Michael J. Zakour · David F. Gillespie

Community Disaster Vulnerability

Theory, Research, and Practice

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Chapter 1
Disasters and the Promise of Disaster Vulnerability Theory

In this chapter we introduce disasters and disaster vulnerability theory. The characteristics, distribution, and effects from disasters are discussed to establish a context and to justify our focus on community disaster vulnerability. Key concepts of vulnerability theory are defined, core assumptions are stated and briefly discussed, and boundaries are drawn. The utility of this theory to human service professionals, emergency managers, and social work education, and research is considered. Subsequent chapters break out facets of the theory to elaborate its structure, provide details, and report relevant research findings.

Disasters

Disasters are triggered by hazards. Technological hazards include chemical spills, explosions, and many other kinds of large-scale industrial accidents (McEntire, 2007a, 2007b). Natural hazards are the potential physical forces that, when conditions are right, cause hurricanes, floods, earthquakes, volcanic eruptions, tsunamis, wildfires, and other calamities. Tropical cyclones (i.e., hurricanes, typhoons, tropical storms) include both wind and storm surge often magnified by a high tide. Flood hazards include streams and creeks with low banks (flash floods), major rivers (slow-onset floods), and extended rainfall or impounded water floods. Especially in places such as South Asia (e.g., Pakistan, India, Bangladesh), flooding additionally includes a lack of proper water management and human modification floods. Geological hazards include earthquakes and volcanoes.

A community's vulnerability to natural and technological disasters is directly tied to the number and condition of hazards in the community's environment. Disasters create disruptions of community systems and obstruct the provision of resources needed for survival and well-being (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008; Quarantelli, 2005). These resources include food, shelter/housing, medical care, employment, and social and emotional support (Zakour, 2007). Disasters are defined most generally as a form of collective stress

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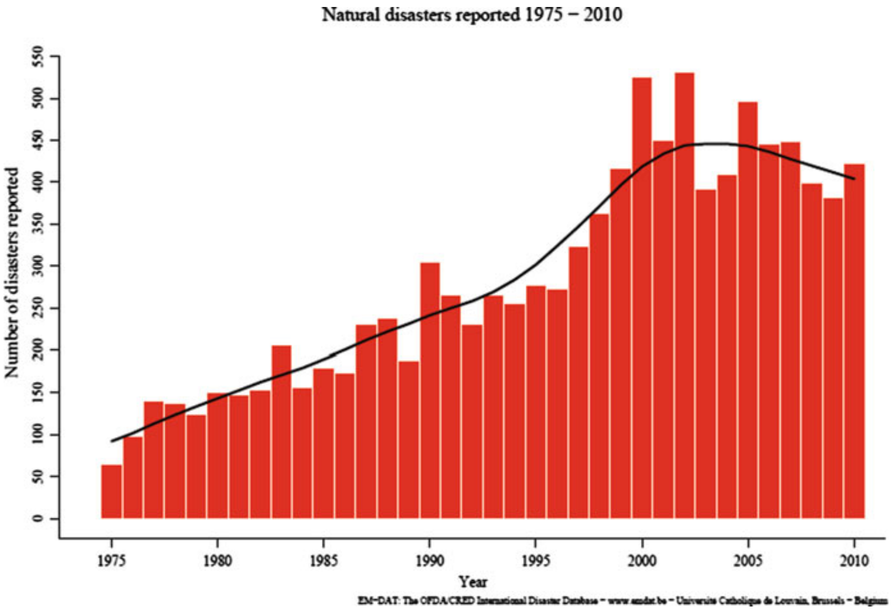

Fig. 1.1 Natural disasters reported 1975–2010

(Barton, 1969, 2005; Gillespie, 2008a). The level of collective stress is typically highest immediately after the eruption of a hazard, referred to as a disaster event. Worldwide disasters are a routine event. As documented in Fig. 1.1, everyday somewhere in the world there is a disaster.

From 1975 through 1993 the annual number of disasters around the world rose steadily from 100 to 250 reported disasters a year, an annual average increase of over eight disasters each year (http://www.emdat.be/). During the decade from 1993 to 2003 the number of disasters jumped from 250 to 450 a year, an increase of 20 disasters each year. Since 2003 the number of disasters has tapered off from 450 to 400 or a little more than seven fewer disasters each year.

From January 2001 to December 2010 there were 38,400 disasters. Of the deaths from disasters in this decade, 62.5% occurred in Asia, 23.1% occurred in the Americas, 12.9% occurred in Europe, and 1.3% in Africa. Floods accounted for 45.6% of disasters, while storms made up 27.1% of disasters (http://www.emdat.be/). This global distribution of disasters is typical and will continue into the indefinite future. Disasters are a natural part of the Earth's system. While disasters are a permanent part of our system, the negative consequences from disaster are not permanent and can be reduced. For example, as revealed in Fig. 1.2, the number of people killed by disasters has decreased slightly over the past 35 years.

As reflected in the data from 1975 through 2010 the number of people killed by disasters varies moderately from year to year with occasional sharp spikes (http://www.emdat.be/). The long-term trend is slightly downward. However, it is the spikes that grab people's attention. These disaster events are shocking and the

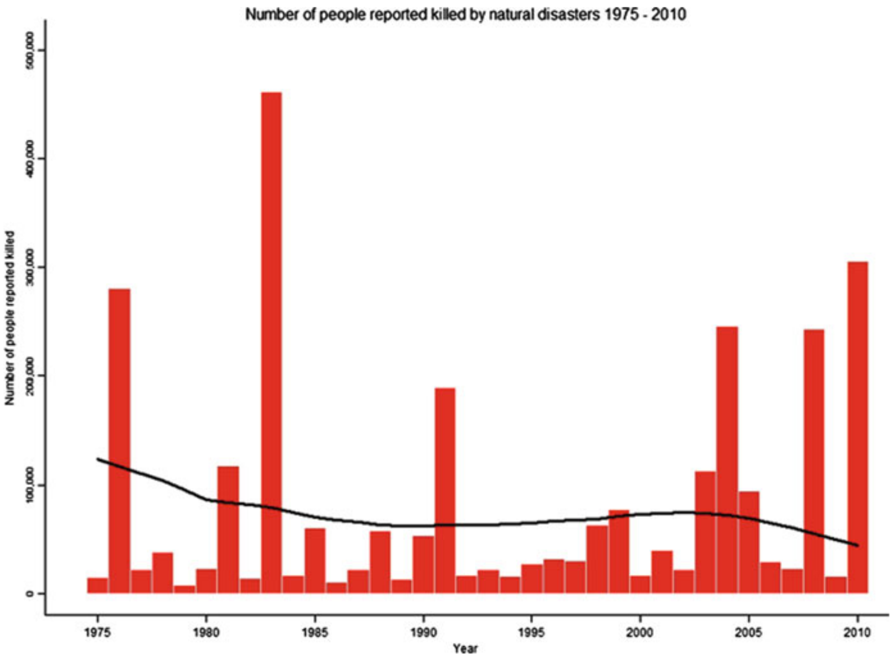

Fig. 1.2 Number of people reported killed by natural disasters 1975–2010

associated statistics are grim. The 1976 Tangshan earthquake in China killed an estimated 600,000 people; the 1991 flood in Bangladesh killed 139,000 and the Manji-Rudbar earthquake in Iran that same year claimed another 50,000 lives; the 2004 Indian Ocean tsunami killed 230,000; the 2008 cyclone in Myanmar killed 138,000 and the Sichuan earthquake in China that year killed 68,000; the 2010 earthquake in Haiti killed 316,000. These extraordinary disaster events reveal the weak links in our systems and knowledge of these links create unique opportunities for change. As discussed below, vulnerability is geared toward identifying these links and mitigating loss from disaster.

Emergency managers and human service professionals have done much to save lives, but still too many lives are lost each year. Disaster work is also becoming more challenging as the world becomes increasingly interdependent. Strategies to further increase effective loss reduction in disasters are an urgent need for emergency managers and human services professionals (McEntire, 2008). In contrast to the data trend represented with deaths from disaster, the number of people affected by disaster has been rising. This trend is documented in Fig. 1.3.

As Fig. 1.3 indicates, disasters affect hundreds of millions of people worldwide (http://www.emdat.be/). Since the year 2000 more than two billion people have been directly affected in negative ways by natural disasters around the world. In addition to the social and cultural disruption, disasters sometimes devastate community infrastructures, requiring huge infusions of money and years of recovery. For example, work continues to this day in Haiti from the 2010 earthquake, in

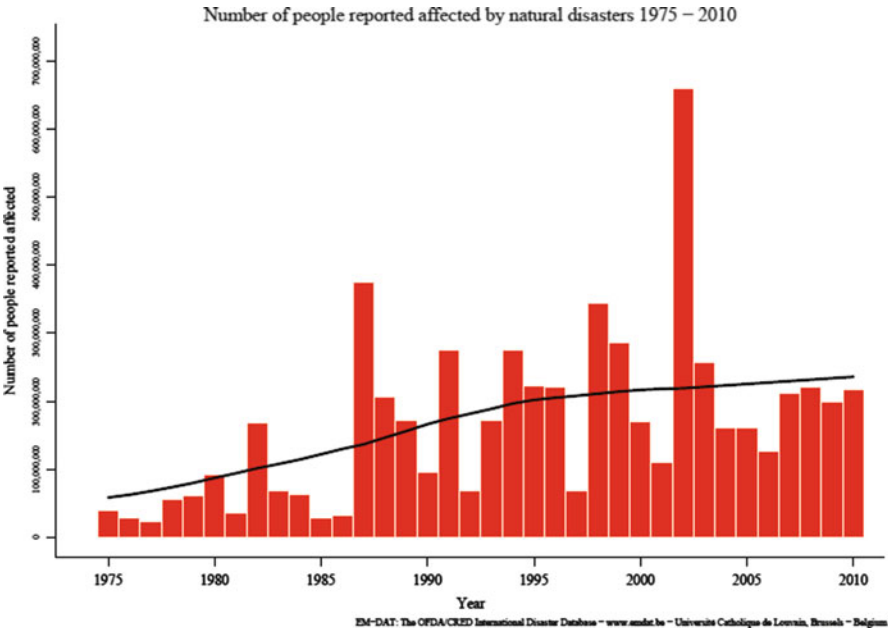

Fig. 1.3 Number of people reported affected by natural disasters 1975–2010

Louisiana from the 2005 hurricanes, and in several countries including Indonesia from the 2004 Indian Ocean tsunami. It is generally accepted that improving mitigation, preparedness, response, and recovery techniques are needed to reduce the negative effects of natural disasters. But empirically the data indicate that poverty is the most important root cause of long-term negative effects from disasters. The poor are not well prepared and not able to become well prepared to deal with the disruptions from disaster.

Economic damage from natural disasters has been increasing since 1975, with the rate of increase rising higher since the mid-1980s (Fig. 1.4). In 15 of the years from 1990 to 2010 disaster economic losses were $50 billion or greater. The 1995 Kobe earthquake, the 2005 Katrina hurricane, and the 2008 Wenchuan earthquake cost $155 billion, $220 billion, and $195 billion, respectively, and those recoveries continue. The five costliest years for disaster losses occurred since 1995, with annual losses between $120 billion and $220 billion (Zakour, 2012b). The increase in annual economic losses is partly explained by the growing scale and globalization of technological, economic, and social systems (Zakour, 2010).

