related issues. Our goal in this chapter is to pull together examples of these sometimes-diverse strands of research.

Our discussion is organized utilizing Quarantelli's (1982, 1995) typology: emergency sheltering, temporary sheltering, temporary housing, and permanent housing. Quarantelli (1982, 1995) and others recognized that this typology is not without problems, particularly if viewed as phases in which households are expected to progress. Many households never progress through each phase, others jump around, forward, and back, and still others become "stuck," such that temporary housing becomes permanent. Nevertheless, Quarantelli's typology has found utility in the literature (Lindell, Perry, & Prater, 2006; Peacock, Dash, & Zhang, 2006; Phillips, 2016) providing a recognizable way to classify different forms of disaster related housing and shelter. We begin with a discussion of research on sheltering, temporary shelter, and temporary housing, followed by research on permanent housing recovery. The final section will address the future of research on these topics and some potential issues that should be addressed.

27.2 Sheltering and Temporary Housing

Globally, disasters displace a significant number of people annually with recent data indicating that approximately 19.2 million people were displaced in 2016, including 63,000 in the United States, 91,000 in Mexico, over 2 million in Nepal and 3.5 million in China (Bilak et al., 2016). Understanding the phenomena of emergency sheltering as Quarantelli (1982, 1995) defines it focuses on the immediate response disaster victims take to shelter themselves for short periods of time either before a hazard or immediately after impact. The period of time was thought to be short, a few hours to overnight, depending on specific hazard conditions and population dynamics, but more recent findings suggest that this period may be up to two weeks or in some cases longer, such as in 2005's Hurricane Katrina, which was estimated to be eight weeks (Mitchell, Esnard, & Sapat, 2011). Emergency sheltering is often spontaneous and focused on locational convenience and immediacy of need (Lindell, Perry, & Tierney, 2001; Alexander, 2002; Bolin and Stanford, 1998b; Bolin, 1993b). Pre-impact emergency sheltering is particularly common in the United States during wind events like hurricanes, where a period of warning accompanies the hazard threat. Research has found that those who perceive their risk, and are physically and financially able, are more likely to take emergency shelter even if taking protective measures is accompanied by inconvenience (Dash & Morrow, 2001). However, it is important to realize that it is not limited to pre-impact needs. Emergency sheltering also includes locations of refuge after all types of disasters particularly due to damage, fear of further damage and utility outage (Bolin, 1993b; Phillips, 1993; Morrow, 1997). After earthquakes, for example, emergency shelter may include individuals sleeping in their yards, parks, or cars for fear of additional aftershocks or undetected damage (Bolin, 1993b; Phillips, 1993; Bolin & Stanford, 1991, 1998b).

In fact, where pre-impact sheltering fits into Quarantelli's typology is not very clear. While Quarantelli (1982, 1995) argues that emergency sheltering usually happens spontaneously by victims themselves for their immediate safety, some confusion exists as to what types of sheltering belong in this category. If we assume, as Quarantelli does, that emergency sheltering is spontaneous individual or household protective

measures, then it is consistent that planning would be challenging and rarely involving organizational activities. On the other hand, emergency sheltering also includes planned activities particularly related to hurricane events in the United States where the American Red Cross or state/local organizations lead the effort to open and staff shelters for those evacuating. While these emergency shelters usually use approved schools outside the evacuation zone, other structures such as the Superdome in New Orleans for Hurricane Katrina may be used as shelters of last resort until FEMA is able to shift people to temporary shelter. Ideally, when the immediate threat passes, the need for the shelter is gone, and people resume their normal activities; however, in events that cause large scale housing damage, returning to normal activities may not be possible. The process is dynamic. As conditions pre- and post-disaster change, emergency sheltering also changes rapidly (Tierney, Lindell, & Perry, 2001). Indeed, individuals may return to their undamaged permanent homes shortly after the threat has passed.

On the other hand, emergency sheltering may transition to temporary sheltering when the hazard event creates uninhabitable housing (Bolin, 1994). It is important to note that this transition may not denote the transition from response to recovery in the standard disaster life cycle (Levine, Esnard, & Sapat, 2007), as it has often been treated. Socioeconomic conditions may create challenges in even accessing emergency sheltering, as was the case after the 2010 Haitian earthquake where approximately 680,000 people remained displaced one year after the earthquake, many without even tents (Ganapati & Rahill, 2017). Temporary shelters are places victims can stay for a longer period of time while waiting for it to be safe to return to permanent residences. Unlike emergency sheltering, daily necessities such as food, water, sleeping arrangements, and other needed services (i.e., security) must be provided in temporary shelters, and thus requires more significant preparedness by non-profit and governmental agencies. However, temporary sheltering is never intended to replace primary housing. Quarantelli (1982, 1995) argues that households in temporary shelters make little attempt to reestablish their normal household routines.

While considerable attention by emergency responders is given to public sheltering, the majority of those seeking temporary shelter use public sheltering as a refuge of last resort (Perry, Lindell, & Greene, 1981; Quarantelli, 1982; Drabek, 1986). Research has found that less than a quarter of those seeking sheltering use large-scale public facilities (Lindell et al., 1985; Bolin & Stanford, 1990), and those who do are more likely to have lower socio-economic status, live in rental housing, own homes in disrepair (prior to the hazard), and have few familial resources (Drabek & Boggs, 1968; Tierney, Lindell, & Perry, 2001; Morrow, 1997; Elliott & Pais, 2006). One complication with temporary sheltering is that often disaster victims compete with disaster responders and even the homeless for housing (Phillips, 1993, 1996; FEMA, 1994; Yelvington, 1997), or as Hurricane Andrew emphasizes, extended family members in the area who have also experienced damage (Morrow, 1997). Those with more resources, both socially and financially, are more likely to shelter with friends and family or in hotels/motels (Whitehead et al., 2001).

As with emergency sheltering, temporary sheltering is a social process that is not static; the needs of those seeking shelter vary across individuals and through time. Temporary sheltering is expected to be short-term; however, no one has defined exactly what short-term entails. While emergency preparedness focuses the most attention on this phase of post-disaster recovery (Tierney, Lindell, & Perry, 2001), events like Hurricane Katrina where thousands were relocated from New Orleans to temporary shelters throughout the United States shifted the focus from pre-impact sheltering to understanding the consequences of forced dislocation, and ultimately, the lack of planning for catastrophic events (Esnard & Sapat, 2014). Post-Katrina reports indicate that FEMA sheltered 600,000 people with 8000 still in shelters six weeks after the storm (Gabe, Falk, McCarty, & Mason, 2005).

Research after Hurricane Andrew focused on understanding how social position affected temporary sheltering location. As expected, those with higher incomes were more likely to stay at hotels and motels, while those with lower incomes stayed with family (Morrow, 1997). More significant is that logistic regression results indicated that "among low-income households who had relatives move in with them, the chance of them still being there four months later was nearly three times higher" than for higher income groups (Morrow, 1997, p. 152).

One of the few in-depth studies of temporary sheltering focused on the implementation of tent cities by the U.S. military after Hurricane Andrew. While many of the 180,000 individuals who found themselves homeless after the storm had resources to relocate to homes of family or friends, many found themselves with few options. Financial resources, transportation and lack of friends and relatives outside of the damaged area limited their options. Over 3500 individuals were sheltered at four tent cities in south Florida during the two months they were open. However, it is important to note that the tent cities did not immediately fill (Yelvington, 1997). Instead, as homes were condemned, renters evicted, and rains made uninhabitable the barely habitable damaged homes, the number of individuals increased during the first few weeks after the storm. In addition, population at the tent cities increased as deportation fears of undocumented immigrants diminished and relief information was released in both Spanish and Creole (Yelvington, 1997). For the most part, individuals did not choose tent cities as their first choice of sheltering, but rather ended up there when other options were not available.

These tent cities, however, were not planned for in advance. The use of the military to house disaster victims was an adaptive response to the overwhelming need in south Florida after Hurricane Andrew. Similar adaptive responses occurred after Hurricane Katrina since little or no planning seems to have focused on having significant populations in need of temporary sheltering. While the response after Hurricane Andrew was relatively successful, the response to Hurricane Katrina failed to meet the needs of those who were displaced. What is clear is that while time plays a role in the transition from sheltering to housing, the amount of time varies with those with more resources often able to transition from sheltering to housing more quickly.

The key distinction between sheltering and housing is the resumption of household activities and responsibility (Quarantelli, 1982, 1995). With temporary housing, routine day-to-day household activities are reestablished, and those in temporary housing wait for permanent housing, either returning to their pre-disaster homes or some type of alternative housing solution (Tierney, Lindell, & Perry, 2001). For those with the most extensive damage, temporary housing may be anywhere from weeks, to months, to years. According to a review done by Tierney, Lindell and Perry (2001, p. 102) little is known about how households negotiate this stage of their journey to permanent housing. A significant feature, however, is that in the United States, temporary housing arrangements after disaster are usually funded by the FEMA or the Department of Housing and Urban Development (HUD) through cash grants for temporary rental housing or the provision of manufactured homes (Quarantelli, 1982; Bolin, 1993b, 1994; Bolin & Stanford, 1991, 1998a, 1998b; Comerio, 1998).

Internationally, the issues may be complicated by international aid (Macrae & Hodgkin, 2011), and the consistent struggles to differentiate between the different sheltering and housing stages (Kreimer, 1980; Ganapati & Rahill, 2017) particularly as some large scale events such as the 1999 earthquake in Turkey (Kilci, Kara, & Bozkaya, 2015) extends the idea of sheltering well past "short term." According to reports, seven months after the earthquake, 91,000 people still remained in tents in five cities despite the availability of pre-fabricated houses (Kilci, Kara, & Bozkaya, 2015). This example from Turkey highlights the importance of ground-up instead of top-down planning for temporary housing. The housing sites were a considerable distance from the city center, and as a result, people chose

to remain in tents and return as much as possible to normal daily activities despite being in less than ideal housing conditions (Kilci, Kara, & Bozkaya, 2015). Settlements of one hundred to one thousand units at the outskirts of municipal services required an expansion of these same services to meet the needs of the developments, and resulted in the majority of the units still occupied as rental units five years after the earthquake. Similar to issues after Hurricanes Andrew and Katrina, the Turkish government found it difficult to remove the temporary housing "suburb" as it would require the eviction of residents (Johnson, Lizarralde, & Davidson, 2006).

Similar issues were reported in the wake of Hurricane Katrina where a FEMA-developed mobile home park created undue hardships for those moved to the location. For months, inhabitants lacked transportation options to search for jobs and lacked access to grocery stores, requiring food to be prepared for them (Levine, Esnard, & Sapat, 2007). Community participation in planning for temporary housing can mitigate the issues related to location and cultural inadequacy which often plagues attempts of community outsiders who enter damaged communities to help with housing recovery (Félix, Branco, & Feio, 2013). While trailers are not the preferred temporary housing solution, Hurricane Katrina also emphasized the challenges with the preferred rental voucher system. While financial resources may be available (although often not enough or fast enough), other significant problems exist when trying to find rental options for those who were displaced. Before Hurricane Katrina even made landfall, the availability of affordable housing in New Orleans was already challenging; thus, making it impossible to find temporary housing options for many, particularly, the poor (Burt, Popkin, & Turner, 2006). As a result, thousands of people who moved (or were moved) around the country in the wake of Hurricane Katrina arrived in those locations needing temporary housing assistance. As a result, many lost access to important social networks, and jobs while also limiting their ability to participate in the recovery process for both their home and community (Bates, 2006). For low-income renters displaced to other locations, higher rent costs in the receiving city often meant renting in the outskirts of the community with limited transportation options, access to resources, and little chance to afford rent once FEMA and HUD rental assistance stopped (Bell, Chang, Henneberger, & Mueller, 2011). Low-income renters were also impacted by Stafford Act provisions that limited access to rental assistance to one household per address, and thus, multiple households sharing space were limited in the help they could access (Reid, 2013).

Temporary housing can transition to permanent housing when displaced households cannot return to or refuse to return to their pre-disaster home (Haas, Kates, & Bowden, 1977; Bolin & Stanford, 1991; Bolin, 1994), and other problems such as crime and violence may arise the longer disaster survivors are clustered in close quarters (Enarson & Morrow, 1997; Wilkinson, 2005). Difficulties may arise when trying to transition some households to more permanent housing options. FEMA mobile homes after Hurricane Andrew, for example, were expected to house displaced households for six months; however, the last family moved from their mobile homes 2.5 years after Hurricane Andrew (Morrow, 1997). The problems found after Hurricane Andrew are not unique as research in other disaster settings found mobile homes to be a problematic form of temporary housing (Bolin, 1982 and 1994; Verderber, 2008). Some families who were hard to place in permanent housing due to family size or socioeconomic status were given FEMA trailers and relocated to a different mobile home park that became their permanent housing (Morrow, 1997). For some households, these structures may represent a significant improvement in housing, but in other conditions such structures can inhibit housing recovery (Bates, Killian, & Peacock, 1987; Bolin, 1993b). In addition, these mobile homes become vulnerable housing in wind hazard situations, thus recreating the vulnerability.

Despite knowing the problematic nature of trailers, FEMA provided just under 12,000

trailers for temporary housing about six weeks after Katrina (Gabe et al., 2005) and within a year, 98,000 trailers were deployed in Louisiana, Mississippi and Alabama (Verderber, 2008). The agency's resistance to change and strict definition of "temporary" led Congress to remove FEMA's housing authority in May 2016, and by the following December millions of dollars were invested in what became known as the Katrina Cottage, a small, hurricane-resistant home that could be placed in the yard of a damaged structure while the owner repaired their home (Levine, Esnard, & Sapat, 2007; Evans-Cowley & Kitchen, 2011). These cottages were developed to combat what some have argued to be the "trailer debacle" in Hurricane Katrina, and to mitigate what is known to be problematic about trailers which includes not being aesthetically pleasing, not considered safe and seen as a source of personal stress (Verderber, 2008). While these cottages were in significant demand during a pilot project in Mississippi, particularly by those with lower incomes, the program was still fraught with challenges including community concerns about location and appearance leading to restrictive policies limiting their placement and longevity. Despite the challenges associated with the program, research found that the majority of people living in the cottages were satisfied and desired to remain in them permanently (Evans-Cowley & Kitchen, 2011).