Another reason for the upward trend of damage costs is the population increase in unsafe geographic areas, particularly near coastal and river delta areas. In developed nations with an aging population, such as the USA, large numbers of older people are relocating to or retiring in coastal areas (Cutter, 2006). In less developed countries, increasing numbers of people reside in unsafe coastal areas with land less than three feet above sea level. The increasing numbers of landless and poor

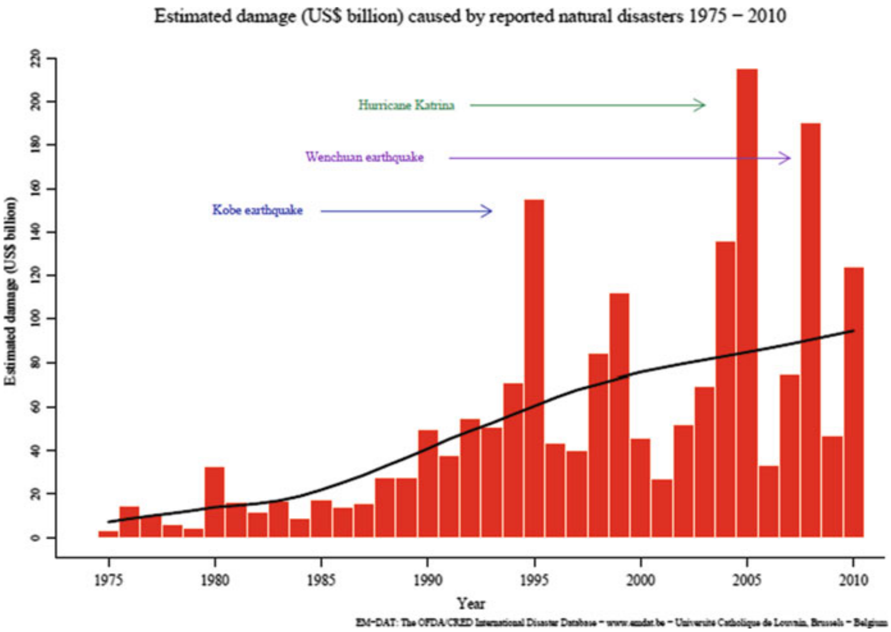

Fig. 1.4 Estimated damage (US$ billion) caused by reported natural disasters 1975–2010

households residing in these geographic areas are contributing to the rising costs from disaster damage.

Given the impoverished status of these households, birth rates are higher than in developed nations because poor families must rely on relatively larger numbers of children to engage in labor and supplement family income. For these families, being landless and poor leads families to reside in hazard-prone areas such as low-lying delta islands, deforested hillsides, and even large garbage heaps. Young children are more vulnerable to disasters than adults, and children increasingly live in households residing on the most hazard-prone land (Wisner, Blaikie, Cannon, & Davis, 2004).

An additional reason for the growing cost of disasters is global climate change (Field et al., 2012). The disaster vulnerability of populations in less-developed communities has increased as global climate change and environmental degradation make larger percentages of land areas at higher risk for disasters [Intergovernmental Panel on Climate Change (IPCC), 2007]. Worldwide, 2005 was the warmest year on record since global weather records began in 1880 and 2010 set a new record. Rainfall patterns are already shifting and dramatically changing in regions such as Africa and the Middle East.

Global climate change is leading to less predictable and more destructive weather patterns, and more powerful and destructive coastal storms (Intergovernmental Panel on Climate Change, 2007). In 2005 there were a record 28 named tropical storms and hurricanes in the Atlantic basin. Hurricanes Katrina and Wilma in 2005 and the 2008 Myanmar (Burma) cyclone are consistent with this trend toward more powerful storms (Zakour, 2012b). An increase in storm intensity and in related flooding means that hillsides and landfills on which some populations reside will experience more avalanches and landslides.

Worldwide, increasing average temperatures lead not only to droughts and more powerful storms, but also to the rise in mean global sea levels. Sea level rise is from expansion of warming water, and melting of glaciers and the polar ice cap. The rise in mean sea levels since the beginning of the industrial revolution is a fact, and will continue for decades or centuries as excess heat works its way to deeper levels of the oceans, greatly expanding the volume of water in the world's oceans and seas. At current rates of sea level rise, mean sea levels will rise about three feet by the end of this century (Field et al., 2012), leading to increased damage from tsunamis, hurricanes, and coastal floods (Greene & Greene, 2009). Rising sea levels are likely to inundate freshwater river deltas, such as the Mississippi, Nile, and Mekong Deltas. Higher sea levels will damage wetlands and formerly arable land, killing wildlife important for the food supply of nations such as the USA, Egypt, and Vietnam (Zakour, 2008b). Another result of increased sea level is greater pressure on freshwater supplies, as population increases and freshwater deltas are inundated by salt water.

With rising sea levels and increasing numbers of families with young children living on land vulnerable to flooding, the trend of increasing numbers of disasters seems likely to continue for the rest of this century. Weather hazards will likely increase in number and particularly in severity as global climate change proceeds (Field et al., 2012). Accompanying this trend is increasing economic losses for greater numbers of people each year. This is likely to lead to a great increase in health, mental health, and psychosocial problems, including posttraumatic stress disorder (PTSD) (Intergovernmental Panel on Climate Change, 2007). This decrease in the well-being of populations because of disasters is a global phenomenon, though climate change has already disproportionately affected less-developed countries and impoverished communities and regions, especially in Africa [International Federation of Red Cross and Red Crescent Societies (IFRC), 2008]. Currently, livelihood losses and decreases in wellness have been greatest in less-developed regions (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002; Wisner et al., 2004).

The disruptive effects of disasters on communities can become long-lasting (Zakour, 2010). These chronic disasters have been called a "new species of trouble" (Erickson, 1994). The adverse effects of disasters are more persistent than they were in previous decades, even in developed nations like the USA. For example, 5 years after Hurricane Katrina, only about half of the residents living in the City of New Orleans before Hurricane Katrina had returned to reside in the city. Katrina destroyed nearly 80% of the city's buildings (Zakour, 2012a). During Katrina, chemical spills in St. Bernard Parish in southeast Louisiana made half of that county uninhabitable for years. Heavy metal contamination, including mercury and arsenic, accompanied flooding of New Orleans.

In 2010, as the result of an explosion at a drilling platform which killed 11 people, there was a massive oil spill south of the delta of the Mississippi. Oil from that spill first reached Louisiana in almost exactly the same land area where Hurricane Katrina made landfall nearly 5 years earlier. This environmental disaster has killed wildlife and damaged the fragile infrastructure of freshwater wetlands and tidal lakes surrounding the New Orleans area. The total damage from the Gulf of Mexico drilling platform explosion and resulting oil spill in the Gulf will not be known for years. Some effects of large oil spills in an ocean or gulf may not manifest for years, and then can continue for decades or generations. Many of these effects are currently unknown but could include long-term contamination of seafood, water supplies, the regional water table, and wildlife areas. The possibility of an impact on future generations may produce fear in affected communities, and this fear of the unknown may produce more social disruption than the hazard itself. Environmental catastrophes can produce collective deprivation for generations, and there may be no low point or known endpoint for these types of emergencies (Renfrew, 2009).

Disasters as Community Disruption

Disasters from a social work perspective encompass the community-wide disruption of the social, economic, and environmental conditions necessary for well-being (Streeter, 1991; Zakour, 2007). Community systems in non-disaster situations produce the conditions necessary for survival, health, and needs attainment (Streeter, 1991). Social work research on life-span development conceptualizes disasters as a severe type of stressor (McFarlane & Norris, 2006) with a major impact on the psychosocial functioning of individuals (Greene & Greene, 2009). These conceptualizations focus less on the natural or technological hazard itself and more on the disruption of community functioning. This makes sense from theoretical and practical perspectives because it is not possible in most cases to eliminate the occurrence of hazards (Gillespie, 2008a, 2008b, 2010; Zakour, 2008b). Hazards are very difficult forces to control, especially natural ones, and it will be impossible in the foreseeable future to prevent or control hazards such as earthquakes, tsunamis, tropical cyclones, tornados, and floods (Zakour, 2010).

Immediate outcomes of disasters are influenced by the type of disaster hazard. In tropical cyclones (hurricanes, typhoons, tropical storms) impacts include the loss of livestock, housing, and implements; the destruction of livelihoods of poor households; and finally the salinization of agricultural land. Salinization means that salt and other minerals cover agricultural land, making some areas unproductive for decades. Household members die and are injured at a disproportionately high level for poor populations and communities. People in these communities suffer high losses relative to their total assets of buildings, livestock, crops, and arable land.

The immediate effects of floods include land loss from erosion and crop loss. Homes and other assets are lost or damaged, and illness or injury prevents resumption of livelihoods. Animals depended on for agricultural activities are lost, injured, or sick. Evacuation may occur but often there will be an inability to return, along with increased insecurity in a new setting. There are immediate deaths in the aftermath of flooding through drowning, and there are deaths which occur later from injuries, illness, and starvation (Wisner et al., 2004). In geologic disasters, including earthquakes and volcanos, when ground shaking and fires occur together, they result in severe damage and loss of life. In the Kobe earthquake disaster (1995), the primary impact was earthquake ground shaking, and the secondary impacts were fires. Both impacts together resulted in some of the highest damage ever recorded in a Japanese earthquake.

Disasters as community disruption tend to unfold and develop over time, leading to collective stress and biological, psychological, and social dysfunction (Barton, 1969, 2005; Norris, Tracy, & Galea, 2009). Major disasters often involve many types of loss and trauma, including serious personal injury or death of a close family member or friend. Accidents and hazardous environmental conditions which continue into the rebuilding phase of a disaster often contribute to stress from disasters. Environmental destruction can lead to severe health problems from exposure to toxic chemicals, and from mosquito-borne and other contagious diseases (Bourque, Siegel, Kano, & Wood, 2006).

Environmental stressors in disasters have to do with the transactions between persons and their physical environment. They include environmental worry and ecological stress from continued disruption during rebuilding. The destruction of organizations and businesses can add to unemployment, especially if organizations permanently relocate outside of the local geographic area (Tierney, 2007). In traditional societies, disasters may have additional meaning when natural resources are destroyed, as in the case of oil spills in Alaska and the Gulf Coast. The destruction of natural resources damages livelihoods and has detrimental cultural effects. When natural resources are destroyed, the means through which cultural values are passed down inter-generationally can be impaired. Since natural resources provide a basis for social exchange, the nature of social capital and social organization of the affected cultures can be permanently altered (Norris & Wind, 2009; Oliver-Smith, 1996).

Norris, Friedman, Watson, et al. (2002) and Norris, Friedman, and Watson (2002) identified a number of disaster mental health outcomes. The first type of outcome is specific psychological problems. These have been observed through studies of disaster mental health (Norris & Elrod, 2006). The most common symptoms of these specific psychological problems are the same as those of PTSD. The second most common symptom is depression. The third most common post-disaster symptom is anxiety, especially generalized anxiety. Less-frequent observed symptoms include phobias and panic disorders.

In addition to psychological symptoms, another set of outcomes is nonspecific distress-related symptoms, which include higher levels of arousal such as elevation of various stress-related symptoms. Nonspecific distress has been measured quite often in studies of disasters (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002). Other symptoms of nonspecific distress are demoralization, perceived stress, and negative affect. Besides, psychological disorders and nonspecific stress are health problems and concerns. Illnesses such as cardiovascular disease and respiratory problems are exacerbated by this stress (Niederhoffer & Pennebaker, 2009). There may be somatic complaints or psychosomatic complaints. An extremely common health concern after a disaster is disruption of sleep. Alcohol consumption also tends to increase, especially in those who drank frequently before the disaster. There is also a general increase in the relapse of health or mental health problems which existed before the disaster.

Another set of outcomes that occur during disasters, distinguishable from disaster health and mental health symptoms and disorders, are chronic problems in living. These kinds of outcomes have not been assessed very frequently in disasters but anecdotally they seem to occur widely (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002). Some examples of problems in living are hassles or life events that serve as stressors. These secondary stressors are related to interpersonal relationships, new family strains, and family conflicts. Other secondary stressors are work related, such as occupational and financial stress. When stressors existed pre-disaster, these chronic problems in living are exacerbated in disasters. Many of the stressors or problems in living act as mediating variables. They usually mediate or intervene between severity of disaster exposure and the chronic psychological or health outcomes of disasters (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002).

This rise in health and mental health problems in a disaster is made worse by the displacement or destruction of health and medical services organizations. Formal and informal resources may be depleted in a community as it responds and tries to meet the needs of the many individuals affected by the disaster (Zakour, 2012a). Social resources are very important for individuals and groups to become and remain disaster resilient (Zakour, 2010). The deleterious impact of the disasters on networks of support and the social resources embedded in these networks can severely limit resources, and reduce disaster and day-to-day resilience. For populations which were economically and socially marginalized before the disaster occurred, this loss of accessible social resources is likely to have a strong negative effect on resilience. If an impoverished population was close to the survival level in terms of resources, even a minor disaster could create a crisis in resources needed for survival and well-being (Cardona, 2004).

To sum up this brief overview of disasters, we note that disasters are triggered by hazards which are potentially destructive forces present in every community. The constellation of destructive forces is always changing. For example, there are increasing numbers of people moving to unsafe geographic areas. Climate change is raising the percentage of land areas at higher risk for disasters. Changes of this sort can be long-lasting and sponsor chronic disasters. In addition, the increasing system interdependences around the world are raising the occurrence of complex mixtures of natural and technological disasters, such as the 2011 earthquake–tsunami–nuclear power disaster in Japan. From the social work perspective, disasters represent the disruption of social, economic, and environmental conditions necessary for the well-being of a community and its members.

Social work research seeks to understand how and why communities become disrupted from disaster events, to document the extent of disruptions, and to identify or create ways of mitigating or reducing the amount and kinds of disruption and associated negative consequences stemming from disasters. Disaster vulnerability theory is focused on how and why communities become disrupted. The focus of this theory overlaps extensively with the populations and communities served by social work. The generality of the theory covers the full range of circumstances social work incorporates. There is tremendous promise for our communities through applications of disaster vulnerability theory in the hands of social work researchers, human service professionals, emergency managers, community organizers, and others working to strengthen the resilience of our communities. We turn now to a brief overview of the theory of disaster vulnerability.

Disaster Vulnerability Theory

The concept of vulnerability has been recognized as a bridging idea with the potential to link research findings about disaster across disciplines and hazards (McEntire, 2004a, b). Vulnerability can encompass each stage of disaster and every kind of hazard. The concept of vulnerability has theoretical and practical significance in a wide range of disciplines and professions (Gillespie, 2008a, 2008b, 2010). The emerging theory of vulnerability not only draws on traditional methods of disaster mitigation, preparedness, response, and recovery but also expands the boundary of disaster by fusing with other areas such as environmental sustainability, terrorism, and social development. Integrating these streams of research across types of hazards and stages of disaster holds significant promise for generating and testing hypotheses about the effectiveness of various interventions to reduce disaster losses (Cutter, 2006). Vulnerability theory has the potential to make theoretical generalizations about disasters across populations, and social and cultural contexts (McEntire, 2005).

Because hazards themselves are not preventable, decreasing the vulnerability of populations and communities is the most direct means of minimizing losses and achieving effective and timely recovery after disasters (Gillespie, 2008a, 2008b, 2010). Vulnerability is defined as the level of community susceptibility to disasters compared to their level of disaster resilience (Zakour, 2010). Details on community susceptibility to disasters are presented in Chap. 3 as we elaborate on the theory of disaster vulnerability, and information on disaster resilience is covered in Chaps. 4 and 10 as the complement to community vulnerability.

Vulnerability theory fits within a systems theory framework to understand disaster causation and to intervene at points along the causal chain creating vulnerability (Oliver-Smith, 2004). Vulnerability theory has generated a wealth of new ideas and models about the causes of disaster, causes grounded in social and cultural systems. Accordingly, this theory promises insights into social and cultural theory. By validating vulnerability models that inform practices at each stage of disaster, levels of community susceptibility to disasters can be reduced. Fostering increased community resilience is also likely to reduce community susceptibility and vulnerability to disasters (McEntire, 2004a, b).

Vulnerability theory directs our attention to the social and cultural patterns governing the structure of our communities. Community structures vary widely around the world. Although every region of the world has hazards, the losses from disasters occur disproportionately in undeveloped countries and in the poorest communities of developed countries. The Centre for the Epidemiology of Disasters (CRED) reported that on average over 200 million people suffered losses from disasters each year between 2000 and 2011 (CRED, 2011). These losses are preventable.

According to vulnerability theory, community vulnerability to disasters is not equally distributed among nations or regions of the world. Though absolute economic losses from natural disasters are usually highest in developed nations such as the USA and Japan, the number of people killed or affected by disasters per 100 thousand inhabitants is highest in less-developed and developing nations and regions such as sub-Saharan Africa (http://www.emdat.be/).

At the same time that interdependence and fragility of global systems has increased, social and economic globalization has reduced cultural and adaptive heterogeneity in traditional societies (Oliver-Smith, 2004). Almost 80% of all deaths from disaster in the decade after 2000 were in less-developed or developing nations. These developing nations included Myanmar (Burma), the People's Republic of China, Thailand, Indonesia, the Philippines, and Haiti [United Nations International Strategy for Disaster Reduction (UNISDR), 2009].

Over the past few decades, the number of people affected by disasters has continually increased, yet the number of reported natural and technological hazards has recently begun to recede (compare Fig. 1.3 and Fig. 1.1). These trends support the assumption that it is not primarily the characteristics of hazards that account for disaster losses. Instead, social, cultural, and political-economic conditions preceding and present when a hazard occurs are the primary determinants of disaster loss.

The use of vulnerability theory with its expanding knowledge of disaster vulnerabilities and resilience promises a significantly greater understanding of the societal and environmental forces that contribute to the occurrence of disasters (Wisner et al., 2004). An improved understanding of the environmental, social, cultural, economic, and political causes of disasters will form the basis for new community interventions that reduce vulnerabilities and increase resilience in communities (Oliver-Smith, 2004; Zakour, 2010). The ultimate value of vulnerability theory lies in reducing disaster losses and fostering community capabilities and disaster resilience (Gillespie, 2008a, 2008b, 2010).

The level of disaster vulnerability in communities is the degree to which community social systems are susceptible to loss and damage from disasters relative to their level of disaster resilience (McEntire, 2007a, b). Disasters occur when a hazard impacts people and their communities operating in an unsafe environment. As noted above, disasters disproportionately affect poor and socially marginalized communities (Zakour, 2010). These communities also suffer relatively greater numbers of disaster deaths and other casualties and lose a higher proportion of total household wealth than do affluent or developed communities. Natural disasters are recognized as human-caused disasters and they are increasing in severity, and leading to big reductions in development levels and well-being of affected societies and regions (UNISDR, 2009).

Low-income communities are generally vulnerable to disasters. This vulnerability arises from social conditions and limited access to resources. Lower-income families live in housing less able to withstand the destructive forces of natural hazards. Inner-city areas in which many low-income households reside have older buildings and infrastructures including roads, bridges, sewerage, and water systems. Also low-income and older people tend to reside in unsafe areas and undesirable neighborhoods prone to disasters because they have lower rents and housing costs. Because of de facto segregation and the concentration of poverty, poor households are less able to receive financial or other help from neighbors or kin, who are likely to have suffered disaster losses themselves (Zakour, 2010).

Vulnerability research in disasters may be particularly helpful in complex emergencies, which are a combination of natural or technological disasters and human-caused conflict. There will be differences among the psychosocial impacts of different types of disasters such as hurricanes and terrorist attacks, but these differences are likely to result from the severity, duration, and geographic extent typical of each type of disaster (Norris et al., 2008). Vulnerability theory hypothesizes that all disasters originate in human agency. However, in disasters involving violence, the intent of some actors to physically harm or kill others adds an extra level of fear and anger to the psychosocial effects.

Niederhoffer and Pennebaker (2009) claim social support is the single most important determinant of well-being after a traumatic experience. While greatly increased social support is needed to cope with the loss and trauma from disaster, social support networks of individuals, groups, and formal service organizations are less accessible, disrupted, or damaged after a disaster (Zakour, 2010). The loss of human service organizations in large-scale or regional disasters may make obtaining services needed for recovery more difficult or even impossible. Given damage to the social support systems in a disaster, the need for support among disaster survivors may far exceed available social support and formal services for months or years (Norris, Murphy, Kaniasty, Perilla, & Ortis, 2001). The theory of vulnerability is helping us understand how to improve the structure of support systems.

Social Work and Vulnerability Theory

Social work research, education, and practice have important roles to play in understanding disasters and reducing disaster losses. Social work examines and intervenes in systems at all levels, from the individual to nation states to global initiatives. This orientation is consistent with the conceptualization of disasters as affecting systems at all levels. Social work is interdisciplinary in nature, and the study of disasters and disaster interventions is based in many disciplines such as sociology, geography, anthropology, civil engineering, public health, and disaster medicine. Social workers also seek to change social, economic, political, and environmental systems to improve the well-being of clients. Finally, social work focuses on vulnerable populations as the profession's core clients. Vulnerable populations include the very young and very old, low-income people, less-developed communities, women, persons with health or mental health difficulties, and persons with disabilities. These populations are also more likely to be vulnerable in disasters.

Social work is currently responding to the heightened disaster vulnerability of older adults, people of color, and low-income households which are often female-headed households with young children (Zakour, 2010). These populations have been historically served by the profession (Minahan & Pincus, 1977). The populations served by social work are more vulnerable in part not only because of the unequal distribution of the resources needed for disaster resilience but also because of poor understanding about how to use what they have to maximize safety. The practical orientation of vulnerability theory leads its adherents to first consider the optimal use of existing resources for maximum safety.

Ultimately, however, vulnerability theory implies a redistribution of societal resources. The theory of vulnerability is driven by assumptions governing distributive justice. Distributive justice is the condition in which all people in a community and all communities in a society have equal access to resources needed for overall well-being and resilience in the face of adversity. This social justice approach is consistent with disaster vulnerability theory in that it seeks to change conditions in the social and physical environment to prevent negative outcomes such as community dysfunction stemming from disaster disruptions. Given the central importance of social justice in social work research, education, and practice, it is apparent that vulnerability theory has an important place in disaster research and intervention (Gillespie, 2008a, 2008b, 2010).