Some states have been experimenting with demonstration programs that target the transition from temporary to permanent housing. Disasters like Hurricanes Ike and Sandy are recent reminders of the challenges of this transition and its potential for derailing long-term recovery for both the household and the community. As noted earlier, the much-maligned "FEMA Trailer" has become a symbol of government's' failures in southern Louisiana in the aftermath of Katrina. Yet more innovative approaches like the Katrina Cottage allow families to remain in their neighborhoods keeping their sense of place (Kim & Oh, 2014) and social capital, which are critical to disaster recovery (Aldrich & Meyer, 2015). The RAPIDO Demonstration program in the Lower Rio Grande Valley of Texas is another example of a demonstration program that was designed to provide an alternative to such temporary housing solutions (Van Zandt and Sloan, 2017). In areas like the Gulf Coast, with high proportions of single-family housing and higher-than-average homeownership levels, these kinds of rapid re-housing programs have great potential. They minimize the transition from temporary to permanent housing, allowing families to get back into their homes and onto their properties more quickly than trailers or housing vouchers. This allows individuals to return to their normal routines more quickly, which should accelerate the community recovery process. Further, the approach of the demonstration program has been to work with residents to make key design decisions for their homes. Involving residents in the design of housing can be time consuming, but builds resilience by building commitment on the part of the resident to the community and to the building process. Residents who have had a say in their housing design are more likely to return permanently and stay in place, which can stabilize neighborhoods and promote home maintenance and upkeep.

Solutions like the one proposed in the RAPIDO program require extensive pre-planning to work, from pre-procurement of materials to pre-permitting of approved plans, and pre-identification of local designers, builders, case managers, and contractors. FEMA has long preferred national vendors, but experiments such as RAPIDO indicate that using pre-determined local or regional vendors may have multiple benefits, including the infusion of local knowledge into the design and choice of materials, as well as long-term commitment to completing the job. A final benefit is the support of local economies. While local labor forces may be inadequate for the whole job, using local contractors will maximize this labor force and return profits to the community itself, which builds capacity and resilience over time.

The problems and issues regarding temporary housing are not isolated to the United States. Research conducted in Italy, for example, after the Friuli earthquake in 1976 found that the nature of temporary housing can significantly

disrupt the nature of communities, social networks, and livelihoods, and had negative consequences for the psychological health of inhabitants (Hogg, 1980; Geipel, 1982). Bates (1982) and colleagues found that in Guatemala temporary housing can have potentially debilitating impacts for long-term housing recovery (see also Peacock et al., 1987; Bates & Peacock, 1987). Specifically, they found that many households simply converted temporary housing into permanent housing, because they lacked sufficient resources to procure or reconstruct permanent housing. The failure to recognize that the severe limitations many households face when addressing housing issues in normal situations can result in a failure to transition out of temporary housing into permanent housing is a message relevant in nearly all post disaster situations globally.

27.3 Permanent Housing Recovery

In 1979, two nationwide studies in the United States found little if any long-term impacts of disasters on various dimensions of community and county indicators including housing (Wright, Rossi, Wright, & Weber-Durdin, 1979; Friesema, Caporaso, Goldstein, Linberry, & McClear, 1979). The next two decades, however, saw researchers raise issue with aggregate level findings that obscured differential impacts and patterns of housing recovery. Bolin and colleagues documented differential disaster impacts and housing recovery for minority and low-income households and drew attention to the difficulties for renters (Bolin & Stanford, 1998a, 1998b; Bolin & Bolton, 1986). Research following Hurricane Andrew also documented differential disaster impacts and access to housing recovery resources related to race/ethnicity and income and their consequences for early recovery stages (Dash, Peacock, & Morrow, 1997; Morrow & Peacock, 1997; Peacock & Girard, 1997). Importantly, Comerio's (1998) comparative analysis suggested that post disaster housing policy's focus on single-family owner-occupied housing contributes to inequalities in housing recovery, particularly with respect to rental and multifamily housing.

Katrina opened the eyes of many in the larger research and policy community to disparity issues that had long been discussed within the disaster community (Tierney, 2006; Rodriguez & Barnshaw, 2006), both reinforcing and expanding on social vulnerability patterns with respect to race and income explaining disparities in housing damage and recovery (Green, Bates, & Smyth, 2007; Lowe, 2012; Masozera, Bailey, & Kerchner, 2007). Importantly, we have also seen the use of new and innovative data in research conducted in the United States and internationally to more systematically examine housing recovery patterns and the consequences of damage, tenure, and socio-demographic characteristics for differentials in housing recovery trajectories, as well as important work on the varying roles of government, civil society, and the private sector (cf. Wu & Lindell, 2004; Comerio, 2006; Bevington, Davidson, Hill, Rathfon, & Vicini, 2012; Zhang & Peacock, 2010; Zhang, 2012; Elliot & Pais, 2006; Cutter, Schumann, & Emrich, 2014).

The spectrum of international research addressing permanent housing recovery from a variety of nations including Chile, China, Haiti, India, Italy, Japan, New Zealand, and the United States, raises the important issue of how best to address, programmatically speaking, permanent housing solutions. Comerio (1998) offers a typology for considering different models of housing recovery she terms: redevelopment, capital infusion, limited intervention, and market. *Redevelopment* approaches are characterized by a strong national government leading the development and financing of housing recovery efforts, with China as the prime example. External funds and resources being introduced and filtered through governmental or non-governmental agencies that develop and administer housing programs characterizes the *capital infusion* model. The response to the Haitian and Guatemalan earthquake, as well as much of the Indian Ocean tsunami disaster efforts might also be considered as examples (c.f., Arlikatti, Grover, Peacock, & Prater, 2006). The

limited intervention model works through insurance, with limited governmental assistance through grants or loans primarily to households and businesses to address housing recovery issues. Here the United States and Japan might be the prime example. Finally, the *market model* is simply an extreme form of limited intervention, where the market addresses recovery issues, or as Comerio (1998, p. 127) states, the "real estate market will sort out the winners and losers." Comerio (2014) has elsewhere suggested that housing programs might also be characterized as falling between two axes, one defined by government involvement (weak to strong) and the other by community participation (weak to strong). Based on this classification, both China's and Chile's response would be high on the central government's role in housing recovery, while the former is weak on community participation and the latter is high. Similarly, Haiti falls as the weak on both axes, while the United States would be low on government's role, but relatively high on local community involvement.

27.4 Permanent Housing Recovery: How Housing Markets Create Vulnerabilities

With the exception of the 1964 Alaskan Earthquake where the federal government was actively involved in the management and reconstruction of residential housing (Kates, 1970; NAS, 1987; Quarantelli & Dynes, 1989), the U.S. federal government does not take an active role in housing recovery processes. In the United States, permanent housing recovery is primarily a market driven process (Bolin, 1985; Peacock & Ragsdale, 1997; Comerio, 1998; Bolin, 1993b), although government at federal and state levels does play a role in guiding and financing elements of the recovery process. The basic tenets of federal and state policy are to fill the gaps or, as Comerio (1998, p. 197) notes, provide a 'safety net' and hence falling under her characterization of *limited intervention*. Allowing the market to, for the most part, 'manage' housing recovery in the United States as well as in Japan has led a number of researchers to characterize the results as essentially conservative in nature with restoration of the status quo ante as the goal (Bolin, 1982, 1985; Bates & Peacock, 1989). While it is a generally held assumption that pre-disaster social patterns will shape permanent housing recovery (Bates, 1982; Quarantelli, 1982; Comerio, 1998; Bates & Peacock, 1987; Oliver-Smith, 1990; Blaikie et al., 1994), some have also suggested that market based recovery scenarios may in fact accentuate pre-disaster inequities (Bowden, Haas, & Kates, 1977; Bolin, 1982, 1985; Bolin & Stanford, 1991; Peacock & Ragsdale, 1997; Bolin & Stanford, 1998b). This can easily be seen in the United States when examining the nature of its housing markets and resulting distribution of housing.

Housing markets in the United States are characterized by a sequential process of "filtering" in which successively lower-income households inhabit single-family homes and neighborhoods as they deteriorate physically, while higher-income households move into newer and higher-quality homes (Foley, 1980; Grigsby, 1963; Myers, 1975). Further, many lower-income households are constrained to renting more affordable housing types, such as condominiums, townhomes, or apartments. These housing types are often regulated out of more desirable areas through large-lot or low-density zoning and building permit caps that limit the availability of affordable housing options (Pendall, 2000). Thus affordable housing is typically in areas where large proportions of low-income and minority populations are already located (Pendall, 2000; Pendall & Carruthers, 2003; Dawkins, 2005; Talen, 2005). Continued discrimination in the housing and real estate industries reinforces and perpetuates such segregation. Traditionally, real estate agents have used steering, blockbusting, and other forms of differential treatment (Denton, 2006; Choi, Ondrich, & Yinger, 2005; Galster & Godfrey, 2005); while mortgage lenders have used redlining in their property appraisal techniques (Guy, Pol, & Ryker, 1982; LaCour-Little, 1999; Jackson, 1985; Dane, 1993), as well as discriminatory practices in their underwriting of loans

(Apgar & Calder, 2005). Minorities continue to be much more likely to receive high cost, high risk loans than are white borrowers, even when controlling for relevant factors such as credit scores, income, assets, expense ratios, neighborhood characteristics, and others (Feagin & Sikes, 1994; Albright, Massey, Rugh, & Steil, 2016; Bayer, Ferreira, & Ross, 2014; Been, Ellen, & Madar, 2009; Bocian, Li, Reid, & Quercia, 2011; Rugh, Albright, & Massey, 2015; Rugh et al., 2015; Carr & Kolluri, 2001). Not surprisingly, racial segregation has both facilitated and exacerbated the foreclosure crisis (Rugh & Massey, 2010). The Great Recession of 2008 hit minority communities particularly hard, stripping vulnerable homeowners of financial stability and devastating many low-income and minority neighborhoods and communities (Lucy, 2010; Burd-Sharps & Rasch, 2015).

The net effect of the above is that poor and minority households continue to live in older and lower-quality homes in less healthy and potentially more risky neighborhoods (Bolin, 1986; Bolin & Bolton, 1983, 1986; Peacock & Girard, 1997; Bolin & Stanford, 1998b; Bolin, 1994; Charles, 2003; Peacock, Dash, & Zhang, 2006; Payne-Sturges & Gee, 2006; Van Zandt, 2007; Braveman & Gottlieb, 2014; Hendricks, 2017). Older homes are typically built to less rigorous standards and older building codes, use lower quality construction materials, are less well maintained, and are likely to be located in low-lying or flood-prone areas, making the occupants more susceptible to environmental health hazards and problems (Bolin & Bolton, 1983; Girard & Peacock, 1997; Bolin & Stanford, 1998b; Bolin, 1994; Gamble et al., 2013). As a result, one of the most consistent findings in the disaster literature, both in the United States and abroad, is that low-income and minority households tend to suffer disproportionately higher levels of damage (Bates, Fogleman, Parenton, Pittman, & Travy, 1962; Haas et al., 1977; Bates, 1982; Bates & Peacock, 1987; Bolin, 1982; Drabek & Key, 1984; Quarantelli, 1982; Bolin, 1986; Bolin & Bolton, 1986; Bolin, 1993b; Blaikie et al., 1994; Dash, Morrow, & Peacock, 1997; Peacock & Girard, 1997; Fothergill, Darlington, & Maestas, 1999; Fothergill & Peek, 2004; Van Zandt et al., 2012; Peacock et al., 2012).

The images emerging from Katrina certainly were consistent with these expectations and subsequent systematic research bore it out (Logan, 2006; Elliott & Pais, 2006; Bates & Green, 2009; Kamel, 2012). While relationships between income or minority status and damage are generally based on descriptive or bivariate analyses, a recent study on the impacts of Hurricane Ike found that even after controlling for storm effects (wind and flood levels), housing characteristics, and other factors, that housing in lower income and minority (non-Hispanic Black and Hispanic) neighborhoods suffered higher levels of damage (Highfield, Peacock, & Van Zandt, 2014). Similarly, multivariate models of disaster impact and recovery following Hurricanes Ike (a flood/surge event) and Andrew (a wind event) have found that housing in lower income and minority areas, along with rental housing in general suffered higher levels of damage, holding other factors constant (Zhang & Peacock, 2010; Highfield, Peacock, Van Zandt, & Zhang, 2014; Hamideh, Peacock, & Van Zandt, 2017).

The consequences of initial damage, and inequalities in damage should not be underestimated, because in many respects the damage sustained by a home sets the initial baseline for housing and ultimately household recovery and is critical for understanding resilience. Damage is a critical determinant for household displacement and dislocation (Mitchell, Esnard, & Sapat, 2011; Esnard & Sapat, 2014), which can have major consequences for household recovery. Higher levels of damage will of course demand higher levels of financial resources to repair or rebuild housing and, in the United States, once the 50% threshold is reached, repairs and reconstruction must be brought up to new building code and floodplain construction standards which can add significantly to the costs of repairs and rebuilding. Indeed, the added necessity of elevating homes after Katrina was one of the major issues confronting many poor and minority households (Bates & Green, 2009; Green & Olshansky,

2012). Additionally, longitudinal studies on housing recovery have found that the consequences of initial damage can be long lasting, extending 4-8 years, and debilitating for housing recovery, particularly when considering rental and multi-family housing (Lu, Peacock, Zhang & Dash, 2007a, 2007b; Zhang & Peacock, 2010; Rathfon et al., 2012; Peacock et al., 2014; Hamideh, Peacock, & Van Zandt, 2017). As a consequence, researchers have noted that mitigation as part of housing recovery, is critical to long-term community resilience (cf. Highfield, Peacock, Van Zandt, 2014; Mileti, 1999; Rathfon et al., 2012).

27.5 Permanent Housing Recovery: Insurance

In the United States, insurance is the primary source for funding the repairing and rebuilding of homes (Comerio, 1998; Kunreuther & Roth, 1998; Wu & Lindell, 2004; Brody, Highfield, & Lindell, 2017), however there can be considerable variations in its relative importance across hazards. For example, according to Kunreuther (1998, p. 39) earthquake coverage can be included in a general homeowner's policy for an additional premium in most states, except in California where residential earthquake policies are purchased through the California Earthquake Authority, a state agency. Flood insurance is never covered as part of a typical residential policy and must be purchased separately. The National Flood Insurance Program (NFIP) established by Congress in 1968 underwrites flood insurance. The NFIP has undergone a number of revisions through time (King, 2013; Olshansky & Johnson, 2014), but remains a federal program administered jointly by private insurance industry and FEMA. Wind hazards associated with hurricanes, tornadoes and other storms are often covered by basic wind coverage, sometimes with separate limits, as part of a normal residential policy (Kunreuther, 1998, p. 40), but this is not always the case. In some coastal areas in Florida and in both coastal and inland wind hazard areas in Texas insurers do not necessarily cover wind as part of residential policies. Furthermore, many private insurers do not offer wind coverage and homeowners must obtain wind coverage from state sponsored wind-pools as is the case in Texas and Florida. International research has found very different forms of insurance in other countries, such as in New Zealand where the Earthquake commission (EQC) provides both earthquake and fire insurance. The literature has consistently found that earthquake and flooding insurance policies are much less likely to be purchased than normal residential policies (Blanchard, Hodgson, Lyons, & Palm, 1990; Palm, 1995; Roth, 1998; Pastrick, 1998; Comerio, 2014; Lindell et al., 2017; Brody, Lee, & Highfield, 2016) in the United States. Comerio (2014) reports that only 11% of homeowners in California have earthquake insurance. Similarly, Peacock et al. (2014) reported that only 50% of homeowners reported having flood insurance in Galveston after Hurricane Ike and Masozer, Bailey, and Kerchner (2007) found a significant negative correlation between block-group poverty levels and flood insurance policies in New Orleans based on pre-Katrina data. However, Comerio (2014) found that 95% of homeowners in New Zealand have earthquake insurance and Peacock et al. (2011) noted that wind coverage along the Texas coast is quite high among new homes with mortgages.