Preview of Book Chapters

In this book we examine the concepts, questions, and research methods used in the theory of disaster vulnerability. Chapter 2 describes the current state of vulnerability theory in relation to assumptions made and methods used. The main core of the chapter is devoted to describing the assumptions that define the framework guiding vulnerability theorists. In Chap. 2 we describe the general framework of disaster vulnerability theory. We begin with an overview that gives a brief account of the origins of the theory, and we discuss its recent reemergence in several different disciplines and professions including social work. We discuss the classification of environmental variables as liabilities and capabilities. We spell out the reasons why it makes sense to work with and advance this theory.

Chapter 3 expands the boundary of vulnerability theory by linking with ideas from the social development perspective. This chapter presents the social development perspective and considers its contribution to vulnerability theory. We draw heavily on the work of Wisner et al. (2004) who have done much to lay the foundation of vulnerability theory. These theorists contend that too much emphasis has been devoted to natural hazards (e.g., the water, earth, or wind conditions that trigger disasters) and not enough emphasis has been given to the social processes that influence the ways hazards and disasters affect people and communities. They view the natural environment as inextricably bound with the social, economic, and political environments.

Chapter 4 adds details regarding the resilience perspective. A community's vulnerability and resiliency are intertwined and work together to mutually strengthen or weaken the community's capacity to respond and recover from disaster. Resilience refers to the ability of an individual, group, or community to cope with adversity. It emerges after a disaster or stressful event. This coping with adversity means to recuperate or return relatively quickly to a previous state of normal functioning, or to recover better than expected. Resilience is most widely understood as a process, not as a characteristic of individuals, groups, or communities. In order for resilience to become recognized in vulnerability theory and useful in disaster recovery it needs to be more carefully conceptualized and reliably measured (Norris et al., 2008).

Chapters 5–9 cover the findings from early as well as recent research methods used in studying disaster vulnerability and resilience. Vulnerability theory has been established and is being developed with linear hypothesis testing methods, with nonlinear descriptive methods, and with nonlinear explanatory methods. Our account of vulnerability theory is documented to the extent possible with evidence-based research on community disaster vulnerability. We consider research questions in conjunction with the methods used because different kinds of questions require particular methods (Gillespie & Streeter, 1994), and this relationship is not always understood by researchers (Benight, McFarlane, & Norris, 2006).

Chapters 5 and 6 focus on linear methods for hypothesis testing, and Chaps. 7 and 8 deal with nonlinear descriptive methods of vulnerability research. In Chap. 7 we discuss how geographic methods are used to describe the locations, depth, and extent of disaster vulnerability. These methods produce descriptive information. Identifying specific locations of vulnerability, describing how these locations are distributed, and documenting trends have provided support for five of the general assumptions underlying vulnerability theory. In Chap. 8 we discuss research findings from social network analysis relevant to vulnerability theory. The application of network analysis to vulnerability theory has been quite recent and limited. Nevertheless, network methods are well suited to address several of the general assumptions underlying vulnerability theory.

In Chap. 9 we describe system dynamics, reveal how it has been used to refine and extend theory, and discuss an application showing how a system dynamics simulation model contributed to the disaster policy and planning process. Simulation models offer representations of community systems and give emergency managers and other decision makers the opportunity to ask "what if" questions about their policies and the conditions that exist in their communities. System dynamics can be used to explore ideas, describe situations, and to test hypotheses and explain situations. Modeling system causes and describing how the system changes over time provide explanations and offer the potential of identifying leverage points or strategic places to intervene in the system (Senge, 2006).

In Chap. 10 we join vulnerability and resiliency theories, showing their similarities and describing resiliency theory as complementary to vulnerability theory. Resiliency theory is joined to vulnerability theory to create vulnerability$^+$ theory. We discuss the core variables in vulnerability$^+$ theory, and propose a causal model of the progression to vulnerability or resiliency. We examine the future of vulnerability research, with a focus on root societal causes, resources, social development, and liabilities and capabilities. Further research on vulnerability and resilience promises to continually improve the practice of disaster social work, as well as interventions aimed at community empowerment and social and distributive justice. Finally, based on the findings in this book on vulnerability and resilience, and on the proposed causal model, suggestions are offered to improve social work disaster practice.

Chapter 2
Vulnerability Theory

In this chapter we describe the general framework of disaster vulnerability theory. We begin with an overview that gives a brief account of the origins of the theory, then we discuss its recent reemergence in several different disciplines and professions including social work, and finally we spell out the reasons why it makes sense to work with and advance this theory. We discuss the classification of environmental variables as liabilities and capabilities. These two kinds of variables form the bedrock of vulnerability theory. We briefly introduce a number of variables that have been found to characterize vulnerable populations. The main core of this chapter is devoted to describing the assumptions that define the framework guiding vulnerability theorists. These assumptions clarify the nature of the vulnerability concept and broadly outline the causal texture of the system environments within which vulnerability rises and falls. In later chapters we refine this initial conceptualization and draw on empirical evidence relevant to vulnerability theory to establish its utility, identify aspects in need of revision, and to further enhance the theory.

Overview

Disaster vulnerability theory seeks to explain the susceptibility of individuals, groups, organizations, communities, and countries to losses from disaster. The basic idea of vulnerability is practical and easily understood. For example, Oliver-Smith and Button (2005) define vulnerability as a ratio of risk to susceptibility. The vulnerability concept first surfaced in the 1970s when it was noticed that the losses from disasters were rising while the number of disasters remained about the same (O'Keefe, Westgate, & Wisner, 1976). O'Keefe et al. also noticed that disasters of the same magnitude produce dramatically different consequences, such as the 73,338 lives lost in the 2005 Pakistan 7.5 earthquake versus the 68 lives lost in the 1989 Loma Prieta, California, 7.5 earthquake (http://www.emdat.be/). These scholars reasoned that since the number of disasters was constant while losses and

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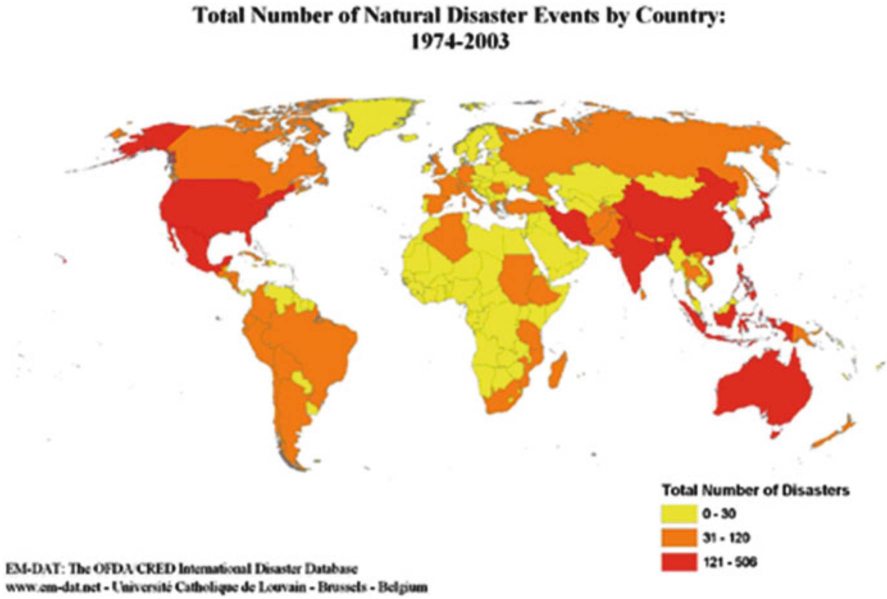

Fig. 2.1 Total number of natural disaster events by country: 1974–2003. *Source*: http://www.emdat.be/natural-disasters-trends

cost were rising, and the same magnitude disasters in different regions had dramatically different consequences, the causes had to be rooted in social system.

The importance of root societal causes in determining the consequences of disasters is shown in Figs. 2.1 and 2.2. The number of disasters from 1974 through 2003 is widely distributed throughout the world, in both developed and less-developed nations. In the first figure, the global north experienced a relatively high number of disasters, as shown by the shading of nations in North America, Europe, and Australia. However, when the number of persons who were killed or affected by disasters is displayed (number per 100,000 people), the global north has much lower rates of disaster casualties (http://www.emdat.be/).

The idea of vulnerability was recognized as a central focal point in reducing losses from disasters. Hewitt (1983) assembled the first anthology of scholarly work on vulnerability. Cuny (1983), Wijkman and Timberlake (1984), and others pursued the promise of vulnerability. However, this early interest in vulnerability theory declined during the 1980s. Some criticized the theory as deemphasizing personal responsibility and oversimplifying the problem. For example, in this initial work vulnerability was measured simply by proximity to a hazard zone, such as living on a flood plain, hurricane path, or in an earthquake hazard zone. In addition, this early work on vulnerability was framed in Marxism, and interest in Marx declined at the end of the cold war. Vulnerability theory appeared to be dead by 1990 when the Berlin wall came down. But any announcement of its death was premature.

Work on vulnerability resurfaced in the early 2000s as an encompassing idea because of its flexibility and capability of integrating the wide spectrum of issues

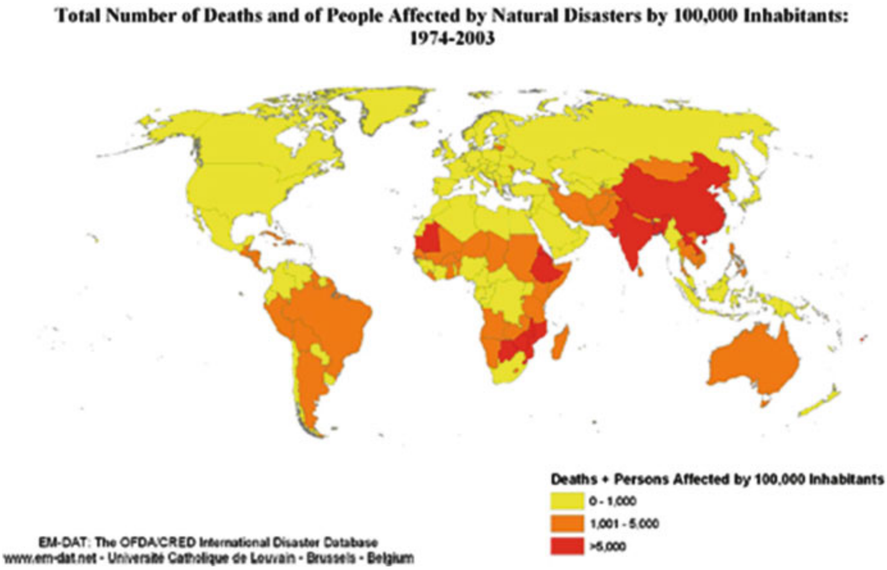

Fig. 2.2 Total number of deaths and of people affected by natural disasters by 100,000 inhabitants: 1974–2003. *Source*: http://www.emdat.be/natural-disasters-trends

and challenges involved in reducing the casualties and damage from disasters. McEntire (2004a, 2004b, 2005) in public administration, Villagran De Leon (2006) in physics, Oliver-Smith (2002, 2004) in anthropology, and especially Wisner, Blaikie, Cannon, and Davis (2004) in geography began refining and extending the original work of O'Keefe et al. (1976) and Hewitt (1983). The current work on vulnerability is not conceptualized from a Marxist perspective, but it is still sharply focused on changing the system. This focus is consistent with social work values and practice. In social work, the primary conceptual foundation for vulnerability is social and especially distributive justice (Soliman & Rogge, 2002; Zakour, 2010).

In addition to the fit with social work values and practice, there are good reasons for social work researchers to develop and make use of vulnerability theory (Zakour, 2010). First, there is not much we can do to prevent natural hazards, but we can reduce vulnerability. Second, vulnerability relates to and encompasses every kind of hazard and disaster. Third, vulnerability takes into account both positive (e.g., protective factors) and negative (e.g., risk factors) features of social systems (Bonanno & Gupta, 2009). Fourth, vulnerability is a function of many variables representing different disciplines and professions. Fifth, vulnerability is continuously changing, and it must be periodically reappraised. Sixth, there are things that can be done during each phase of disaster, from mitigation to reconstruction, to reduce vulnerability. Vulnerability theory offers social work a way to build on its roots, contributes significantly to the disaster field, and reduces disaster losses (Gillespie, 2010).

Vulnerability results most directly from unsafe conditions. This lack of safety includes dangerous locations, unprotected infrastructures, and a lack of disaster preparedness

(Wisner et al., 2004). Unsafe conditions are illustrated by the disaster vulnerability of low-income communities. Low-income families tend to reside in unsafe areas and undesirable neighborhoods that are prone to disasters, but are cheaper to rent or own. Housing in these neighborhoods is typically less able to withstand the destructive forces of disasters. These houses are often uninsured (Peacock & Girard, 1997). Inner-city areas with many low-income households have older infrastructures—roads, bridges, sewerage and water systems, and public buildings. Lack of an automobile is another problem for low-income households, which are disproportionately made up of people of color, females, and children under five years old (Zakour & Harrell, 2003). Poor households are less able to receive financial or other help from extended-family, neighbors, or other community members before or during a disaster (Zakour, 2010).

As an estimate of a future state of the system, disaster vulnerability is expressed as a probability. Specifically, vulnerability is estimated as the probability of disturbance from a hazard and the severity of the resulting disaster. Probabilities of disaster are calculated for specific areas and time periods (Chakraborty, Tobin, & Montz, 2005). For example, people living along the central Gulf Coast of the USA have a 0.125 probability of experiencing hurricane-force winds (74 miles per hour or greater); that is, they can expect a hurricane on average once every 8 years.

Vulnerability includes the extent and severity of damage that is likely to occur to the functioning and well-being of people and social systems (Wisner et al., 2004). For individuals, the adverse effects on biopsychosocial functioning may range from minimal to extremely severe, especially for those who are seriously injured during disaster. To stay with the hurricane example, single-parent households with several young children living in a trailer near the Gulf Coast can expect a category 1 hurricane (74–94 mph) to destroy their homes and cause serious injury to one or more of the children, assuming the household does not evacuate. Additional losses are likely to result from lack of access to medical care, and lack of homeowners' insurance.

McEntire (2004a, 2004b) conceptualizes disaster vulnerability as having four components: susceptibility, risk, resilience, and resistance. Susceptibility is the likelihood of people suffering harm or hardship stemming from disaster. Some authors consider risk to be interchangeable with susceptibility (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008), but McEntire considers risk as applying only to the physical structures and assets of a community. Resilience is the ability of a social system to resume functioning in an adaptive manner following disaster; we review the work on resilience in Chap. 4 and combine it with vulnerability theory in Chap. 10. Resistance is the ability of physical structures such as buildings or road systems to withstand a disaster hazard without damage. Resistance is studied primarily by physicists and engineers (McEntire, 2008).

Vulnerability to disaster is affected by both the physical and social environments. The physical environment subsumes the natural, built, and technological environments. The social environment includes the economic, political, and cultural environments. More specifically, social environments are reflected in the values, norms, beliefs, and other cultural characteristics governing a system (Zakour, 2010). Variables in the physical and social environments are classified as liabilities or capabilities (Gillespie, 2008b, 2010; Zakour, 2008b, 2010). Variables that are liabilities cause increases in susceptibility to disaster while variables that are capabilities cause decreases in susceptibility to disaster.

Liabilities and Capabilities

Liabilities

Liabilities are environmental characteristics that magnify the effects of stress, adversity, or loss. In other words, liabilities increase the probability of disaster, amplify the harmful effects of disaster, and dampen the response and recovery processes. Liabilities in the environment increase the disaster vulnerability of social and cultural systems. Some liabilities are ubiquitous yet nearly invisible because they are embedded in our everyday routines. These liabilities are conceptualized as root causes of vulnerability (Blaikie, Cameron, & Seddon, 1980). They include limited access to political power, low levels of social and natural environmental resources, and lack of access to resources. Ideologies that justify political and economic inequality are among the liabilities and root causes that increase disaster susceptibility.

Other more immediate and visible liabilities are conceptualized as structural forces that combine with root causes to increase disaster vulnerability (Wisner et al., 2004). These include aging and unprotected physical infrastructures, low incomes, endemic disease, and poorly functioning institutions or lack of social institutions providing resources for people (McEntire, 2009). Less-developed communities and regions also suffer disproportionately from social problems such as hunger, mental illness, drug and alcohol abuse, homelessness, poverty, and violence. All of these liabilities lead to a high level of disaster susceptibility and can result in increased trauma, loss, and severe stress reactions (Bolin, 2007).

Additional liabilities that lead to increased vulnerability include female roles, endemic poverty, racism, a history of colonial exploitation, imbalances in trade, and underdevelopment. Research in Africa shows that economic pressures associated with colonialism and global trade create unsustainable practices that increase local vulnerability to hazards (Mascarenhas & Wisner, 2012). In some parts of the world, such as the African Sahara, people have long had to deal with social disruption triggered by drought, famine, and political insecurity. These disruptions have sometimes been anticipated events, but local adaptive strategies can become strained by the larger scale of global vulnerability. For example, global climate change and industrial agriculture have caused habitat loss of smallholder farmers who formerly preserved plant and animal biodiversity in their local areas. The loss of biodiversity has meant overexploitation of soil, and greater vulnerability to loss of crops from plant diseases (Girot, 2012). This has accompanied the transformations inflicted on indigenous societies since Western contact, colonialism, industrialization, and incorporation into the global market (Henry, 2007).

Developing countries lack funding for education, equipment for disaster prevention, response, and recovery. These countries are highly vulnerable to disasters because of impoverished living conditions and poor warning systems. In less-developed countries, building codes are rarely established or enforced. Squatter towns in Bhopal, India were built near the Union Carbide chemical plant. This pattern of close proximity is partly responsible for the high death rate from the fugitive emission from the Union Carbide plant. Location in coastal areas is a liability that increases community disaster vulnerability. Many villages in coastal Thailand, Sri Lanka, and India were washed away during the 2004 tsunami (McEntire & Mathis, 2007).

Working with communities to mitigate environmental liabilities is a useful way to decrease community disaster vulnerability (Zakour & Gillespie, 2010). Root cause liabilities are a threat to social justice, particularly distributive justice. Reducing root cause liabilities may involve challenging ideologies that help maintain inequality and lack of access to resources. Mitigating environmental liabilities reduces the level of environmental injustice (Zakour, 2010).

Capabilities

Environmental capabilities reflect aspects of the social, physical, and natural environment which provide resources needed to mitigate, prepare for, respond to, and recover from disaster (Zakour, 2010). The capabilities of the environment are a form of capital. These resources include social, environmental, and physical capital. Social capital includes the tangible and intangible resources embedded in social networks and community social structures (Zakour & Gillespie, 2010). Many communities have substantial strengths and environmental resources, but marginal populations in these communities lack access to needed social and physical resources (Klinenberg, 2002).

Capabilities include political influence, economic assets, and societal ideologies in support of the dignity and rights of people to enjoy a high quality of life. Ideologies promoting social justice and altruism among different groups in a society, and the presence of institutions that reduce political and economic stratification, are examples of capabilities which reduce community disaster vulnerability. Emergency management organizations, disaster mitigation projects, and a coordinated network of disaster services organizations are also important environmental capabilities that reduce vulnerability and increase resilience (Wisner et al., 2004).

Additional capabilities include effective functioning of human services and emergency management organizations. More specifically, these capabilities include (a) access to services; (b) availability of responsive client-centered services including case management, case finding, case advocacy, outreach, brokering, and referral; (c) a sufficient number of disaster services organizations with adequate capacity, including sufficiently paid staff, trained volunteers as appropriate, and regularly updated disaster plans; and (d) disaster mitigation (prevention), preparedness, response, relief, and recovery organizations with a high level of organizational coordination

(Zakour, 2008b, 2010). A related capability includes adequate evacuation resources in the community and region (Zakour, 2008a).

Capabilities can also be part of the natural and physical environments of communities. Examples of natural environmental capabilities are the marshlands and wetlands below the city of New Orleans, Louisiana. The height of the storm surge from hurricanes is diminished by approximately one foot for every three miles of wetlands. The degree of wetlands replenishment versus erosion in South Louisiana will help to determine the destructiveness of future hurricanes. The scope and extent of wetlands also have a positive influence by preventing saltwater intrusion on land that is fed by freshwater. Saltwater intrusion destroys wetlands and hastens erosion (Wisner et al., 2004).

In developed nations, communities are likely to be able to acquire and mobilize resources (Meichenbaum, 1997). Affluent developed nations such as the USA have extensive resources and allocate both money and expertise for mitigation and preparedness measures in communities. Studies are often funded in developed countries to identify hazard prone areas and recognize appropriate measures of protection. Training systems are created to prepare disaster response teams. Developed nations have programs of education and technology to develop warning systems for the general public. As a result of higher levels of environmental capabilities, communities in developed countries experience lower numbers of casualties than do developing nations (McEntire & Mathis, 2007).

The availability of social capital is an important environmental capability. Social support in an emergency, including a disaster, is a type of social capital that is critical for recovery. Social support may act as a buffer against the negative outcomes of disasters, or support may increase wellness regardless of the presence of a disaster. Though social support is conceptualized as a capability, the effects of perceived support may be as or more important in reducing the negative effects of disaster (Kaniasty & Norris, 2009). Some examples of social support and social capital relevant to preparedness for children and families are access to warm relationships and guidance from family members and relatives, connections with one or more types of pro-social organizations, and access to high-quality education (Doll & Lyon, 1998). Other social capital environmental capabilities include civil society, high levels of social development, and a voluntary sector that is well coordinated to amplify the voices of constituents (Zakour, 2010).

Environmental capabilities vary across diverse cultural and geographic regions, and these capabilities are always subject to change. The types of capabilities and their levels differ according to the cultural, economic, and historical developments of a region (Pedrotti, Edwards, & Lopez, 2009). A strong voluntary sector, democratic institutions, and a vibrant economy are environmental capabilities governed by cultural patterns. Emergency management organizations and human services organizations with high levels of social capital are key examples of environmental capabilities directly relevant to reducing community disaster vulnerability (Zakour, 2010). Capabilities differ by historical, cultural, and geographical context (Putnam, 2000).