When considering homeowners' insurance in general, coverage appears to be high. For example, Girard and Peacock (1997, p. 188) reported that in the Hurricane Andrew case, 95% of homeowners' had insurance. This represents a substantial improvement in coverage, particularly when compared to some historical studies (cf. Bates, Layman, Moore, & Parenton, 1963; Cochrane, 1975; Bolin, 1982; Drabek & Key, 1984; Quarantelli, 1982). The research literature also suggests that households having insurance generally report receiving sufficient settlements or at least what they consider fair/adequate settlements. Peacock and Girard (1997) reported that nearly 76% of homeowners

following Hurricane Andrew received sufficient settlements and were on the whole satisfied. While this percentage is high compared to some prior research settings, the general pattern appeared to hold at least into the 1980s (Drabek & Key, 1984; Bolin, 1982; Quarantelli, 1982; Bolin & Bolton, 1986). Nevertheless, research did find that poor and minority households were more likely to report insurance payments that were not adequate to meet repair and reconstruction needs (Bolin, 1982; Bolin & Bolton, 1986). Peacock and Girard (1997) found a similar pattern in Miami-Dade County following Hurricane Andrew where minority homeowners, both Black and Hispanic, were more likely to report insufficient insurance settlements for repairs and reconstruction. Specifically, households not covered by one of the top-three insurance companies underwriting in the area were more likely to report insufficient insurance payments and a key determinant of having coverage by these companies was the proportion of non-Hispanic Blacks residing in the block where the home was located. In other words, there was evidence suggesting that insurance redlining prior to Hurricane Andrew resulted in lower insurance settlements. The overall results found that Black and lower income households were significantly more likely to report insurance settlements that were not sufficient to meet housing recovery needs (Peacock & Girard, 1997).

27.6 Permanent Housing Recovery: Other Resources

In the event that insurance is not sufficient or completely lacking, then the "safety net" in the form of low interest SBA loans, Minimum Housing repair, as part of FEMA's Individual and Household Assistance program (FEMA, 2017), becomes critical. Poor language skills and educational backgrounds can leave many households, particularly minorities, low-income households, and even female-headed households, at a distinct disadvantage in the protracted qualification and negotiation processes often necessary to obtain public financial resources (Fothergill, 1999; Phillips, 1993; Bolin, 1985; Bolin & Stanford, 1990; Morrow, 1997; Morrow & Enarson, 1997). Low-income households are often limited in transportation options and this limitation may increase following a disaster when public transportation is extensively disrupted and personal transportation is destroyed. Lack of mobility may slow down the effort of recovery for these households and even jeopardize their employment (Morrow, 1997; Peacock & Girard, 1997). With less economic power and political representation, marginalized racial/ethnic groups are often excluded from community post-disaster planning and recovery activities (Bolin & Bolton, 1983; Quarantelli, 1982; Tierney, 1989; Phillips, 1993; Morrow, 1997; Morrow & Peacock, 1997; Prater & Lindell, 2000; Bates, 2006) and may be taken advantage of by private businesses. For example, a group of low-income Hispanic homeowners in southern sections of Miami-Dade County had little success at negotiations with their insurer who they felt had not properly compensated them for damage to their homes. It was only after a community-based organization pleading their case to the insurance commissioner that the company increased their payout (Morrow & Peacock, 1997). Other low-income minorities did not fare as well (Peacock & Girard, 1997; Dash et al., 1997; Morrow, 1997). Similarly, low-income Hispanic households in South Texas filed a class action lawsuit, and won (with the help of a community organization and a local legal aid provider) against FEMA for using a "deferred maintenance" clause to deny over 6000 claims because homes were already in poor repair before Hurricanes Dolly and Ike hit in the fall of 2008 (Van Zandt & Sloan, 2017).

Households and neighborhoods that are poorer prior to disaster often fall far short of receiving necessary aid to jump start the recovery process,

particularly for housing (Rubin, 1985; Bolin & Stanford, 1991; Phillips, 1993; Berke et al., 1993; Bolin & Stanford, 1991; Dash et al., 1997). A key program to assist homeowners that do not have insurance, or inadequate insurance coverage is the Small Business Administration's low interest loan program. Unfortunately, because this is a loan program, low-income households are less likely to qualify for governmental reconstruction programs because of their weak capability to repay (Bolin, 1982, 1986; Bolin & Bolton, 1983; Tierney, 1989). Indeed, the research has clearly shown that low-income households are much more likely to fail to qualify for an SBA loan, than are higher income and Anglo or White households (Bolin, 1982, 1986, 1993b; Drabek & Key, 1984; Quarantelli, 1982; Bolin & Bolton, 1986; Bolin & Stanford, 1998a, 1998b). More recent research found that race/ethnicity was not a significant determinant of qualifying for an SBA loan, but, of course, income was positively associated with qualifying (Galindo, 2007). Kamel and Loukaitou-Sideris (2004) examined funding from all federal programs (Minimum Home Repair, MHR; Individual and Family Grants, IFG; Small Business Administration, SBA) by examining the total funding going into zip-code areas following the Northridge earthquake based on damage and limited socio-economic characteristics at the zip-code level. Not surprisingly, after controlling for damage, they found SBA funding was positively related to median household income, while MHR was negatively related to income. These findings suggest correct targeting. However, it must be pointed out that FEMA's MHR is exactly that, "minimum," a program funding limited emergency repairs, in the interest of preventing further damage, and no more. Kamel (2012) replicated this work following hurricane Katrina in New Orleans, but just for, what is now termed, FEMA's Individual and Household Program that provides minimum home repair funds and personal property loss. Again, his findings suggest proper targeting – high overall levels of assistance tended to go to areas with high damage and higher percentages of low-income, minorities, and even renters. However, he also found that only average levels of assistance amounts went into areas with high damage and yet lower income. The picture that emerges is that targeting of these funds appears to be appropriate, however the amounts are low, which suggests the potential for uneven recovery given limited or nonexistent funding from other sources flowing to these areas.

The final major program emanates from the Department of Housing and Urban Development (HUD) in the form of Community Development Block Grants for Disaster Recovery (CDBG-DR). In some sense, this program began after Northridge, as part of the CDBG program, but has become more institutionalized with the CDBG-DR program which requires congressional appropriations, of which there have been 19 by 2013 (Gotham, 2014). CDBG-DR funds are "noncompetitive, non-recurring disaster-recovery grants by a formula that takes into account disaster-recovery needs unmet by other federal disaster programs implemented by the Federal Emergency Management Agency (FEMA), the Small Business Administration (SBA), and the U.S. Army Corps of Engineers" (Gotham, 2014, p. 193). They are granted to states or local governments, are highly flexible, indeed, these entities can utilize these funds in quite innovative ways, but programs must meet general CDBG criteria of, for example, benefitting low and moderate income individuals and aid in the prevention or elimination of urban slums and blight. The *Road Home Program*, administered by the State of Louisiana, which was funded at around $15 billion is an example of such a program and Mississippi also received CDBG-DR funding as well (cf. Green & Olshansky, 2012; Spader & Turnham, 2014; Lowe, 2012; Olshansky & Johnson, 2014). The *Road Home Program* provided funding to qualified homeowners to either sell their property or to rebuild. In the metropolitan New Orleans area, there were approximately 96,000 grants given to households, with just over 90% of those opting to stay and rebuild (Green & Olshansky, 2012). Unfortunately, there is little in the way of systematic data to assess the effectiveness of this program. However, a number of researchers pointed out that in addition to significant delays,

which caused major problems for households, there is some evidence to suggest that funding was significantly biased against ensuring sufficient rebuilding for housing in low-income and African-American areas (Green, Bates, & Smyth, 2007; Nelson, Ehrenfeucht, & Laska, 2007; Olshansky & Johnson, 2010; Spader & Turnham, 2014; Gotham, 2014; Sloan & Fowler, 2015). Lowe (2012) has noted that while these funds were also supposed to target small rental properties, very little funding actual went to such properties. Indeed, a Government Accounting Office report found that programs targeting low income rental properties showed limited success and progress with only "14 percent of the 10,115 properties funded in Louisiana and 25 percent of the 4242 rental units funded in Mississippi were completed as of July and August 2009, respectively" GAO, 2010, p. 30). In addition, Mississippi employed its CDBG-DR funding in a manner that was not appropriately targeted to address general CDBG goals, but rather was diverted to improve port facilities (Lowe, 2012).

The picture that emerges from the household recovery literature clearly suggests that while both insurance and public funding are important for household recovery, access to these resources is far from equal. For the majority with access to good insurance, perhaps supplemented by some public recovery resources, recovery can be rapid. Zhang and Peacock's (2010) longitudinal research suggest that single-family owner occupied housing, net of other factors, reached restoration levels within two years after Hurricane Andrew. Rathfon and colleagues (2012), employing permit and remote sensing data, also found that recovery levels were reached for most housing within two years in the relatively affluent and predominantly Anglo community of Punta Gorda after Hurricane Charley. Similarly, Pais and Elliott (2008), using census data from the early 90s, characterized communities as recovery machines, but these transformations can be uneven. In particular, as noted above, lower-income and minority homeowners often appear to have much greater difficulty procuring access to adequate insurance and qualifying for SBA loans and potentially gaining sufficient access to other safety-net resources needed for housing recovery. While this research tends to focus only indirectly on housing recovery itself, the findings suggest that housing recovery is uneven at best and leads to significantly lower rates of housing recovery and increasing housing inequality at worst. The parallels to normal housing attainment processes do appear to play out in the post-disaster period; unfortunately, there is little systematic research that directly addresses and assesses uneven recovery rates in housing recovery. The picture for renters follows the same general pattern.

27.7 Permanent Housing Recovery: Rental Housing

Rental properties have unique recovery problems and issues. In the aftermath of a natural disaster, renters are much more likely to be displaced, for they have few if any rights to the property, only to the contents within them, whereas single family homeowners can often choose to stay despite the damage (Girard & Peacock, 1997). Renters are much less likely to have insurance to cover their assets (Kunreuther & Roth, 1998) and the range of government programs open to them is much more limited as discussed above (i.e., IFG, Housing Choice Vouchers; SBA rental loans) (Bolin, 1982; Quarantelli, 1982; Bolin & Stanford, 1998a, 1998b; Comerio, 1998). Low-income and minority rental households often have particular difficulty finding alternative housing in no small measure because affordable housing is likely to be in short supply prior to the disaster (Quarantelli, 1982; Bolin, 1982, 1985, 1993b). As a consequence, they are much more likely to find themselves in various forms of temporary sheltering and housing options (Bolin, 1985, 1993b). Of course, renters are, in some sense, more mobile and less constrained than perhaps homeowners who often feel compelled to secure and guard their property. Hence, renters, at least theoretically, are free to move on to other rental opportunities. However, their ability to locate permanent housing will depend upon a number of factors such as transportation,

economic resources such as savings, job and family locations, and, most importantly, rental vacancies and options.

In addition, while renters may be "freer" to relocate, like other households they are often as tied to location, due to employment, schools and social networks, as homeowners. For lower income households these factors are all in question and, as noted above, racial discrimination in housing can also limit possibilities of minorities (Morrow, 1997; Girard & Peacock, 1997). In addition, as has been noted by a number of studies, rents often increase in the post impact period and higher income and more affluent households often occupy the vacant rental properties that are available (Quarantelli, 1982; Comerio, 1998; Bolin, 1993b; Bolin & Stanford, 1998a, 1998b). The net effect is that in major natural disasters, rental-housing opportunities can be very limited, which places those most vulnerable in a very untenable situation. This has clearly been played out in the aftermath of Hurricane Katrina for the many low-income renters that have found themselves scattered to the winds.

Difficulty bringing rental housing back online can exacerbate affordable housing shortages tremendously (Sloan & Fowler, 2015; Van Zandt & Sloan 2017; Rumbach & Makarewiz 2017). The owners of rental properties, whether individuals or commercial entities, are responsible for recovery duties, such as inspecting buildings and repairing damage to ensure safe occupancy. Rental properties often take significantly longer to rebuild and in the rebuilding process these projects rarely target low-income affordable housing, a continuation of normal housing issues. In their research after the Whittier Narrows, Loma Prieta and Northridge earthquakes, Bolin (1986, 1993b), Comerio et al. (1994), and Bolin and Stanford (1998a, 1998b) found evidence that some landlords delay repairs to damaged housing because of limited financial assets and developers seeking to establish new multi-family units are often blocked by local officials or residents. The public resistance and delays to recovery of rental housing can be particularly felt when it comes to the rebuilding of various forms of public housing (White, 2010; Sloan & Fowler, 2015; Van Zandt & Sloan 2017; Morrow & Peacock 1997). The slow return of rental housing has been systematically examined with longitudinal data following Hurricanes Andrew and Ike. Zhang and Peacock (2010) found that rental housing, among single family structures, were significantly slower in the recovery process, failing on average to reach recovery levels, after controlling for other factors, four years after the storm. Similarly, Peacock et al. (2014), found an even more dramatic pattern following hurricane Ike. In addition, systematic analysis of housing types generally associated with rental properties (duplexes and multi-family housing) also found that these properties fell significantly behind single-family recovery rates (Lu et al., 2007a, 2007b). Systematic longitudinal research employing building permit and remote sensing data on housing recovery in Punta Gorda, Florida following Hurricane Charley also found that multi-family housing was much more likely (25-35% of the time) to be demolished, rather than repaired, when compared to single-family homes (Rathfon et al., 2012). Similarly, Comerio (2006) utilizing permit data found that single family houses recovered much more quickly than multi-family structures. The slower reconstruction rates for rental properties, places neighborhoods with high proportion of rental properties at risk of failing to recover and potentially becoming blighted areas typically referred to in the literature as post-disaster ghost towns (Morrow & Peacock, 1997; Comerio, 1998; Bolin & Stanford, 1998b; Zhang, 2012).

27.8 Permanent Housing Recovery: The Redevelopment Model

New research allows us to contrast the more market-based or limited intervention models with post-disaster permanent housing recovery in China, best characterized as an approach that features a strong role by the national government and limited community participation (Abramson

& Qi, 2011; Chen, 2005; Comerio, 2014; Grossi, del Re, & Wang, 2006). Post-disaster recovery is viewed as an opportunity to implement the national government's vision of development. The central state holds a tight control over major local development decisions through the use of hierarchical governance and centralized resource allocation. While this state-local power relationship can be further strengthened after a disaster because the affected region needs the resources from the national government, disaster recovery can also create conditions that challenge the national government's tight control (Abramson & Qi, 2011; Shen & Ma, 2008; Zhang & Drake, 2017).

The M7.8 Tangshan Earthquake and the M7.9 Wenchuan Earthquake are among the deadliest natural disasters in history. The 1976 Tangshan earthquake nearly flattened the entire city of Tangshan. Ninety-five percent of buildings in the city collapsed. More than 900,000 residents were displaced (Fang, 1979). The Wenchuan earthquake struck southwest China on May 12, 2008. Its damage extended across a vast area of 51,196 mi^2 (about the same size as the state of Louisiana). Even though no major cities were directly damaged by the earthquake, some towns and many villages were completely destroyed in parts of Sichuan Province. The quake claimed over 69,000 lives and displaced more than 15 million people (China State Council, 2008).

In Tangshan, it took more than 10 years for the transition to permanent housing to be complete (Chen, 2005; Cheng, 2008; Drake, Olshansky, Zhang, & Zhang, 2015; Grossi, del re, & Wang, 2006; Li, 2002; Shen & Ma, 2008; Zhang et al., 2016). While the central state mobilized a rapid response effort, it was insensitive to the conflict between the urgent housing needs of residents and the government's development vision. The recovery effort between 1976 and 1979 focused primarily on reinventing the city, including the relocation of an entire city district, neighborhood redesign, upgraded building standards, and comprehensive infrastructure improvements. The evolving ideas from party leadership caused the recovery plan to be constantly modified. Insufficient attention was given to the urgent needs of residents, especially the need for permanent housing and the restoration of basic normalcy. The slow housing transition prompted residents to build semi-permanent housing on their own. As a result, the recovery plan lost its ability to guide recovery activities. Due in large part to the presence of these unplanned semi-permanent housing settlements, the recovery plan was later greatly adjusted in the early 1980s to accommodate conditions on the ground and focus shifted to housing reconstruction. Many earlier, unrealistic recovery goals were either completely scrapped or greatly scaled back. In many respects the changing policy pictures, the failures to appreciate and address local issues and conflicts within and among local governments have parallels with the Katrina situation in the United States (Olshansky and Johnson, 2010). Yet, a very different picture emerged following the Wenchuan earthquake.

The recovery after the Wenchuan earthquake reflected the central state's vision of development for this part of China (Abramson & Qi, 2011; Dunford & Li, 2011; Ge, Gu, & Deng, 2010; Xu & Lu, 2011, 2013; Ye, Zhai, & Hu, 2011). The national government treated recovery as an accelerated way to advance urbanization, improve infrastructure systems, and modernize rural housing (China State Council, 2008). The national recovery plan identified housing as the highest recovery priority (Xiao et al., 2015; Zhang et al., 2016; Zhang & Drake, 2017). It set a three-year target to complete the transition to permanent housing, with improved building standards for all new or retrofitted structures, improved neighborhood design standards, and improved infrastructure and public facilities.

The transition to permanent housing after the initial emergency sheltering and temporary housing phases largely followed the planned schedule (Zhang et al., 2016; Zhang & Drake, 2017). Two years after the earthquake, most displaced residents had completed the transition to permanent housing. While local residents were positive about the physical conditions of their houses, many of them, especially the rural residents, expressed negative views about the lack of public input in the planning phase and mass relocations. Many rural residents reported that

their indigenous lifestyles and social networks were drastically disrupted during recovery. In some urban communities, the centralized approach towards housing recovery was met with strong resistance from residents (Abramson & Qi, 2011; Zhang & Drake, 2017; Chandrasekhar, Zhang, & Xiao, 2015). The alienation from the decision-making process prompted citizens to form groups to oppose the government's initial plan. At the same time, the pressure of recovery created conditions where the Chinese government became more receptive to public participation. The combination of these factors led to cases where neighborhoods and residents became highly involved in housing recovery.

27.9 Sheltering and Housing Summary

What is clear from the above discussion is that regardless of the type of shelter or housing being addressed, pre-existing social processes related to housing attainment or, more broadly, the social construction of vulnerability, play important roles in shaping outcomes. Specifically, the above discussion highlights the consequences class and racial/ethnic differences play in the complex social process of returning to permanent housing after disaster. Whether considering differential levels of damage caused by natural hazard events, the ability to insure property and household assets, the availability of adequate emergency and temporary sheltering and temporary housing or the challenges faced when garnering adequate resources to recover, the process from disaster impact to permanent housing recovery is complicated, particularly for low income and minority households. The housing recovery process is rife with challenges for those with few personal, social and financial assets.

The market "managed" and limited intervention recovery schemes upon which the United States depends are structured to favor those most likely to have resources to recover in the first place. Disaster recovery policy focuses on offering single-family homeowners assistance in rebuilding their homes, and thus, their lives, while leaving renters and the most financially marginal homeowners with more limited options. There is much that is successful about a market-managed system for large components of our society and its housing infrastructure; markets do respond and housing does get repaired and rebuilt and life moves on for many. But, the safety net is flawed and in an increasingly diverse society that is likely to experience many future disasters, we cannot ignore these flaws and failures. And yet, because little systematic research has highlighted these inequities and problems, policy continues to focus on owner-occupied single-family housing recovery even though in many areas the majority of households would be left to recover on their own. Only through a clear research agenda focused on the reality of disaster impact and recovery for all types of housing and households, can we inform public policy and suggest change that will better meet the needs of all households.

Given the increasing recognition of the complexities, problems, and inequalities in recovery processes, another key issue beginning to emerge in the research and practice literatures is the nature and effectiveness of *recovery planning* in general, and *permanent housing recovery planning* in particular (Berke, Kartez, & Wenger, 1993; Berke & Campanella, 2006; Olshansky, Johnson, & Topping, 2006; Horne, Johnson, Nee, & Olshansky, 2008; Olshansky & Johnson, 2010; Johnson & Hayashi, 2012; Olshansky, Hopkins, & Johnson, 2012; Masterson et al., 2014; Berke et al., 2014; Boyd, 2014; Schwab, 2014). Indeed, whereas in the past, housing recovery was not even considered and even actively discouraged as part of post-disaster planning (Peacock & Ragsdale, 1997), we now see a clear recognition of the importance of planning for housing recovery as part of pre- and post-disaster recovery (FEMA, 2011; Smith, 2011; Schwab, 2014; Comerio, 2014; Ganapati & Mukherji, 2014; Olshansky & Johnson, 2014). However, there is also clear recognition that planning, particularly community-based recovery planning and planning that explicitly address housing beyond owner occupied single-family

housing – rental housing, multi-family housing, condominiums, etc. – is not only falling short, is almost non-existent (FEMA, 2009, 2011; Bryant, Cantrell, Nahmens, Peavey, & Stair, 2012).

While our focus has been primarily on housing issues in the United States, as Mary Comerio (1998, 2014) suggests there is much to be gained from comparative research Indeed, much of the work cited above drew extensively from research conducted in Latin America (Haas et al., 1977; Bolin & Trainer, 1978; Bolin & Bolton, 1983; Bates, 1982; Bates & Peacock, 1987, 1992, 1993; Comerio, 1998, 2014; Peacock et al., 1987; Oliver-Smith, 1990, 1991, Wisner et al., 2003), the Caribbean (Berkie et al., 1993; Morrow, 1992), Europe (Bates & Peacock, 1992, 2008; Geipel, 1982; Hogg, 1980) and Japan (Wisner, 1998; Hirayama, 2000). Indeed, the insights related to social vulnerability and linking disasters with normal developmental processes which has so fundamentally shaped recent research that has been undertaken on housing recovery, was greatly influenced by international research (i.e., Blaikie, Cannon, Davis & Wisner, 1994). In addition, the international literature is relatively more well developed in the areas of emergency and temporary sheltering and to a certain extent on issues related to temporary housing (e.g., Davis, 1978, 1981), and U.S. researchers might well learn from it. In addition, to the extent that market phenomena are readily spreading with marked increases in globalization, the lessons learned in the United States regarding housing market failings, insurance, and their consequences for housing recovery are likely to find increasing relevance internationally.

27.10 Discussion and Future Research

We began this chapter with a focus on housing recovery following disasters and in so doing adopted the shelter and housing typology introduced by Quarantelli (1982) in an attempt to clarify the various forms of shelter and housing individuals and households often find themselves in need of or involved in as they cope with the displacement that is associated with natural disasters. For some households, this displacement is very limited, perhaps better termed temporary dislocation, as they flee their homes because of an acute hazard threat, or in the immediate aftermath due to limited damage to their homes or lifeline disruption. However, for households that are displaced because they are victims of a major natural disaster which has destroyed or otherwise left their homes uninhabitable seeking emergency shelter becomes only the first step in what may well be a long and protracted process of reestablishing permanent housing. Until Hurricane Katrina, the United States seemed somewhat immune to large-scale displacement creating internally displaced populations; however, clearly Hurricane Katrina illustrates what can happen when a socially vulnerable population experiences a large-scale disaster.

This chapter has highlighted research findings associated with each form of sheltering and housing, playing particular attention to what is generally considered the goal, reestablishing permanent housing, or again, in the vernacular, reestablishing home. While much has been accomplished, we offer the following general suggestions for future research needs:

- Solid ethnographic/qualitative research needs to be undertaken following panels of households through the process of housing recovery paying particular attention to transition points in the process. Ethnographic decision tree analyses would be particularly fruitful in helping the research and policy-making communities better understand factors shaping household decision making in the complex housing recovery process.
- Solid ethnographic/qualitative research also needs to be undertaken on developers, rental property owners and managers, to better understand the decision making process related to post-disaster repair, rebuilding, and

redevelopment decisions. This should not only examine owners and developers of properties that existed prior to a disaster, but also on those that consider such activities following a disaster.

- Longitudinal panel studies of households – both renter and homeowner households – transitioning through the housing recovery process following a major natural disaster. In light of future demographic trends, focusing on populations in large multi-ethnic metropolitan areas would be particularly important as well as considering all dimensions of social vulnerability (i.e., gender, age, etc.) not simply class and race/ethnicity.
- Drawing on work on vulnerability and resilience, a comprehensive review of disaster planning documents particularly socially and geographically vulnerable locations needs to focus on plans for not only short term sheltering, but long-term displacement. The displacement of thousands from their homes post-Katrina to locations throughout the United States highlights the need to have more comprehensive sheltering plans.
- Longitudinal panel studies of different forms of housing (single family, multi-family, condominiums, etc.) and the difficulties experienced by households occupying these structures having varying tenure status should be undertaken. This must directly connect housing, households, and the aid they received from all sources to more completely understand the impacts different forms of aid have on housing and household recovery.
- Hurricane Katrina highlighted the need to better understand the varied types of household structures minority and low-income households develop, and the implications for disaster planning. Poor and minority households, particularly those in high rental markets such as New York City and San Francisco, develop innovative living arrangements that create post-disaster hardships. Understanding these structures and mapping them to provisions in the Stafford Act and other policies would allow communities to better understand the gaps in their disaster planning.
- Consistent and appropriate quantitative multivariate analysis of future, existing, and historical datasets should be undertaken. Advances in generalized linear models, hierarchical linear models, and panel analytic techniques provide a greater range and flexibility for researchers to undertake appropriate analyses with all forms of recovery measures. Revisiting and reanalyzing historical datasets might be particularly fruitful.
- With the emergence of more emphasis on both pre- and post-disaster recovery planning, more focus must be paid to the role that planning for recovery, particularly housing recovery, might have on the speed and mitigation/adaptive consequences of post disaster housing changes might have for local communities and residents – all residents.

Clearly, there have been insights gained from the international research arena that have been fruitfully applied in the United States context. However, we have not seen concerted efforts to integrate research between these settings. As research focusing on housing recovery emerges, more efforts must be undertaken to share and exchange insights and thereby promote transferability.

Perhaps most importantly we return to Quarantelli's (1982, p. 80) admonition: conceptual rigor and clarity. As researchers, we must strive for conceptual and theoretical clarity in our work. This may involve the creation of distinctive concepts as tools for the development of our theories and research or the refinement of existing concepts; but unless we are clear in our theorizing about the phenomena under study, we cannot hope to cumulatively develop as a mature area of research. As such we need conceptual clarity and measures for the concepts of housing recovery, recovery processes, restoration, and resilience. But critical for that endeavor is, of course, solid research to test our ideas and stimulate further the science. In 2008, the National Science Foundation funded a workshop that called for the creation of a Resiliency and

Vulnerability Observatory Network (RAVON) (Peacock et al., 2008). Such a network would greatly enhance research on all aspects of resilience, particularly with respect to the built environment (buildings and infrastructure) and ultimately housing. Development of an observatory network would greatly enhance this project. We, as a research community, need to push for the development of this network.

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Disaster Recovery in an Era of Climate Change: The Unrealized Promise of Institutional Resilience

28

Gavin Smith, Amanda Martin and Dennis E. Wenger

Contents

28.1 Introduction

The original version of this chapter began with the sentence: "Disaster recovery represents the least understood aspect of emergency management, from the standpoint of both the research community and practitioners" (Smith & Wenger, 2006, p. 234). We argued that there were sufficient research findings spanning key dimensions of sustainability to guide the development of a national disaster recovery policy agenda, and yet the knowledge generated was not operationalized in practice (Smith & Wenger, 2006). We also proposed the creation of the Disaster Recovery Act, which was intended to clarify roles and responsibilities of those engaged in disaster recovery and build federal, state, and local capacity (Smith & Wenger, 2006). More than 10 years later, the nation has yet to fully develop an actionable pre-event disaster recovery policy or provide appropriate funding to carry out what remain vague, often uncoordinated federal goals. Nor have we adopted clear measures that can guide planning and support the targeted delivery of technical assistance aimed at building pre-event institutional capacity. The historical legacy of disaster recovery policy in the United States is also reflected in the limited degree to

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which the guidance that is available has led to new or improved state and local recovery plans.

A sound national disaster recovery policy requires developing more robust state plans focused on local capacity building and creating local plans undergirded by the active involvement of a broader "disaster recovery assistance network" (Smith, 2011). In this chapter we draw on the disaster recovery indicators and planning principles literature to provide an improved platform to operationalize the gaps identified in our original chapter. Situating recovery in this context emphasizes the significance of "institutional resilience" and the closely associated role of planning.

Three significant, albeit insufficient, changes have occurred spanning practice and research in the United States since the publication of our original chapter. One, the National Disaster Recovery Framework (NDRF) was created in response to withering criticism from the media, local officials, and the academic community following Hurricane Katrina (GAO, 2010; Olshansky, 2006; Smith, 2011). Two, resilience has become a common aspirational goal of disaster recovery practice and a term used to frame research efforts, replacing a prior focus on sustainability. Three, a growing emphasis has been placed on injecting climate change adaptation measures into post-disaster recovery programs, which provides an opportunity to expand the network of participating institutions (Glavovic & Smith, 2014). Each of these changes provide an important context for the remainder of this chapter.