Vulnerable Populations

If different populations in a community have very different levels of vulnerability, then the community cannot expect to rapidly and fully recover from disasters (Norris et al., 2008). Disaster vulnerability is not a function of bad decisions at the personal or household level. Individual and household choices are constrained by liabilities such as unsafe social and economic conditions (Wisner et al., 2004). For example, in the Indian Ocean tsunami the psychological, economic, and social recovery of tsunami survivors has been closely linked to preexisting social and economic conditions. Many affected communities were small-scale fishing communities dependent on boats that were destroyed by the tsunami. Lacking insurance, boat owners continued to repay loans on vessels that were destroyed, as well as take out loans for new equipment (Kendra & Wachtendorf, 2007).

Socioeconomic status (SES) is consistently related to more positive and fewer adverse outcomes in disaster including mental health disorders, declines in functioning, and nonspecific distress. The effect of SES as a capability, or protective factor, has been shown in numerous countries and across cultures (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002). Most studies of SES treat it as a main effect in disaster mental health, while a few studies have shown SES to interact with severity of exposure (Kaniasty & Norris, 2009). Poor populations often lack resources to relocate away from unsafe and marginal land characterized by dangerous and unsanitary conditions. This places them at greater risk for disasters and limits their disaster recovery prospects. The poor also tend to have no property insurance or inadequate insurance. They have fewer resources in reserve for emergencies than do more affluent people (Peacock & Girard, 1997). Low-income individuals and indigenous rural peoples have developed self-protective measures over centuries. Many of these measures, however, such as houses built on higher land in south Asia, are used mostly by wealthier groups who live near village centers (Wisner et al., 2004).

Membership in an ethnic or other minority group is consistently associated with poor outcomes after a disaster (Hawkins, Zinzow, Amstadter, et al., 2009). Communities with high percentages of ethnic and racial minorities (Gabe, Falk, McCarty, & Mason, 2005), and which are rapidly increasing in population, tend to be the most vulnerable to disasters (Cutter, Boruff, & Shirley, 2003). Ethnic minority populations and communities are more susceptible to disaster stressors, and they are also more severely exposed to trauma (Norris et al., 2008). In some parts of the USA, minority group members migrate to areas with nearby chemical facilities, placing them at greater risk from chemical spills and toxic emissions (Mitchell, Thomas, & Cutter, 1999). Racial and ethnic minority populations are disproportionately in lower income categories.

Both minority status and poverty increase vulnerability because of reduced access to resources. For example, in the Northridge earthquake, recovery was influenced primarily by access to assistance and other social protections. Access to resources was influenced by class, race, and cultural factors. Disaster assistance was not targeted to renters, the unemployed, or the homeless (Bolin, 2007). Ethnic minority and poor populations are also more likely to appraise their prospects for disaster recovery through a fatalistic lens, which is associated with negative outcomes after disasters. Fatalism is often an objectively realistic cognitive schema for ethnic minority groups and poor people (Kaniasty & Norris, 2009). A lack of control over adversity, such as severity of disaster exposure, often leads to fatalism and an external locus of control (Meichenbaum, 1997).

Gender is associated with differences in post-disaster stress, distress, and health and mental health disorders (Bolin, 2007). Female survivors are more likely to be adversely affected in disasters (Gillespie, 2010). Gender differences are found within all age ranges, including young people, adolescents, and older adults. These differences are cross-cultural as well. It appears that female survivors fare worse than male survivors on all types of outcomes (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002). Men are more likely to abuse alcohol after a disaster, while females are twice as likely as males to develop posttraumatic stress disorder (PTSD).

Many political and economic systems in less-developed countries are male-dominated, and resources are allocated in favor of men (Norris, Baker, Murphy, & Kaniasty, 2005). Though women may disproportionately put efforts into disaster readiness and recovery, they may need to work harder in paid and unpaid work than men do, and they may be more prone to post-disaster disease (Ronan & Johnston, 2005). To the extent that young children are more likely to be cared for by women, their relative vulnerability is increased as well (Wisner et al., 2004).

Violence against girls and women is an issue after disasters. After disasters girls are also more vulnerable to sexual abuse and exploitation, especially if they are displaced girls. Abuse against girls and women was common after Hurricane Mitch in Nicaragua. In Cambodia women risked sexual assault when they involuntarily migrated to find work after flood disasters. After the 2004 Indian Ocean tsunami there were numerous accounts of violence against women and sexual exploitation of girls (Enarson, Fothergill, & Peek, 2007).

Research in North America shows similar patterns of vulnerability for women in disasters (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002). There are increased requests for services, and violence is also documented by the staff of antiviolence agencies. In the USA and Canada, intimate partner violence in particular tends to increase after disaster (Enarson et al., 2007). This is partly because police protection decreases, social control norms change, and laws regarding domestic violence or disputes are not consistently enforced. Women's disaster needs in the short and long term are often neglected. Among people over 65 with a disability, women are more likely than men to require additional assistive medical equipment during an evacuation, but most evacuation shelters do not provide this equipment (McGuire, Ford, & Okoro, 2007). Social class, race, ethnicity, and gender are interrelated in determining aid and resource qualification profiles. For example, after Hurricane Andrew poor women did not receive the assistance that they were entitled to because of a bias against female-headed households.

It is likely that there are moderating or mediating factors for the more negative outcomes females experience in disasters. For example, in Mexican culture, gender differences in disasters are greater than in Anglo-American cultural contexts.

However, African-American culture attenuates these gender differences, while non-English-speaking populations in Australia show gender differences closer to that of Mexican populations. Gender differences in outcomes may originate primarily with females' subjective interpretation of events, rather than solely because of objective severity of disaster exposure (Meichenbaum, 1997). Compared to men and boys, women and girls appraise damage from a disaster as more severe. It is also likely that women and girls suffer from an imbalance of social support received and support given to others. Wellman and Frank (2001) found that higher percentages of women among all actors in a network were positively associated with level of social support provided to network actors. Though females may receive substantial social support in disasters, their obligations to provide support to others outweighs the social support that they receive (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002).

Being a single or married parent increases the likelihood of adverse outcomes in disasters (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002). This relationship is strongest when young children are being cared for. In nuclear plant disasters such as the near-meltdown at Three Mile Island and radiation emissions from the Chernobyl nuclear power plant in the Ukraine, there was persistent (10 and 6 years post-disaster, respectively) fear concerning effects on children. For parents of young children, there was fear that nuclear radiation could adversely affect the health of children and of unborn future generations. Marital stress also increases during and after disasters. Levels of psychiatric symptoms for children are very strongly related to levels of symptoms of their parents. Greater psychopathology in parents often leads to lower levels of social support toward their children. Overall, parents' psychopathology and family atmosphere (level of irritability and supportiveness) are shown to be the best predictors of adverse outcomes in children (Meichenbaum, 1997).

In the USA the relationship between disaster susceptibility and age is curvilinear, with the greatest disaster effects seen in middle-aged adults. Middle-aged individuals not only experience greater effects in disasters, but they also provide more social support and receive less in return (Kaniasty & Norris, 2009). Another reason for the greater effects of disaster on middle-aged adults, compared to younger or older adults, is that middle-aged persons experience higher levels of chronic stressors and burdens. Though all three groups of adults (young, middle-aged, and older) receive considerable social support in disasters, middle-aged adults show an imbalance in support received versus support provided. They provide much more social support and help to others than they receive.

When age and severity of disaster effects are examined cross-culturally, findings regarding the relationships between age and disaster effects are inconsistent (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002). In some cases middle-aged women receive very high levels of social support. Mexican disaster survivors showed a negative and linear association between age and disaster effects, while Polish disaster survivors showed a positive linear relationship between age and adverse outcomes. In Mexico, younger survivors suffered the worst effects from disaster, while in Poland, older survivors were most affected. Differences in disaster effects associated with age are likely related to differing family lifecycles. Family roles and lifecycles are determined by cultural context. Young, middle-aged, and older adults may assume or achieve different roles and statuses according to cultural context. Rights and obligations related to social support and age are determined by culture. There is no one consistent relationship of age with disaster effects.

Assumptions

Theories are created through the assumptions they make. Vulnerability theory is based on 12 general assumptions. The first three assumptions cover the definition of vulnerability (#1), its distribution (#2), and its dimensionality (#3). The remaining nine assumptions set out a broad causal framework. This framework identifies the kind of variables that cause disaster vulnerability as well as their proximity to one another. Six of the assumptions are from vulnerability theorists and researchers.

These 12 assumptions are based on theoretical ideas from the disaster literature or from related literatures. For example, the first assumption is based on political ecology and development ideas (e.g., Collins, 2008a; McEntire, 2004a, 2004b). The second assumption is based on the idea that almost all communities are stratified along some dimension (e.g., Bottero, 2007). The third assumption is related to the conceptualization of disasters as all-encompassing experiences which impact every dimension of life in a community (Wallace, 1956a). Assumption six is based on the frequent association between demographic variables and environmental liabilities. External variables generally account for these relationships (see Rosenberg, 1968). Assumption 10 is derived from the importance of cultural and ideological variables, as well as shared meaning, in early theorizing on disaster (e.g., Barton, 1969; Wallace, 1956b). Assumption 11 is derived from stress and coping approaches (Raphaell, Cieslak, & Waldrep, 2009) which acknowledge the complex relationships among severe stress, protective factors (capabilities), and susceptibility. Some protective factors (capabilities) may only interact with severe stress to decrease susceptibility, others have only an independent effect on susceptibility, and yet other protective factors reduce susceptibility both as direct and interactive effects (see Neria, Galea, & Norris, 2009; Norris, Galea, Friedman, & Watson, 2006).

Vulnerability theory applies to any kind of social system. This generality is appealing to social work researchers because of the diverse range of people and communities studied. Table 2.1 lists the 12 assumptions in summary form. The rest of this chapter is devoted to expanding briefly on each assumption and also briefly referring to the empirical work covered in subsequent chapters that supports each assumption.

The first assumption is that vulnerability represents the reduced capacity of a system to adapt to environmental circumstances (Cardona, 2004). This assumption suggests that the rate and success of community development is a central pressure in the progression to disaster vulnerability or resilience (Zakour, 2010). Development is understood as a process of increasing harmony between the social systems guiding people

Table 2.1 Assumptions of vulnerability theory

1. Vulnerability of social systems is the reduced capacity to adapt to environmental circumstances
2. Vulnerability is not evenly distributed among people or communities
3. The concept of disaster vulnerability is multidimensional
4. The availability and equitable distribution of resources in a community decreases disaster vulnerability and facilitates resilience (Norris et al., 2008)
5. Vulnerability is largely the result of environmental capabilities and liabilities (McEntire, 2004a, 2004b)
6. Social and demographic attributes of people are associated with, but do not cause, disaster vulnerability
7. Unsafe conditions in which people live and work are the most proximate and immediate societal causes of disaster (Blaikie & Brookfield, 1987)
8. Root causes, the sociocultural characteristics of a community or society, historically and in the present, are the ultimate causes of disasters (Blaikie et al., 1980)
9. Disasters occur because of a chain of causality in which root causes interact with structural pressures to produce unsafe conditions. Hazards then interact with unsafe conditions to trigger a disaster (Wisner et al., 2004)
10. Culture, ideology, and shared meaning are of central importance in the progression to disaster vulnerability
11. Environmental capabilities, liabilities, and disaster susceptibility are related in complex ways to produce the level of community vulnerability
12. The environments of communities are growing in complexity and are increasingly global in scale (Oliver-Smith, 2004)

and their physical environment. Sustainable development and sustainable disaster mitigation are closely related development goals (Gillespie, 2008a, 2010). If development is not in harmony with the physical and natural environment of communities, both social development and community disaster mitigation will be unsustainable.