28.2 Chapter Summary

In order to unpack problems identified throughout this chapter, we offer a research agenda to address gaps in knowledge and based on the findings, suggest a set of evidence-based policy solutions. First, we discuss the shift in thinking from sustainable development to resilience as an organizing concept for disaster recovery. We suggest that these concepts are best understood as intertwined and that their relationship should guide research and practice. Then we describe the rise of programs espousing resilience and the need for indicators to help define and measure disaster recovery processes and outcomes. This is followed by a discussion of the need to improve the collective capacity of what we refer to as the "disaster recovery assistance network." Then we describe the importance of strengthening state and local planning, including how the use of planning principles can inform disaster recovery processes and outcomes. We conclude with a set of policy recommendations that draw on the initial chapter's suggestions and more recent advances in the field.

28.3 Situating Resilience Within the Larger Sphere of Sustainability: Implications for Research and Practice

A number of disaster recovery practitioners and scholars have replaced one concept (*sustainability*), with another (*resilience*), without discussing the implications of this approach. Nor have current scholars adequately reviewed earlier literature that argues for their integration, to include how planning can further this aim (Beatley, 2009; Berke & Smith, 2009; Godschalk, Beatley, Berke, Brower, & Kaiser, 1999; Godschalk, Kaiser, & Berke, 1998; Mileti, 1999). We argue that the use of planning principles and disaster recovery indicators provide a way to assist communities recover from both rapid and slow-onset hazards threats, including those tied to or influenced by a changing climate.

Given this underlying context, we provide a new definition of disaster recovery that draws from our original chapter as well as more recent thinking. Thus we define disaster recovery as: *The differential process of restoring, rebuilding, and reshaping the physical, social, economic, and natural environment through pre-event planning and post-event actions that enhance the resilience and adaptive capacity of assistance networks to effectively address recovery needs that span rapid and slow onset hazards and disasters*.

A synthesis of the sustainable development and resilience literature suggests that a

sustainable society takes a long-term view, addressing systemic problems like vulnerability and its closely associated corollary capacity, while a resilient society learns from the past and changes course when necessary in order to cope and adapt. The intertwining of these concepts become increasingly prescient in an era of climate change, when neighborhoods, cities, regions, states, and nations seek to address natural hazards threats under conditions of growing uncertainty. Communities face a related challenge to recover from more frequent extreme events considering that the spatial and design features common to human settlements tend to reflect a climate of the past.

Resilience has deep roots in ecology and has been used to explain how natural systems respond to perturbations, including major disruptions (Holling, 1973). The linkage to the study of natural hazards and disasters is based on the realization that natural hazards are an important, "value neutral" part of environmental systems and disasters are a human construct as described in both seminal studies of hazards research (Mileti, 1999; White & Haas, 1975). While those that study natural hazards and disasters have understood these interrelationships for some time, practitioners in the United States were slower to adopt the concept of resilience. The aspirational goal of increasing community resilience gained prominence several years after Hurricane Katrina and was adopted more broadly following Hurricane Sandy. Today, disaster recovery and climate adaptation experts often refer to resilience as the capacity of a place to absorb and recovery from weather-related shocks (National Research Council, 2012).

Resilience is a key attribute of sustainability and much of the literature supports this claim (Smith, 2015). Beatley, in his book *Planning for Coastal Resilience: Best Practices for Calamitous Times* (2009) describes resilience and sustainability as a set of interrelated and mutually reinforcing topics. Beatley contends that the sustainability of a system, be it an ecosystem or city inherently requires resilience (pp. 11–12). Godschalk et al., (1999) similarly argues that "federal sustainable development policy" should strive to further "resilient communities, capable of managing extreme events" by enhancing "state, local, and regional commitment and capacity" to develop mitigation plans, policies, and projects (p. 531). Described in more stark terms, the failure to reduce escalating disaster losses is inherently unsustainable (Gall, Borden, Emrich, & Cutter, 2011).

Berke and Smith, drawing on the concept of a three-legged stool (which expands upon a graphic originally created by Godschalk et al. (1998), contend that economic, social, and environmental resiliency "…must be in balance for the community to support the ultimate goal of sustainability" (2009, p. 5) (Fig. 28.1). This metaphor not only emphasizes the inter-related dimensions of resilience and how they undergird the larger aim of sustainability, it highlights the role of planning as a procedural means to coordinate and operationalize these concepts, to include, a community's vision of sustainability and resilience, as well as goals tied to social, economic, and environmental dimensions described in the sustainable development and resilience literature. In Disasters by Design, Mileti argues that "sustainable hazards mitigation" means that "…a locality can tolerate–and overcome–damage, diminished productivity, and reduced quality of life from an extreme event without significant outside assistance," by simultaneously achieving six objectives, one of which is to foster local resiliency and responsibility (1999, p. 4). Paton, McClure, and Burgelt state that resilience is closely tied to the capacity of local groups to utilize personal and social resources to manage the effects of disasters (2006, p. 106). In our prior chapter, we suggested that self-reliance is an important aim of achieving "sustainable community disaster recovery" (Smith & Wenger, 2006).

Figure 28.1 builds on the three-legged stool concept initially proposed by Godschalk, Kaiser, and Berke by adding another band titled "institutional resilience" which further binds the legs of the stool to the seat top. We posit that disaster recovery, like other complex societal challenges, necessitates understanding how organizations interact as part of a larger collective system or

Fig. 28.1 Integrating sustainability and resilience (modified from Berke & Smith, 2009, p. 5)

network. Institutional resilience is achieved through what we refer to as "disaster recovery assistance networks," recognizing that the interconnectedness among and across organizations can influence both processes and outcomes based on the nature of collaborative actions, like planning (Smith, 2009; Smith & Birkland, 2012).

Institutional resilience is defined as: *the ability of a network of organizations, groups, and individuals acting collectively to address short or long-term natural hazards and disaster-based shocks to economic, environmental, social, and physical systems*. Institutional resilience describes the degree to which these networks plan for, learn from, and operate to address threats, build capacity, and act through coordinative vehicles like planning. The fragmented network of organizations involved in creating and managing disaster recovery policy as well as those who are often unexpectedly charged with navigating its complexities, necessitates the formation of inter-institutional partnerships (Berke, Kartez, & Wenger, 1993; May & Williams, 1986; Mitchell, 2006; Smith, 2011). Institutional resilience does not describe the resilience of individual organizations or institutions; rather it captures the collective contributions of the network of organizations based on the nature of the interactions between them.

Networks of institutions carry out actions that influence the level of institutional resilience over long-term timescales as well as during episodic spikes in activity as is common following disasters. Walker and Salt (as described by Beatley, 2009, p. 9) suggest an "overlap in governance structures" to create "redundancy" in systems which allows for a greater variety of solutions when issues emerge. While the strength, durability, and adaptability of bonds among organizations is highly varied and tested most clearly after disasters, ongoing capacity building efforts are ideally put into practice in advance of an extreme event.

Berke and Smith suggest that: "Social resiliency is directly tied to the strengths of social networks and interpersonal bonds" (see "Social Capital in Disaster Research" by Meyer in this handbook). These relationships provide psycho-social support, a venue for the exchange of information, and a sharing of resources before and after disasters" (2009, p. 4). We believe that a further review of this association should describe the collective impact of institutions that support economic, social, and environmental dimensions of both sustainability and resilience. An approach grounded in institutional resilience supported by planning provides a basis for the operationalization of national policy (i.e., meeting sustainability- and resilience-based goals) over short- and long-term timescales.

Underlying elements of sustainable development are intergenerational equity and the role of

coordination across institutions. As stated by the Brundtland Commission: "Sustainable development, which implies meeting the needs of the present without compromising the ability of future generations to meet their own needs, should become a central guiding principle of the United Nations, Governments and private institutions, organizations and enterprises" (World Commission on Environment and Development, 1987). Understood relative to natural hazards and disasters, sustainable development implies a purposeful means by which sustainability (i.e., "the ability of a human, natural or mixed system to withstand or adapt to endogenous or exogenous change indefinitely") can be deliberately achieved over time (Handmer & Dovers, 1996, p. 485). The concept of current and future needs, including those that span multi-generational timescales, contributes a temporal element to the discussion of disaster recovery and institutional resilience. This condition also applies to thinking about how institutions address climate change adaptation, in part, by adopting plans and associated policies that include longer time horizons, recognizing that changes over time may be uncertain or at least less predictable than in the past.

Bringing the concept of resilience into sustainability has also helped scholars include the unexpected in their understanding of sustainability. Walker and Salt (2006) argue that the modularity of and tight feedbacks within systems allow for the absorption of perturbations as well as an ability to adopt new measures as needed before key thresholds are exceeded. The authors go on to suggest that policies should account for "slow variables" associated with environmental change, including those threats that are tied to natural hazards and disasters (Beatley, 2009, pp. 8–9). Mitchell recommends that we think about "linking recovery to other national policy goals and opening a dialogue between sustainability and surprise" (2006, p. 240), adding that "…disaster recovery cannot be solely a matter of building toward a sustainable future; it must also address unexpected contingencies" (p. 242).

This dialogue between sustainability and surprise requires that we move away from a strict reliance on the concept of "stationarity" which implies that we can continue to develop hazards models to inform policies, plans, and the associated type and location of human settlements by relying upon past events to predict the future (O'Hare & White, 2013; White, 2014). One way we can address this uncertainty is to place a greater emphasis on future land use planning that accommodates natural hazards (including those that are climate-related) and to develop flexible institutional networks capable of implementing coordinated changes over time in anticipation of and in response to threats (Glavovic & Smith, 2014). In the post-disaster timeframe, the disaster recovery period provides unique opportunities to implement land use planning practices and for institutional networks to build capacity given the influx of funding, attention placed on unmet needs, creation of new or amended policy, and the delivery of technical assistance.

The capacity to address the unexpected can be framed as an ability to understand and ultimately meet varied and changing local needs both before and after disasters. This approach recognizes long-standing conditions that predispose human settlements to disaster as well as emergent post-disaster conditions that arise unexpectedly. Furthermore, the framing of local needs should reflect the institutional context of the resource providers, which are best described as a loosely coupled network (Smith, 2011). In practice, many of the post-disaster recovery policies and programs at the federal and state level fail to meet the needs of those who seek assistance, in particular, the most vulnerable and those lacking the pre-event capacity and political capital required to address the multiple challenges associated with disaster recovery (Cutter et al., 2014; Peacock, Morrow, & Gladwin, 2000; Smith, 2011).

An overreliance on post-disaster recovery programs has the effect of disincentivizing proactive behavior across networks (Smith, 2011). Many of the difficulties associated with enhancing resilience are a result of policies that encourage non-resilient action across a range of stakeholders. These policies include the uncoordinated and often conflicting nature of recovery

resource distribution strategies and the underwhelming emphasis on pre-event planning and capacity-building across networks (Olshansky & Chang, 2009; Olshansky & Johnson, 2013; Smith, 2011). We argue that the dual effect of a non-collaborative process, coupled with communities that are ill-equipped to plan for and manage the multitude of resources available post-disaster, often results in poor recovery outcomes that are neither sustainable nor resilient. Unfortunately, key members of the larger network, including federal and state government agencies tasked with building pre-event capacity, have largely failed to learn from repeated mistakes and alter the way in which resources are invested before a disaster (Birkland and Waterman, 2008; Birkland and DeYoung, 2011; Smith, 2011; Smith, Lyles, & Berke, 2013). Nor have the institutions responsible for the management of the disaster recovery process in the aftermath of an extreme event effectively addressed gaps in the coordination of available resources, including the emergence of new organizations uniquely positioned to address local needs (Aldrich, 2010; Nelson, Ehrenfeucht, & Laska, 2007b; Smith, 2011). These systemic problems hinder our ability to operationalize institutional resilience.

Good disaster recovery plans help foster resource distribution strategies that are flexible, recognizing that the delivery of assistance, both before and after disasters, should be based on unique local conditions. Specific examples of unique local conditions include the varied and ever-shifting impacts of a changing climate as well as the ebb and flow of resources available through disaster recovery assistance networks. Flexibility allows for improvisation (Kendra & Wachtendorf, 2006; see "Organizational Adaptation in Disasters" by Mendonça and Renaud, and "Community Innovation and Disasters" by Wachtendorf, Kendra, and DeYoung in this handbook), the emergence of local groups targeting specific gaps in assistance (Drabek & McEntire, 2003; Phillips, 1993; Smith, 2011, pp. 242–261), and the creation of the conditions in which location-specific leadership and collaboration can thrive (Johnson & Olshansky, 2013; Mammen, 2011, p. 249; Smith, 2011, p. 402).

Even though there has been an explosion in the array of programs and tools purporting to advance the concept of resilience, there remains a number of examples of how established disaster recovery policies are hindering the ability of communities to become more resilient. In many cases, post-disaster strategies have entrenched dependence not self-reliance, fostered short-term reactionary thinking versus contemplatively derived and enduring planning horizons, encouraged resistance rather than resilience, institutionalized inequitable versus equitable resource distribution mechanisms, and furthered uncoordinated rather than collaborative decision-making processes. Thus a key question becomes, how can we tackle these problems in light of current policies that have failed to adequately advance institutional resilience?

28.4 Disaster Recovery Indicators and Plan Quality Principles

Recent advances in applied research, including disaster recovery indicators and plan quality principles, which have the potential to move disaster recovery practice closer to promoting resilience, are described next. A focus on these emerging fields of inquiry provides a basis from which to develop an improved national disaster recovery policy that moves beyond a largely reactionary process to one that furthers institutional resilience through planning.

28.4.1 Disaster Recovery Indicators

Research and practice benefit from advances in the ability to measure disaster recovery, particularly when assessed across multiple dimensions and case studies (Horney, Dwyer, Aminto, Berke, & Smith, 2016). Indicators have the potential to assist disaster recovery researchers by making it possible to draw comparisons across disasters, places, and times (Horney et al., 2016). Indicators can help policymakers assess

progress and inform future recovery action, which is particularly important because of the iterative and adaptive nature of disaster recovery planning (Schwab, 2014; Smith, 2011). More recent research has shown that this information can be used to monitor, evaluate, and update plans over time and lead planners and policymakers to consider facets of recovery that have historically been overlooked but are nonetheless important (Horney et al., 2016).

However, some local officials may be reluctant to use indicators to evaluate their own approach to recovery. On one hand, they may worry that scoring high on recovery indicators could preclude their access to certain needs-based recovery funds (Dwyer & Horney, 2014) of which states and local governments are highly reliant. This concern highlights an increasing dependence on federal disaster relief (Birkland, 2008; Birkland & DeYoung, 2011; Platt, 1999; Rubin, 2007) which has hindered the development of strong local capacity to adapt to and recover from disasters (Smith, 2011; Smith et al., 2013). On the other hand, local officials may worry that scoring low on recovery indicators could reduce public confidence, provide fodder for critics, and hinder the accreditation status of communities seeking professional certifications (Dwyer & Horney, 2014). Additional concerns may include dissuading business interests from investing in the area, or precluding local governments from obtaining grant funding that requires competing with other applicants that possess a demonstrated capacity to successfully achieve the goals of those organizations that provide assistance. A separate, data-related challenge is that with growing evidence of differential recovery processes and outcomes among geographic or demographic subgroups, some indicators must be measurable across varied scales and populations (Tierney & Oliver-Smith, 2012).

Despite an oft-discussed need, only two comprehensive sets of community-level disaster recovery indicators exist in the United States (Jordan & Javernick-Will, 2013; Horney et al., 2016). Both sets of indicators were informed by a review of the literature and vetted through a formal assessment process by experts (Dwyer & Horney, 2014). The Jordan and Javernick-Will indicators include economic, environmental, infrastructure, and social categories, which roughly correspond with the dimensions of sustainable development. The set of 19 indicators measure broad recovery outcomes, such as employment and restoration of infrastructure. The Horney et al., indicators are organized according to the Recovery Support Functions of the NDRF, and then arranged into the following thematic areas: financial recovery, social recovery, public sector recovery, and recovery process. The 79 indicators include a mix of recovery inputs (e.g., dollars allocated), outputs (e.g., community meetings), and outcomes (e.g., restoration of healthcare facilities). A key intent of the indicators is to capture government and stakeholder capacity, which is particularly important to understanding recovery planning efforts, including the use of adaptive and iterative decision-making processes (Berke, Cooper, Aminto, Grabich, & Horney, 2014; Schwab, 2014). Field tests conducted in six Texas communities provide insights into the challenges of implementing disaster recovery indicators in locales with differing capabilities (Horney & Smith, 2015). The researchers found that the size of community and magnitude of the event affect the utility of different indicators. On average, only 25 percent of the metrics could be obtained. Indicators that were not already collected for administrative purposes represent a particular challenge. Continued field-testing of this type is needed to further inform the use of indicators in communities planning for or recovering from disasters. In addition, there is a need to enhance local capacity to collect and assess the data, to include its incorporation into disaster recovery plans. The limited ability of local governments and others to collect indicator-related data demonstrates the need to enhance state-delivered training and the provision of supporting information and tools that help to build and sustain this capability.

The application of recovery indicators faces additional challenges that illustrate gaps in disaster recovery theory and research, just as our

previous chapter highlighted the non-existence of an organizing theory of recovery that could inform practice. First, to measure recovery, one has to identify a locally relevant definition and associated goals. For many communities, recovery means a return to pre-disaster conditions, which implies a baseline (pre-disaster) metric against which all recovery will be measured (White & Haas, 1975). Analysts, particularly economists, might take a counterfactual approach, defining recovery as the state that would be achieved if no disaster had occurred. This approach captures, for example, the effect of ongoing trends external to the disaster that affect metrics we might use to measure recovery, such as unemployment rates and housing prices. Metrics of recovery are qualitatively different when comparing these two approaches (Cheng, Ganapati, & Ganapati, 2015).

Several definitions of recovery include a normative improvement on past conditions such as a reduced vulnerability to natural hazards. Others identify a "new normal" as recovery's end state, and while this may provide a simplified version of consensus in the research, and in particular the practice-based literature, it remains a major challenge to operationalize or measure when the "new normal" has been achieved (Tierney & Oliver-Smith, 2012). Thus it is difficult to standardize indicators without widespread agreement about the definition of recovery, including those conditions that describe a desirable end state. Nor is it clear whether these conditions match identified community goals found in plans and other policy documents. Challenges tied to standardization include varied local conditions and abilities, the differential targeting of local capacity-building efforts by state agencies, and ill-defined national recovery policy goals.

Any effort to standardize recovery indicators through the use of normative terms should assess how processes and outcomes take into account social vulnerability. Questions of the larger disaster recovery assistance network should include the degree to which resource distribution strategies and local needs are met by a process that is predicated on equity and justice. Communities may appear recovered on many widely accepted metrics such as housing value or employment level, but this may reflect reconstruction processes that push socially vulnerable populations out of the disaster-affected area. For instance, efforts to demolish the City of Galveston's public housing units and the ensuing public opposition to their redevelopment following Hurricane Ike highlights this post-disaster problem (Way & Sloan, 2013, pp. 232–233). Research has documented inequitable housing recovery processes in repeated disasters (Comerio, 1998; Peacock, Van Zandt, Zhang, & Highfield, 2014) including Katrina (Gotham, 2014; Welsh & Esnard, 2009), Andrew (Dash, Morrow, Mainster, & Cunningham, 2007; Peacock et al., 2000), the 1906 San Francisco earthquake (Fradkin, 2005), the 1995 Chicago Heat Wave (Klinenberg, 2002) and numerous international catastrophes (Ganapati & Ganapati, 2009; Oliver-Smith, 1979, 1990; Oliver-Smith & Goldman, 1988; Sapat & Esnard 2017).

More work is needed to capture whether, or to what degree, disaster recovery is achieved by virtue of excluding low-income or other vulnerable populations from engaging in the planning process. Further research should also explore the variation in individual recovery indicators (Horney & Smith, 2015) across spatially segregated sub-populations living in the same community (Cutter et al., 2014). Another challenge acknowledged in the literature is the need to test how well existing recovery indicators capture the recovery experiences of individuals, households, and community leaders who may not possess professional expertise in disaster recovery but have local knowledge and life experience, including an awareness of local needs before and after disasters. The value of indigenous knowledge and its use in planning has been shown to be particularly important in understanding disaster recovery processes and outcomes (Aldrich, 2010; Ganapati & Ganapati, 2009; Poutasi, Daly, Kohlhase, & Nelson, 2014; Oliver-Smith, 1990; Smith, 2011, pp. 244–245; United Nations, 1982, p. 4).

Two additional problems for the research community to address is the degree to which

disaster recovery indicators are correlated with one another and their level of spatial dependence. If recovery indicators are highly correlated with one another, scholars must examine whether the indicators measure different phenomena or if multiple indicators capture a single characteristic of recovering communities. In the case of individual communities, additional data points, even if correlated with one another, may provide practicable information. However, for comparison across communities or storms, and particularly if measurements are placed into indices or averaged, highly correlated indicators may present threats to the validity of the comparison. Spatial dependence is a separate issue; it refers to the influence of one place on another that is located nearby. Examining spatial dependence of individual and multiple disaster recovery indicators may provide insights into overall patterns and drivers of recovery by showing how a community's recovery pattern and trajectory is influenced by the recovery of nearby communities.

28.4.2 Disaster Recovery Plan Quality Principles

We suggested in our original chapter that the benefits of disaster recovery planning, while important, remained largely unrealized. Ten years later, modest progress has been made by scholars and practitioners on what is widely believed to be an important driver of a sustainable and resilient recovery. Part of the lack of progress is due to the reality that scholars have not adequately studied the relationship between good planning and enhanced levels of resilience by speeding the recovery process and reducing future vulnerability in the aftermath of a disaster (National Research Council, 2012). While plan quality principles have been used to critically review disaster recovery plans at the local (Berke et al., 2014) and state (Sandler & Smith, 2013; Smith & Flatt, 2011) level, these assessments did not empirically evaluate the relationship between plan quality and disaster recovery outcomes. We believe that the combined application of plan quality principles and recovery indicators provide a robust and targeted means to evaluate disaster recovery processes and outcomes. We also believe that these advances in applied research can be used to guide the development of good disaster recovery plans, thereby assisting in the implementation of the NDRF.

Plan quality analysis is a process by which plans are assessed according to recognized standards of practice (Baer, 1997; Berke & Godschalk, 2009; Kaiser, Godschalk, & Chapin, 1995; Kaiser & Davies, 1999). Plan quality principles, as applied to disaster recovery plans, can help to: 1) provide tangible and actionable guidance for the still emerging NDRF and climate change policy at the national level, 2) inform state and local planning efforts that are evolving irrespective of national policy, and 3) offer the means to empirically test the relationship between planning and recovery processes and outcomes.

The plan quality assessment process has been used to evaluate a range of plans including those tied to hazard mitigation (Berke, Smith, & Lyles, 2012; Godschalk et al., 1999; Lyles, Berke, & Smith, 2014a; Nelson & French, 2002) and to a lesser extent disaster recovery (Berke et al., 2014; Sandler & Smith, 2013; Smith, 2011) and climate change adaptation (Bakera et al., 2012; Stults & Woodruff 2016; Woodruff & Stults, 2016).

The content of plans is broken down into a set of interrelated principles. The principles of plan quality as described by Berke and Godschalk (2009), include: 1) vision and issue identification, 2) fact base, 3) goals, 4) policies, 5) implementation, 6) monitoring and evaluation, 7) internal consistency, 8) interdependent actions, 9) organizational clarity, and 10) participation.

28.4.2.1 Vision

A plan's vision provides a description of an aspirational future, including the underlying themes the plan is designed to address. Understood relative to this chapter, a disaster recovery plan may be guided by sustainable development and disaster resilience, thereby providing a

means to address root causes of disasters and closely associated pre-event conditions. This approach also entails being prepared to address episodically occurring conditions in the aftermath of disasters such as the emergence of new organizations, unexpected physical impacts, and rapid changes in federal, state, and local recovery policies and funding.

28.4.2.2 Goals

Goals are value-based statements that provide direction for implementing the plans larger vision. Given a vision tied to sustainability and resilience, one option to consider is to base goals on social, economic, environmental, and physical dimensions described in the sustainable development and resilience literature. In a related example that spans broad themes of sustainability and resilience, Berke et al., suggests that recovery plan goals should be both restorative, to alleviate losses quickly and efficiently, and transformational, to include building back better (2014). Restorative goals closely align with the aims of resilience. Transformational change may include altering human settlement patterns such as the retreat from high hazard areas and disinvestment in infrastructure deemed vulnerable to current and future hazards, which draws on both short-term and multi-generational approaches associated with resilience and sustainability.

28.4.2.3 Fact Base

The fact base is comprised of data intended to inform goals and associated policies. Key elements of a fact base in a recovery plan include an assessment of risk and the capability of the disaster recovery assistance network to act. A risk assessment catalogs the study areas hazards history, delineates hazardous locations, and describes the exposure of people and property to identified threats. Hazards scenarios are frequently developed to address speed of onset, intensity, duration, and spatial extent as well as how these hazard characteristics differentially affect populations across geographically delineated areas.

The assessment of a jurisdiction's capability to act is an essential part of a good recovery plan and provides a means to assess important elements of institutional resilience. The analysis should evaluate the level of fiscal, technical, legal, administrative, and political capacity (or commitment) present in the study area. It should also assess existing policies, plans, and investments in the community and how these documents and associated choices help or hinder the achievement of the disaster recovery plan's vision and goals.

28.4.2.4 Policies

Policies are a statement of what a governmental body intends to do about a public problem (Birkland, 2016, p. 9). Applied to disaster recovery, policies guide public and individual decisions before and after disasters. Common topical areas include housing, environment, infrastructure and public facilities, social services, economic development, financial management, land use, reconstruction, and hazard mitigation. Nested within these categories are policies addressing issues such as the identification of temporary housing sites and debris management procedures. Others policies may include infrastructure repair strategies, the means by which socially vulnerable populations are identified and assisted, and the creation of small business information delivery vehicles. Additional examples include the development of a staffing strategy to manage grants and other forms of post-disaster assistance, the implementation of land use policies that account for pre- and post-disaster conditions, and the creation of temporary building moratoria to afford decision makers the time needed to assess pre-existing reconstruction standards and strengthening them if warranted.

28.4.2.5 Implementation

An implementation strategy is intended to ensure the intent of the plan is achieved through the execution of its vision, goals, and policies. Important components include identifying and holding departments and staff members accountable for assigned responsibilities, determining the means by which policies and projects are funded, and ensuring that other resources, like staff time are adequately committed to the

effort. In addition, it requires prioritizing certain actions over others and creating timelines that reflect realistic staging of and access to resources.

28.4.2.6 Monitoring and Evaluation

Plans should have clear monitoring and evaluation procedures to track progress over time and make adjustments as needed. Monitoring and evaluation should take place at regularly scheduled intervals in order to address changes in local and external conditions. Examples include changes in development patterns and ongoing growth, as well as new or modified federal, state, and local policies and programs. Monitoring and evaluation of plans should also be undertaken following disasters as they "test" existing components of plans and expose issues that may have been unaddressed or conflict with other plans and programs. Developing clear indicators of recovery offers an important way to monitor and evaluate plans.

28.4.2.7 Internal Consistency

Internal consistency describes the degree to which the plan's vision, goals, policies, and implementation strategy are clearly linked and mutually reinforcing. Consistency across planning principles is critical as their interconnectedness serves to further the role of a plan as a logical decision making tool.

28.4.2.8 Horizontal and Vertical Integration

Horizontal integration refers to the level of coordination between local institutions such as local government, community organizations, non-profits, businesses, and others in the community. Vertical integration refers to the level of coordination between local, regional, state, and national units of government. Interdependent actions can be described in the context of the disaster recovery assistance network, to include the suggestion that international organizations and nations should be added to the vertical dimension (Smith, 2011, p. 219; see also Fig. 28.2). The need to expand the vertical dimension was made clear following Hurricane Katrina when international aid was offered to the US but the federal government did not possess protocols to accept this type of assistance. In an era of climate change, these types of agreements will become increasingly important (Smith, 2011, p. 228).

28.4.2.9 Organizational Clarity

Organizational clarity is the degree to which the plan is readily understood by a broad set of constituents such as members of disaster recovery assistance networks. It is achieved when a document is logical, sends a consistent message, and links all aspects of the plan in a coherent narrative. Conveying this information effectively relies upon the use of clear language as well as visual aids like maps, tables, figures, and model outputs that include both current and projected future conditions.

28.4.2.10 Participation

Plans provide a means to engage broad audiences in all facets of the planning process (Innes, 1996; Innes & Booher, 1999, 2004), including those that address natural hazards (Burby, 2003) and those that coordinate complex networks (Innes & Booher, 2004). This can prove particularly important as planning for disasters tend to have a weak public constituency (Burby, 2003). A number of hazards scholars have described the importance of developing strong participatory processes in the development and implementation of recovery plans, to include the incorporation of local knowledge and needs into recovery (Ganapati & Ganapati, 2009; Oliver-Smith, 1990; Berke et al. 2011a, 2011b; Nelson et al., 2007b) and climate change adaptation policies (Poutasi et al., 2014).