Empirical support for the first assumption is provided by Benight, Ironson, and Durham (1999) reported on in Chap. 6. The results of this study are that self-efficacy and community efficacy is related to lower levels of vulnerability. Empirical support for this assumption is also given in Chap. 8 with Gillespie and Murty's (1994) finding that communities can connect isolated and peripheral organizations to overcome barriers to resource sharing and coordination with the larger network. Additional support is offered with Gillespie et al.'s (1993) finding that the primary way disaster service organizations connected in a Midwest metropolitan area was with each other was through a single central organization. As reported in Chap. 8, if that organization suffered a direct hit from a disaster and was immobilized the organizational response system would be severely impaired.

The second assumption is that vulnerability is not evenly distributed. Disaster vulnerability is unevenly distributed across the world, continents, countries, communities, and even groups within communities. Communities with more environmental liabilities have a greater probability of extensive damage from disasters (Gillespie, 2008b, 2010). According to Oliver-Smith (2004), social, political, and economic forces channel disaster risk and resilience within a society; this is the essence of vulnerability.

Empirical support for this assumption was reported in Chap. 1, and in this chapter, with worldwide statistics showing that less-developed countries suffer disproportionate losses. More support is reported in Chap. 3 with Wisner et al.'s (2004) finding of inequitable patterns of asset ownership following the Bangladesh floods of 1987, 1988, and 1998. Rogge's (1996) findings, reported in Chap. 5, offer further support for this assumption. Rogge found that toxic emissions were most prevalent in densely populated counties in the USA. In Chap. 6, we discuss the finding from Rüstemli and Karanci (1999) that age is negatively associated with received social support, while education and family income are positively associated. This provides empirical support for assumption two. Additional support is presented in Chap. 7 with Mitchell et al. (1999) finding that organizations processing toxic chemicals are unevenly distributed in South Carolina, and also Chakraborty et al.'s (2005) finding that vulnerability is not evenly distributed across the county. A fourth study with evidence supporting this assumption appears in Chap. 8 with Gillespie et al.'s (1993) finding that the types of organizations relevant to disasters were not evenly distributed across the networks of an American Midwestern metropolitan area.

The third assumption is that vulnerability is multidimensional. Many systems and the correlates of those systems are impacted by disasters. However, the vulnerability of these systems differs. Assessing the vulnerability of a community involves examining the vulnerability of each constituent subsystem as well as assessing the community as a system. System theory states that the whole is greater than the sum of its parts, and this clearly applies when assessing community vulnerability. The vulnerability of the community is not just the average vulnerability of each of its individual members, nor even of each of its subsystems. Instead, to understand community vulnerability, the relationships among social systems and the functioning of the community as a whole must be examined.

Support for this assumption is presented in Chap. 6 by Burnside et al. (2007) whose results show that multiple sources of trusted information increased intention to evacuate in a category 3 hurricane. Support is also shown in Chap. 7 with the measures of vulnerability developed by Chakraborty et al. (2005), Borden, Schmidtlein, Emrich, Piegorsch, and Cutter (2007), and Cutter et al. (2003). The measures from these three studies include from 10 to 42 variables summed to represent multiple dimensions. A serious problem with these measures is that the multiple dimensions have been pooled into indexes rather than being sorted out into dimension-specific indicators. This is an issue we have more to say about in Chap. 10.

The fourth assumption is that the availability and equitable distribution of resources in a community decreases disaster vulnerability (Cutter, 2006). The market approach to nature creates inequality. In this approach, the value of individuals and occupations is closely related to their total wealth and earnings potential. The market value of people and types of work are inversely related to the level of vulnerability from natural and technological hazards (Rogge, 2003), and the social relationships supporting markets and production are reflected in the physical environment of a society (Oliver-Smith, 2004). Social relationships of dominance, oppression, and poverty are inscribed in the natural and built environments, leading to an unequal distribution of resources and ultimately to increased disaster susceptibility and vulnerability (Renfrew, 2009, 2012)

Support for this fourth assumption is discussed in Chap. 3 with Wisner et al. (2004) finding that prejudice toward ethnic minorities and other marginalized social groups acts as a root cause underlying the unequal distribution of economic power. Burnside, Miller, and Rivera (2007), discussed in Chap. 5, provide empirical support for this assumption in their research on predictors of intention to evacuate. Their results indicate that availability of multiple trusted sources of information, including government, television, Internet, family, and relatives is positively associated with intention to evacuate in a category 3 hurricane. Additional support is presented in Chap. 7 with Zakour and Harrell's (2003) finding that individuals with the greatest need for disaster services are located at the greatest geographic distance from the agencies providing these services; with Collins (2008b) finding that working class locals and fixed-income retirees experienced considerable constraints in mitigation, with Renfrew's (2009) finding that neoliberal structuring in Uruguay resulted in new and intensified lead exposure rates; and in Chap. 8 with Gillespie et al.'s (1993) finding that more contacts and more cohesion are positively associated with disaster preparedness.

The fifth assumption is that vulnerability emerges from environmental factors and causes. As noted above, the environment is a diverse constellation of various contents such as physical matter, buildings, bridges and roads, social norms and statuses, cultural values and beliefs, technical tools and devices, and economic systems. Disasters result from root causes in the social and physical environment. Communities are vulnerable when they are unable to control adverse forces in their social and physical environments (Oliver-Smith, 2004).

Support for the fifth assumption is discussed in Chap. 6 with results reported by Bonanno, Galea, Bucciarelli, and Vlahov (2007). Their research indicated that social support and absence of previous life stressors was associated with reduced vulnerability during the World Trade Center collapse in 2001. Support for this assumption includes results reported by Chakraborty et al. (2005), in Chap. 7, showing that vulnerability rises in relation to less access to resources and living closer to the hazard zone. Additional support is given with Zakour's (2008a) finding discussed in Chap. 8 that organizations with a higher diversity of linked types had access to a greater number and variety of resources and were able to mobilize more effectively to achieve their goals. Further support was added in Chap. 8 with Gillespie and Murty's (1994) finding about the important resources of organizations with no links (isolates) or only indirect links (peripherals) to central organizations in the disaster network. However, because of the lack of cooperative links to other organizations in the network, the resources of isolates and peripherals are difficult to mobilize and deploy to where they are most needed. More support was entered with Gillespie et al.'s (1993) finding, also discussed in Chap. 8, that more contacts, higher cohesion, lower hierarchical constraints, and reduced proportionate density were positively associated with disaster preparedness. Finally, support was added, and reported in Chap. 8, with Kapucu, Augustin, and Garagey's (2009) comparison of networks in Louisiana and Mississippi showing that an Emergency Management Assistance Compact helped increase network centrality, The sixth assumption is that biological, demographic, psychological, and social variables do not cause disaster vulnerability. Instead, demographic characteristics such as age and household income are associated with different levels of vulnerability through the liabilities and capabilities of the community's social and physical environments. People defined as vulnerable according to their social and demographic attributes tend to be economically and socially marginalized, suffering limited access to resources for survival and disaster recovery. Examples include low-income people, children and very old individuals, women and girls, ethnic groups, and people of color (Rosenfeld, Caye, Ayalon, & Lahad, 2005; Thomas & Soliman, 2002).

Though a small percentage of all causes, a few causes of disaster vulnerability are part of the developmental status of individuals. For example, children are especially vulnerable because they are more likely than other age groups to be dependent on adult caregivers during disasters. Because they are developing physiologically, children are also highly vulnerable to environmental and technological hazards. Asthma and other respiratory problems, endocrine and immune system damage, and loss of IQ are among the documented or suspected consequences of chemical exposure in children (Rogge, 2003). Other populations which are vulnerable partly because of their developmental status include the very old, those with serious physical or mental illness, and people with other disabilities (Cutter, 2006; Sanders, Bowie, & Bowie, 2003).

McGuire et al.'s (2007) results, discussed in Chap. 5, indicate that white females and unmarried (i.e., single, widowed, divorced) females are more likely to require assistance in an evacuation. Rather than demographic variables causing vulnerability, however, it is likely that age and lack of social support predict greater functional limitations and vulnerability. Additional data in support of the sixth assumption is reported in Chap. 6 with Burnside et al. (2007) findings that older persons are more likely to intend to evacuate for a category 3 hurricane, but only because previous evacuation experience is positively associated with both age and intent to evacuate. Also, in Chap. 7 Cutter et al. (2003) finding that the most vulnerable U.S. counties have the greatest ethnic and racial inequalities provides empirical support for the sixth assumption. Additional support is given in Chap. 7 with Girard and Peacock's (1997) finding that racial status predicted permanent relocation and also Peacock and Girard's (1997) finding that racial segregation of blacks in Miami predicted coverage by top insurance companies.

The seventh assumption is that unsafe conditions in which people live and work are the most proximate and immediate societal causes of disaster. Unsafe conditions interact with physical hazards to produce a disaster. This lack of safety in community conditions includes dangerous locations, unprotected infrastructures, low levels of development, and a lack of disaster preparedness (Wisner et al., 2004). Unsafe conditions are associated with low levels of social capital from interpersonal networks, family, neighborhood, community, and society (Greene and Livingston, 2002; Norris et al., 2008; Wisner et al., 2004).

Empirical support for the seventh assumption is reported in Chap. 3 with Wisner et al.'s (2004) finding that Mexico City, Kobe, and Gujarat each had weak building codes and little enforcement of their codes prior to the earthquakes. Additional support is presented in Chap. 7 with Borden et al.'s (2007) finding that the greater the density and value of built structures on land at-risk for hazards the greater is the vulnerability of the built environment.

The eighth assumption is that root causes inherent in sociocultural aspects of a community or society are the ultimate causes of disasters. Ultimate and root causes are based in sociocultural aspects of a community or society, and these root causes are so ingrained in a society that they are difficult to perceive by members of that society. Root causes are conceptualized as distal causes at the beginning of a causal chain explaining the progression of vulnerability (Blaikie & Brookfield, 1987). There are social, political, economic, environmental, and other root causes which lead to vulnerability. Disasters are designed through root causes such as social, economic, political, and natural environment inequalities.

Support for the eighth assumption is given in Chap. 3 with Wisner et al.'s (2004) study of different kinds of disasters to uncover the root causes of disaster. They identified a number of specific variables operating as root causes. Additional support is presented in Chap. 6 with Burnside et al.'s (2007) finding that no demographic variables were related to intention to evacuate.

The ninth assumption is that disasters are not caused by a single factor or single type of factor, but occur because of a chain of factors in which root causes interact with structural pressures to produce unsafe conditions. Hazards then interact with unsafe conditions to trigger disasters. According to Cardona (2004, p. 49) "In order to analyze vulnerability as part of wider societal patterns, we need to identify the deep-rooted and underlying causes of disaster vulnerability and the mechanisms and dynamic processes that transform these into insecure conditions." Poverty is a good example of a contributing cause to vulnerability because it derives from a deep-rooted process of many variables. Social and economic marginality or exclusion contributes to vulnerability (Pulwarty, Broad, & Finan, 2004).