Plan quality principles allow researchers the means to evaluate disaster recovery plans for their adherence to these broadly accepted tenets. Analyzing plan quality and disaster recovery indicators in tandem provide insights into the relationship between planning, or particular elements of plans, and disaster recovery outcomes. Further field testing and more detailed analyses that employ plan quality principles and disaster recovery indicators have much to offer disaster-stricken areas. Examples include those

that seek to make wise investments in the post-disaster setting and those that seek to proactively advance their level of sustainability and resilience to future natural hazards and disasters, including those influenced by a changing climate.

28.5 Institutional Resilience and the Disaster Recovery Assistance Network

Planning provides a procedural means to insert resilience into recovery by building capacity across a network of institutions that may help deal with future disasters as well as cope with the uncertainty of climate change. Among its many attributes, planning for sustainability and resilience can inform a community's ability to better address pre-event conditions (i.e., vulnerability and capacity), manage the lengthy and complex process of disaster recovery following extreme events, and proactively develop strategies that account for rapid and slow onset hazards. One way to unpack these terms, discuss their interconnectivity, and inform policy and practice is by employing an institutional perspective (Berke et al., 1993, p. 98; Smith & Birkland, 2012). This approach allows researchers and practitioners to better acknowledge and enhance the contribution of various actors in disaster recovery, particularly the ways in which they interact and collaborate, which in turn, enhances resilience. Understood in this context, we explore the "institutional arrangements" that influence pre-disaster recovery planning and associated outcomes (Smith & Birkland, 2012, p. 147), to include the linkage between disaster recovery and climate change adaptation. We suggest that achieving higher order aims like sustainable disaster recovery and resilience requires strengthening the interrelationships across institutions before and after disasters. In order to do so, we should have a framework in place that allows us to understand these relationships.

Institutional resilience requires taking collective actions through what Smith (2011) defines as the Disaster Recovery Assistance Network. Figure 28.2, time series 1 (T1) represents a hypothetical disaster recovery assistance network in which institutions of varied types, shown as nodes on the diagonal line, manage or influence how funding, policy, and technical assistance–referred to as resources–are distributed. The degree to which these resources reflect an understanding of local needs is highly variable as are the rules that define the way in which these resources are managed. In the United States,

Fig. 28.2 Disaster recovery assistance network

where federal resources are often defined by prescriptive rules governing their use, these rules can significantly affect the trajectory of community-level disaster recovery processes and outcomes. In part, because of a failure to develop pre-disaster plans for recovery, states and local governments are hyper-focused on the management of federal grant programs in the aftermath of disasters, with less attention paid to engaging the remainder of the network in coordinating the myriad resources they possess.

Some organizations like foundations, universities, financial institutions, community development organizations, and regional planning organizations play important roles in recovery but are often less connected to others in the planning process. We describe those actors as existing within a "zone of uncertainty." The limited engagement of these groups in multi-institutional planning efforts can hamper recovery processes and outcomes, to include the inefficient and ill-timed use of resources that may be counterproductive to policies and investments adopted by others in the larger assistance network. For instance, members of the private sector (e.g., financial institutions, businesses, contractors, or insurance companies), which dramatically influence recovery processes and outcomes, are often excluded from the development and implementation of local recovery plans. Those who study disaster recovery tend to know less about organizations in the zone of uncertainty and the roles they assume in pre- and post-disaster timeframes (Smith, 2011, pp. 14–15).

The disaster recovery assistance network is best characterized as a loosely coupled set of actors rather than a coordinated group. It is also important to note that the network, as shown in Fig. 28.2, represents a simplified depiction of a highly complex system. For instance, the "federal governments" node encapsulates a number of agencies including the Federal Emergency Management Agency, the National Oceanic and Atmospheric Administration, the Department of Housing and Urban Development, the US Army Corps of Engineers, and others, each of whom possess varied rules governing the management and distribution of resources within and across divisions and associated programs. Nodes in the network can move along the diagonal line, particularly if they learn and adapt their policies, organizational culture, and management to reflect a better understanding of local needs.

Engaging in a recovery planning process with members of the disaster recovery assistance network has the potential to assist participants with a low understanding of local needs gain a greater understanding of the resources available, in effect "standing up" the diagonal line and its associated institutional nodes as shown in time series 2 (T2) (Fig. 28.3). This does not necessarily imply a change in how resources are managed. Rather, the dialogue across members of the network is a communicative process that can foster an important precondition for change as described in the planning literature (Forester, 1980; Habermas, 1984). In a closely associated application of theory and practice, Alternative Dispute Resolution (ADR) techniques, like mediation and policy dialogue, have been used by planners and others to foster multi-party collaboration and address disputes that arise through thoughtful and tested communicative procedures (Godschalk, 1992, 2004; Susskind & Cruikshank, 1987; Susskind & Ozawa, 1984). ADR techniques are particularly appropriate when confronting issues that arise in the disaster recovery process, such as resource distribution

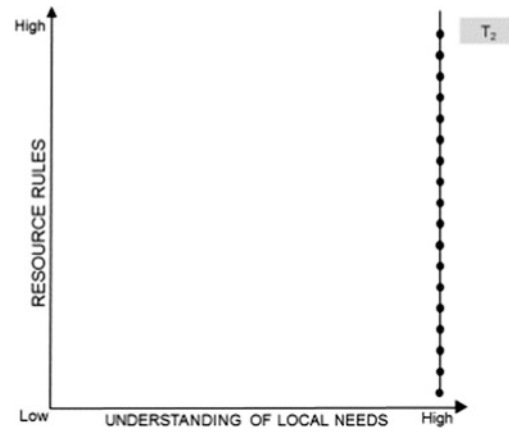

Fig. 28.3 Disaster recovery network: understanding local needs

strategies, which are frequently contentions (Smith, 2011). As noted by Smith,

> ADR principles involve repeated interaction and the use of reciprocal dialogue, the creation of incentives to participate and share information, a demonstration of the tangible benefits of ADR, a clarification of the fact base, the identification of new perspectives and the creation of multiple options, high levels of stakeholder involvement, and the redress of existing power imbalances (2011, p. 293).

These techniques, which improve resource providers' understanding of local needs are the first step in a longer, ongoing process that furthers learning, and in turn, fosters the closely associated corollary, institutional resilience. This iterative process strengthens the bonds across the disaster recovery assistance network, particularly when tangible benefits are accrued over time among participants.

Further dialogue across the network has the potential to explore how institutions can better meet identified local needs through the modification of the rules associated with the resources they manage. A successful representation of this idea is found in Fig. 28.4, denoted as time series 3 (T3) and reflected as a clustering of nodes, which indicates a change in resource rules across institutions in the network. Changing the rules governing resources and associated distribution strategies often involves lengthy and contentious policy debate and negotiation among participants. Key tasks include identifying influential champions within agencies and organizations capable of initiating change, confronting bureaucratic inertia and programmatic turf issues across and within organizations, and modifying laws tied to disaster recovery financing (Smith, 2011, pp. 292–293).

Not only do these institutional conditions apply to recovery, but also climate change adaptation as is evident post-Sandy when federal agencies like HUD allowed the use of supplemental appropriations to fund projects that incorporated higher standards required to account for the uncertainty of future sea level rise (US Department of Housing and Urban Development, 2013). Additional changes included the funding

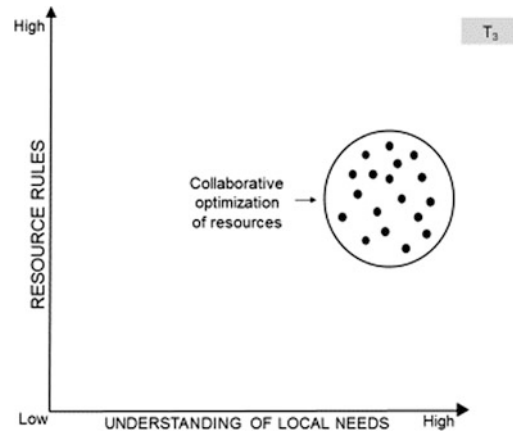

Fig. 28.4 Disaster recovery assistance network: collaborative optimization of resources

of HUD's Rebuild by Design Competition that employed post-disaster teams of architects to address both disaster recovery and climate change adaptation issues. While Sandy showed that program rules could be modified, the disaster recovery "window of opportunity" to affect policy learning and change also led to President Obama's Executive Order requiring all federal agencies to identify how their policies could be altered to account for climate change. The recent change in Presidential administration also shows how policy learning can regress as evidenced by the rollback of policies advancing climate change adaptation. This non-linear process of policy learning merits further study as described in the recommendations section of this chapter. Next, we discuss the potential role of federal and state recovery planning as a means to further institutional resilience.

28.6 Federal and State Recovery Planning Revisited

In our initial chapter, we argued for the passage of a Disaster Recovery Act that would assist states and local governments proactively plan for a sustainable recovery. Following Hurricane Katrina, the United States Congress passed the

Post-Katrina Emergency Management Reform Act (PKEMRA), which required FEMA to create a national recovery strategy. More than ten years after Katrina made landfall, recovery remains ongoing in Louisiana and Mississippi communities and there is still significant uncertainty as to what the national recovery strategy is, and how it is to be operationalized at the state and local level (GAO, 2016; Smith, 2011).

The NDRF includes the following Recovery Support Functions (RSFs): Community Planning and Capacity Building (CPCB); Economic Development; Health, Social, and Community Services; Housing; Infrastructure Systems; and Natural and Cultural Resources (FEMA, 2016a). Federal agencies assume leadership and supporting roles across each of the RSF's and these agencies are expected to provide assistance to states and local governments following federally-declared disasters.

The organizational structure of the NDRF led to a government-centric approach to include encouraging states to adopt similar state-level recovery support functions. In an effort to expand the exclusive focus on government, FEMA has adopted the notion of "whole community," which encourages individuals, businesses, and varied organizations to take responsibility for disaster readiness. Following a national dialogue on the whole community, the following principles and associated narratives emerged:

1) Understand and meet the needs of the whole community. Community engagement can lead to a deeper understanding of the unique and diverse needs of a population, including its demographics, values, norms, community structures, networks, and relationships.
2) Engage and empower all parts of the community. Engaging the whole community and empowering local action will better position stakeholders to plan for and meet the actual needs of a community and strengthen the local capacity to deal with the consequences of all threats and hazards.
3) Strengthen what works well in the community on a daily basis. A whole community approach to building community resilience requires finding ways to support and strengthen the institutions, assets, and networks that already work well in communities and are working to address issues that are important to community members on a daily basis (https://www.fema.gov/whole-community, accessed September 25, 2016b).

The ideas cited above approximate many of the tenets of institutional resilience and the disaster recovery assistance network. Yet its actualization in practice is fraught with challenges. Federal capacity remains insufficient to facilitate this complex challenge as the Community Planning and Capacity Building RSF, which was established, in part, to assume this role, is understaffed relative to the task before them (Smith, 2011). While improvements have occurred since the prior edition of this chapter was written–each of FEMA's 10 regions has a Federal Recovery Coordinator assigned to assist states and communities–this remains inadequate to further pre-event training and other capacity building initiatives.

Perhaps the greatest hindrance to fostering enhanced state and local capacity is the lack of attention placed on the development of pre-disaster recovery plans. Instead, a concerted effort remains focused on the post-disaster delivery of monetary aid. In the post-disaster setting there is a wide variability among states and local governments as to whether they feel planning assistance offered by FEMA's CPCB staff is warranted and in some cases, there is strong opposition to this post-disaster focus (GAO, 2010, 2016). Part of this opposition can be explained by the timing of assistance as state and local officials are often overwhelmed by the management of post-disaster programs and do not possess the capacity to provide data to CPCB staff as requested or work with them to plan for recovery in the aftermath of a disaster.

This problem could be partly alleviated by engaging in a federal-state partnership that advances pre-event planning for post-disaster recovery. Such a partnership could include

gathering and analyzing baseline recovery indicators, and based on this assessment, building the collective capacity of recovery assistance networks before a disaster strikes. Partnerships can also assist in the development of post-disaster recovery plans, recognizing significant variability in the capacity and commitment of state and local officials as well as larger disaster recovery assistance networks to undertake this effort.

Smith (2011) suggests that FEMA should refocus its funding, policies, and technical assistance to support the development of robust pre-disaster recovery plans and gradually hold jurisdictions more accountable to a set of recognized standards. One way this might be achieved is through FEMA's proposed disaster deductible program. Under this initiative, states would be required to spend a predetermined amount of funds annually to reduce risk and enhance resilience in order to access federal disaster assistance to repair damaged public infrastructure following disasters (Government Printing Office, 2017). Examples of risk reduction and resilience-related efforts described in the initial guidance include adopting enhanced building codes, initiating state-funded hazard mitigation projects, and investing in state-funded disaster recovery programs. Connecting the disaster deductible program to concerns expressed in this chapter suggests linking the provision of pre- and post-disaster recovery funding to the development of high quality disaster recovery plans that have clear programmatic, technical, and participatory processes in place (see Smith, 2011, pp. 326–328). The use of plan quality principles and disaster recovery indicators provide a clearer set of process and outcome-based measures to evaluate progress towards recognized standards of practice. If plans and associated indicators are appropriately designed and account for varied state and local capabilities, they provide a means to assess the efficacy of state and federally-provided assistance over time.

The proposed shift to an emphasis on pre-disaster recovery planning and greater community accountability will require the development of strong state disaster recovery plans and associated capacity-building strategies aimed at not only local governments, but also members of the larger disaster recovery assistance network. A key role of state recovery plans should be to create the conditions in which local governments and broader disaster recovery assistance networks can develop and implement local disaster recovery plans in pre- and post-disaster timeframes. In practice, there remains significant uncertainty as to whether state recovery plans can achieve this goal as the quality of plans and their impact on local recovery processes or outcomes remains unknown.

Without this general information, the ability to develop targeted state-level research and training materials remains poor (Smith & Sandler, 2012). One study that evaluated a small sample of state recovery plans found that they did not possess what could be construed as basic planning principles. Rather, the plans more closely approximated a list of post-disaster federal programs available to states and local governments, not a process-oriented, participatory decision-making tool informed by a clear vision, strong fact base, set of integrated goals and policies, and a clear implementation and monitoring strategy (Smith & Flatt, 2011; Smith & Sandler, 2012, 2013). Since that 2011 study, a number of states have developed new recovery plans, informed by more recent FEMA guidance and an increased commitment to meet the intent of the NDRF. An analysis of more recent plans could reveal their quality and whether they increase the capacity of local actors to contribute to disaster recovery.

In our previous chapter we lamented the lack of local recovery plans and suggested that greater attention should be placed on rectifying this situation. While there is anecdotal evidence that this is changing in response to the increased emphasis on recovery planning by FEMA, there remains insufficient attention to this shortfall, including a limited understanding of the number and quality of local plans. Nor do we possess an empirically-grounded awareness of the correlation between plans, process, and outcomes. In a study of local disaster recovery plans, the authors

found that less than one-third of communities designated as "vulnerable" had a recovery plan in place and of those that did, the plans were of low quality (Berke et al., 2014).

28.7 Returning to the Concepts of a Sustainable and Resilient Disaster Recovery

The explanatory power of the disaster recovery assistance network is predicated on understanding the nature of inter-organizational coordination. Framing disaster recovery in this manner has practical applications for the challenges associated with disaster recovery (Smith, 2011) and the uncertainties and expanded planning horizons linked to climate change adaptation. The latter example has been described by a number of researchers as anticipatory governance, which is defined as "a flexible decision framework that uses a wide range of possible futures to prepare for change and to guide current decisions toward maximizing future alternatives or minimizing future threats" (Quay, 2010, p. 496). Fuerth defines the closely associated concept of anticipatory resilience as "a system of institutions, rules and norms that provide a way to use foresight for the purpose of reducing risk, and to increase capacity to respond to events at early rather than later stages of their development" (2009, p. 29).

Systems that promote anticipatory resilience use "incremental adjustments" as well as "transformative action" (Nelson, Adger, & Brown, 2007a). Understood in a planning context this means creating institutions and processes that move beyond the traditional planning paradigm of "predict and plan" to those that better anticipate change under conditions of high uncertainty (Quay, 2010, p. 496). Change may not occur steadily or predictably, as in the case of "punctuated equilibrium," described by Baumgartner & Jones (1993) as long periods of relative inactivity or incremental change followed by dramatic policy shifts following significant precipitating events, like disasters. The agenda setting literature (Kingdon, 1984; Sabatier & Jenkins-Smith, 1993), including the application of this concept to disaster recovery (Birkland, 1997, 2006; Olson, Olson, & Gawronski, 1999; Smith & Wenger, 2006), provides an important way to further explore the linkage between sustainability and resilience.

Viewed through a temporal lens, resilience helps to understand how societies address episodic events like disasters (National Research Council, 2006) while sustainability helps us to understand longer-term, multi-generational changes and associated measures adopted to account for these changes over time (Handmer & Dovers, 1996, p. 507). Other scholars have argued that resilience also entails a longer time horizon achieved through learning and "taking responsibility for making better decisions to improve the capacity to handle hazards" (Cutter et al., 2008, p. 600). More recently, the defining characteristics of resilience have converged to capture episodic and longer timescales as evidenced by the widely cited definition of the National Research Council which defines resilience as "the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse effects" (National Research Council, 2012, p. 1).

The ubiquitous use of the term resilience has in many ways muddled its explanatory power (Aguirre & Best 2014) and threatens effective practice as communities routinely claim that they are "resilient" when in fact their ability to recover relies upon accepting large amounts of federal resources and less on their own locally-derived capabilities (Birkland & DeYoung, 2011; Crabill, 2015; Platt, 1999; Birkland & Waterman, 2008; Smith, 2011). Examples of institutionally resilient actions include dedicated local financial reserves and sound pre-disaster recovery plans. Claims of resilience that are unsubstantiated by measurable indicators limit honest reflection, critical self-assessment, and policy learning. This type of thinking also makes it difficult to assess changes in behavior based on post-disaster experiences.

Unlike resilience, sustainable development has heavy normative baggage described in our original chapter as "liberal bias." While we suggested that a key aim of sustainable development involves striving to become more self-reliant, which is a conservative, or perhaps a

value-neutral idea, the term remains politically charged in the United States. As stated more than ten years ago, "In reality, increasing self-reliance and reducing the outlay of federal assistance appeals to a broader network, including those espousing a more fiscally conservative viewpoint" (Smith & Wenger, 2006, p. 254). In the recommendations that follow, we seek to demonstrate that change is possible by expanding the network of supporters that are willing to embrace an enhanced level of institutional resilience by engaging in pre-event planning.

28.8 Next Steps and New Directions: Planning for a Sustainable and Resilient Disaster Recovery in an Era of Climate Change

The research and practice-based recommendations described next are guided by a growing understanding of disaster recovery, including advances in the application of plan quality principles and indicators. First, we discuss proposed research activities. Then we provide suggested changes in federal, state, and local policy based on the findings. Taken together, they serve as a roadmap to achieve greater institutional resilience through planning.

28.8.1 Draw Lessons from Previous Studies Focused on Hazard Mitigation Planning

In our original chapter we recommended that lessons should be drawn from plans developed following the passage of the Disaster Mitigation Act of 2000 and the findings used to inform the nation's emerging disaster recovery policy (Smith & Wenger, 2006). Approximately 10 years after the passage of the Disaster Mitigation Act of 2000, a national study of hazard mitigation plans was undertaken, focusing on state and local plans. The six-year study, which employed the use of plan quality principles, produced several key findings. The analysis of state plans showed that their role in building local capacity was highly variable based on differences in state-level staffing, training programs, funding, and policies dedicated to risk reduction initiatives (Smith et al., 2013). The analysis of local plans found the following: 1) very few plans scored high across all planning principles, 2) most plans placed a limited emphasis on land use measures, and 3) few plans included climate change adaptation measures (Berke et al., 2012; Lyles, Berke, & Smith, 2014a, 2014b; Smith et al., 2013). In addition, the analysis did not assess the relationship between plan quality and outcomes.

Drawing from these findings should include applying the same or similar variables to assess state efforts to build local disaster recovery planning capacity. Based on the findings, more targeted pre-disaster recovery capacity building programs should be developed as a way to confront the currently unbalanced practice of providing primarily post-disaster aid. At the local level, future disaster recovery planning research should include assessing plan quality across all principles (including their interconnectivity), the role of local land use planning, and the degree to which disaster recovery plans address climate change adaptation. Additional research should focus on furthering our empirical understanding of the relationship between plan quality and improved processes and outcomes, to include the use of disaster recovery indicators in this analysis.

28.8.2 Assess State and Local Disaster Recovery Plans Using Plan Quality Principles and Indicators

In 2006, we suggested that a national assessment of local recovery plans should be conducted. To date there has been some evaluation of state (Sandler & Smith, 2013; Smith & Flatt, 2011) and local recovery plans using plan quality principles (Berke et al., 2014), although neither represents a national sample. In order to address the gap in knowledge, a national comparative time series analysis of state and local plans

should be conducted to understand the status of disaster recovery plans and how they are changing over time. An initial baseline assessment is required to evaluate the current state of practice. Following the baseline assessment, teams should be prepared to evaluate how the plans function following disasters. Given the lengthy disaster recovery process, this will require researchers to evaluate impacted communities over years or even decades.

Further study should evaluate state plans over time to see how they are updated based on new information, including that obtained following disasters, and in response to federal, state, and local capacity building efforts. Additional variables to consider include the effect of state recovery policies, such as those that address the natural hazards-climate change nexus. This evaluation should also assess the degree to which state plans foster the creation of high quality local plans and stronger disaster recovery assistance networks. A national assessment of local recovery plans may prove difficult as the number of existing plans remains small. As noted in Berke et al., (2014), less than a third of communities sampled possessed a local disaster recovery plan. Like state recovery plans, this too is changing, although it remains uncertain when a representative national sample of local plans could be acquired.

Analyses of both state and local disaster recovery plans should recognize the larger inter-institutional context in which these plans are situated and how the actors in a disaster recovery assistance network influence both process and outcomes. As part of this effort, the process-based transformation of the relationship between resource rules and understanding of local needs depicted in Figs. 28.2, 28.3, and 28.4 should be studied empirically. We suggest using a mixed methods approach that tests the validity of these relationships including potential "positive" directional changes that move toward the collective optimization of resources, and conversely, "regressive" shifts from coordinative conditions shown in Fig. 28.3 towards the condition shown in Fig. 28.2.

28.8.3 Incorporate Disaster Recovery Indicators into Plans

Incorporating disaster recovery indicators into plans can help measure the degree to which a plan's vision, goals, and policies are being achieved. Indicators also serve to track a plan's implementation, monitoring, and update processes before and after a disaster, including slow onset hazards tied to climate change. As noted earlier in this chapter, a gap in plan quality research is the untested relationship between plan quality and disaster recovery outcomes. Embedding indicators in plan quality principles can address the gap in applied research and operationalize the NDRF in an empirically sound manner.

As noted in a Government Accountability Office (GAO) report that evaluated the disaster recovery planning program in the United States, it was suggested that FEMA should do a better job tracking progress attained through outreach and other capacity building measures. States, who serve as a primary provider of this type of technical assistance to local governments, reported that it remained unclear what was expected of them, including the measures they needed to take in order to attain federal goals (2016a, 2016b). The findings of the GAO report points to the value of adopting clear indicators of recovery processes and outcomes, testing their validity, and integrating them into supporting national policy. The indicators literature shows that any effort to develop and utilize a universal set of indicators is difficult to achieve given great variability across communities in terms of hazards, capabilities, participating institutions, and agreed upon policies (Horney et al., 2016).

A menu of contextually-specific, local indicators should be developed that are recognized and agreed to by federal, state, and local governments as well as larger disaster recovery assistance networks. Providing a mechanism for local governments to meet higher-order national goals through a greater commitment to capacity-building and a flexible set of policy options has been shown to offer promise, spanning a range of hazards-management programs

(Burby & May, 2009; May et al., 1996; Smith, 2011), including climate change adaptation (Glavovic & Smith, 2014).

In order to use indicators as part of the planning process, they should vary locally to account for differences in capacity while meeting nationally recognized standards of practice (Horney & Smith, 2015; Horney et al., 2016). One option to consider is the inclusion of disaster recovery indicators into emergency management accreditation programs, which have historically placed less emphasis on disaster recovery planning (Smith, 2011, p. 360). This approach provides an incentive-based vehicle to enhance capacity and commitment to goals that are agreed upon by professional organizations tasked with developing these plans. Prior research has shown that other hazards-focused plans benefit from the active involvement of professions like land use planning (Lyles et al., 2014b; Schwab, 2014). Thus an effort should be made to expand the recognition of recovery planning standards among professional associations and other representative organizations in the disaster recovery assistance network. A related option is to incentivize recovery planning by linking the disaster deductible idea proposed by FEMA with the development of pre-disaster recovery plans that meet established standards of practice.

Federal and state government agencies, researchers, professional associations, quasi-governmental organizations, and foundations engaged in recovery planning should place a greater emphasis on the provision of technical assistance and capacity-building measures designed to help local governments of varied capacities collect, analyze, and incorporate indicators into plans and policies. Indicators spanning disaster recovery and climate change adaptation networks should be part of this effort and work done by Quay (2010), to include its application by Berke et al. (2014) relative to adaptive governance, provides evidence that this is possible. Another area worthy of exploration is the notion that embedding recovery indicators in all plans at the local level could help to integrate them as part of a comprehensive plan or a network of plans that are mutually reinforcing (Berke et al., 2015).

28.8.4 Maximize the Untapped Potential of the NDRF to Operationalize Institutional Resilience

One way to improve the federal approach to disaster recovery is by more clearly operationalizing Recovery Support Functions (RSF's) to include clear metrics of "success." This can be achieved by creating recovery plans underpinned by the concepts of the NDRF and the broader disaster recovery assistance network. The emergence of disaster recovery indicators tied to Recovery Support Functions, as developed and tested by Horney et al., (2016) provide an example of research that could support this idea.

A more fundamental question surrounds the degree to which the structure of the NDRF and its associated RSF's adequately meet the needs of communities and provide a vehicle to tackle local issues and needs through the resource distribution strategies of the larger disaster recovery assistance network. While institutional impediments remain, the creation and implementation of good recovery plans can be used to inform a bottom up effort while federal and state programs, policies, and capacity building efforts continue to emerge. The NDRF provides a vehicle to integrate these efforts through a better aligned set of tools, policies, and associated strategies that focus on building state and local capacity. Federal and state agencies, non-profits and foundations, academic institutions, and others have developed an array of tools, map-products, and indicators purporting to help improve disaster recovery outcomes. A similar commitment has not been made, however, to focus on the needs of local communities, to include the development of disaster recovery assistance strategies in partnership with those who will ultimately use them.

Further compounding this problem is the limited emphasis on the more difficult, ongoing process of building institutional capacity and commitment, which continues to lag behind the development of "products." A traditional government-centric approach, which underutilizes the range of resources and capabilities

provided by the larger disaster recovery assistance network, must be expanded to include the active involvement of others, including those located in the "zone of uncertainty." The use of indicators to assess capability that spans the disaster recovery assistance network and targets assistance based on the results of robust and comprehensive capability assessments found in good recovery plans can help build and sustain enduring networks of support. Harnessing this collective capacity should be a central aim of the NDRF, facilitated by federal and state agencies working closely with local officials and other members of the disaster recovery assistance network (see Smith, 2011).

28.8.5 Enhance the Focus of Pre- and Post-disaster Recovery Assistance and Capacity Building Efforts

Our original chapter suggested that we increase our commitment to building the capacity of those charged with disaster recovery. More than ten years later, this recommendation remains unfulfilled. Nor have we developed clear measures of progress undergirding broader national policy goals. To advance institutional resilience, disaster recovery organizations and actors must increase the precision of enduring assistance strategies. This type of assistance should be based on a set of collectively formulated nationally-recognized indicators. For instance, post-disaster aid, including innovative ideas like the Rebuild by Design Competition are representative of one-time infusions of assistance. An ongoing, more systemic approach should focus on the provision of assistance before a disaster, thereby altering the unbalanced expenditure ratio which emphasizes post-disaster aid. Changing the status quo will not be easy. It is much more politically palatable to provide assistance in the aftermath of a disaster than to infuse targeted assistance to communities and associated stakeholders beforehand in anticipation of potential recovery benefits that remain unmeasured.

In our original chapter we also suggested the creation of a Disaster Recovery Act which would focus on building a coalition of support to push for the development of a new "sustainable recovery implementation framework" that improves the "current system which is best described as a disjointed array of recovery programs without a clear set of guiding principles" (Smith & Wenger, 2006, p. 256). We further suggested that the proposed Disaster Recovery Act could foster the creation of a nationwide sustainable disaster recovery ethic. As noted in our prior chapter and here as well, sustainability has suffered from a politicized identity despite its uncontroversial goal to address endemic problems and chart a path for future generations. Resilience has greater staying power if we can more clearly define what resilience is, measure it, and inject it into clear, actionable policies and plans at local, state, and national levels. The focus of these policies should be to build the institutional capacity of disaster recovery assistance networks, thereby furthering progress on what remains an unresolved policy dilemma.

28.9 Concluding Thoughts

Returning to this chapter's central premise, disaster recovery requires understanding and harnessing the power of institutional arrangements, recognizing that disaster recovery assistance networks have the ability to affect positive change over time. Achieving this aim means embracing innovative, locally-grounded solutions, and fostering the ability of the network to learn and adapt, guided by collaborative mechanisms like planning.

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