Support for the ninth assumption is reported in Chap. 3 with a wide range of findings from multiple case studies of four kinds of disasters (flood, cyclone, earthquake, volcano) in various countries ranging in time over the past century (Wisner et al., 2004). These findings are presented within the context of two models—"pressure and release" and "access"—created to explain vulnerability. We describe the pressure and release model in Chap. 3 and discuss its relevance to vulnerability theory. Another source of support for this assumption is from Renfrew's (2009, 2012) findings, reported in Chap. 7, on ideologies about the environment, economic pressures from neoliberal sources, and the interaction of high lead levels and contaminated environments.

The tenth assumption is that culture, ideology, and shared meaning are central to the progression of disaster vulnerability. The ideologies of developed nations are based in and help reinforce dominance over the natural environment (Bankoff, 2004). The relationship between society and nature is one of the fundamental pillars of any society's ideological system (Oliver-Smith, 2004). Ideological systems have implications for vulnerability and the occurrences of disaster. It may not be necessary for a material threat to occur for a disaster to exist, because perception of a threat may be all that is needed to bring about a disaster. Individuals interpret the nature of a disaster's impact, and they use their cultural backgrounds and interpretations to cope with the effects of disaster. These ideological and cultural frameworks are highly variable, and produced mainly by a population's social positions, statuses, and power relationships within a society (Zakour, 2010).

Support for the tenth assumption is discussed in Chap. 4 with Norris et al.'s (2008) finding that resilient recoveries from disaster are facilitated through shared meanings and beliefs regarding effective individual and community coping, and that disasters can disrupt place attachment which compromises identity with the community. Additional support also in Chap. 4 is noted with Tedeschi and Calhoun's (2004) finding that cognitive reprocessing helps people make sense of what happened from the disaster and facilitates a search for meaning. Wellman and Frank's (2001) results, reported in Chap. 5, show that personal network interaction builds shared meaning and norms of social support. These results provide additional empirical support for the tenth assumption of vulnerability theory. In Chap. 6, Rüstemli and Karanci (1999) provide support for the tenth assumption by showing that level of education is positively associated with belief in efficacy of household disaster mitigation measures. In Chap. 9 we discuss further support with Simonovic and Ahmad's (2005) findings that the consistency of flood warnings and the coherence of the community were the most important variables determining evacuation efficiency and effectiveness.

The eleventh assumption is that environmental capabilities, liabilities, and disaster susceptibility are related in complex ways to produce the vulnerability level of a community. In general, capabilities and liabilities are inversely associated with each other, but some anecdotal evidence suggests that there may be no association or a positive association among these (Norris et al., 2008; Putnam, 2000). Capabilities may cause decreases in vulnerability in an additive fashion or they may act as a buffer to liabilities or hazards to reduce disaster vulnerability. Some variables at the individual or population level may act as environmental liabilities, while these same variables at the community level are environmental capabilities leading to community decreases in disaster vulnerability. An example of this last phenomenon is that attachment to place is a liability for individuals, and makes them more susceptible to disasters, while a community norm of attachment to place is a capability and contributes to lower levels of vulnerability at the community level, and also among individual members of the community (Norris et al., 2008).

Research reporting data in support of the eleventh assumption is discussed in Chap. 9 with Simonovic and Ahmad's (2005) findings regarding the impacts from various policy configurations on evacuation efficiency. It is clear from their study that community capabilities, liabilities, and disaster susceptibility are related in complex ways. Kaniasty and Norris's (2009) findings, reported in this chapter and in Chap. 10, on the complex interactions of perceived and received social support, also support the eleventh assumption of the complex interrelationships among capabilities, liabilities, and susceptibility.

The final assumption is that the environments and social systems in which communities are embedded are increasingly global in scale. Population growth, rapid urbanization, environmental degradation, global warming, climate change, and political conflicts are dynamic pressures affecting deep-rooted societal causes which in turn increase disaster vulnerability (Pulwarty et al., 2004). With the increasing influence of globalism on reducing the heterogeneity of culture and ecosystems, the nature of disasters is changing. Globalism increases the complexity and interdependence of human and natural systems, and this process generates more disasters at the regional, national, and international levels. The linkages among different types of vulnerability are now at the global scale, which is becoming different in kind from past scales of societal complexity. Globalism also makes understanding causal chains and processes of vulnerability more complex and difficult (Zakour, 2012b). Disasters are the outcome of destructive social and economic processes that are intensifying on a global scale (Oliver-Smith, 2004).

Support for the twelfth assumption is shown in Renfrew's (2009, 2012) studies, reported in Chap. 7, of neoliberal economic policy at the global scale and its impact on social and environmental conditions in Uraguay. Mascarenhas and Wisner (2012), reported in this chapter, show how demands of a global economy have rendered local practices concerning disaster preparedness unstable or even irrelevant. Also reported in this chapter, Girot (2012) documents the combination of local ecological systems into a global ecosystem with the resultant reduction in biodiversity and increase in disaster vulnerability.

Summary

Disaster vulnerability theory was created to explain the susceptibility of people and communities to losses from disaster. Vulnerability is defined as the ratio of risk to susceptibility. Vulnerability indicates the anticipated physical, social, economic, political, or other predispositions to damage of a system from an agitated hazard. Vulnerability comes from unsafe or hazardous conditions, such as earthquake zones, flood plains, hurricane, cyclone and tornado areas, and many others; unprotected infrastructures, like unreinforced masonry buildings, old floodwalls and retaining walls; and poor or absent disaster preparedness. Vulnerability to disaster is caused by an interaction between the physical and social environments. The root causes of disaster are social. The physical environment includes the natural, built, and technological environments. The social environment is made up of the values, norms, and beliefs governing a system. Variables are classified as liabilities or capabilities. Liabilities generally cause increases in susceptibility to disaster; capabilities generally cause decreases in susceptibility. Vulnerability theory applies to disaster research in many disciplines and professions, and has particular appeal to social work because of the profession's concern with at-risk populations.

In this chapter we have described the general framework of vulnerability theory. In Chap. 3 we consider vulnerability theory from the social development perspective. Social development research has given us a time-ordered and complex layered account of the social causes of vulnerability and disaster. The development perspective sharpens our understanding of the social processes and structural pressures operating to create the unsafe conditions observed in communities around the world. Social work theorists and practitioners require a thorough understanding of this causal structure to enable the creation of effective interventions that enhance community capabilities and diminish liabilities.

Chapter 3
The Development Perspective on Vulnerability

Emergency managers, first responders, and others active in disasters are becoming more proactive in trying to prevent disasters and minimize their negative consequences. The recent reemergence of vulnerability theory is a happy coincidence with this shift in practitioner orientation because vulnerability theory reaches deep into social structure and offers a variety of potentially helpful interventions. As discussed in Chap. 2, disaster vulnerability researchers have focused on combinations of environmental liabilities and capabilities that influence a community's susceptibility to disaster as well as its resilience in the face of disaster. One stream of research currently being pursued studies vulnerability through a social development focus. In this chapter we describe the development perspective, present some of the key findings produced through it, and discuss its importance to vulnerability theory. A second stream of vulnerability research is focusing on the processes of resilience. In Chap. 4 we describe the resilience perspective and relevant findings.

This chapter presents the social development perspective and considers its contribution to vulnerability theory. We draw heavily on the work of Wisner, Blaikie, Cannon, and Davis (2004) who have done much to lay the foundation of vulnerability theory. These theorists contend that too much emphasis has been devoted to natural hazards (the water, earth or wind conditions that trigger disasters) and not enough emphasis has been given to the social processes that influence the ways hazards and disasters affect people and communities. They view the natural environment as inextricably bound with the social, economic, and political environments. Wisner and his colleagues carried out a qualitative meta-analysis of different kinds of disasters in a variety of Third World countries to show how people and communities become vulnerable to disasters. Although this work is grounded in Third World data the ideas, models, and principles apply as well to the developed world.

According to Wisner et al. (2004) vulnerability is governed through social processes over time, beginning with "root causes" that set up "dynamic pressures" that translate effects from the root causes into "unsafe conditions." Root causes are embedded in the ideologies guiding the distribution of power and resources. Dynamic pressures arise through macro-forces such as population growth and rapid

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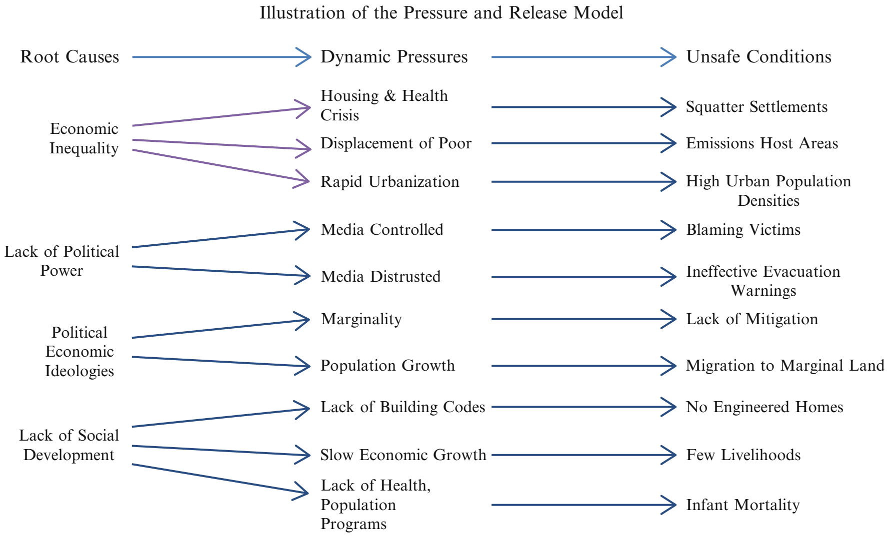


Fig. 3.1 Illustration of the pressure and release model

urbanization as well as deficits in local community institutions, skills, and ethical standards. Some of what Wisner et al. call dynamic pressures represents what we think of as “structural constraints” such as too few persons with a needed skill at a particular time and place or not enough training to meet the demand. Thus, we sometimes use the term structural in place of or in conjunction with dynamic. Unsafe conditions are specific forms of vulnerability in time and space such as living on a flood plain, an earthquake zone, or on a hillside subject to landslides. Disasters occur when unsafe conditions and hazards interact.

This three-level time-based framework for explaining vulnerability to disaster is referred to as the “pressure and release model” (Wisner et al., 2004). The pressure part of the model represents the unsafe conditions (liabilities) that build up over time, becoming more and more susceptible to disaster. The release part of the model represents a reduction in the unsafe conditions or promotion of safe conditions (capabilities). This model essentially elaborates the definition of vulnerability as the ratio of risk to susceptibility. The idea is that disasters can be prevented or their negative effects reduced by changing root causes and structural or dynamic pressures to decrease liabilities and increase capabilities. Figure 3.1 illustrates the model.

We open this chapter with brief overview explanations from a development perspective of the 1985 Mexico City earthquake and the cyclone in Mozambique in 1979. These explanations illustrate the development perspective at work and show the critical role that access to resources plays in vulnerability theory. Next, we give examples of the three types of variables development theorists assume are operating to cause vulnerability: root causes, dynamic (structural) causes, and unsafe conditions. In each of the disasters described, limited access to resources and unequal assets among groups in a community are a root cause of the disaster. We focus

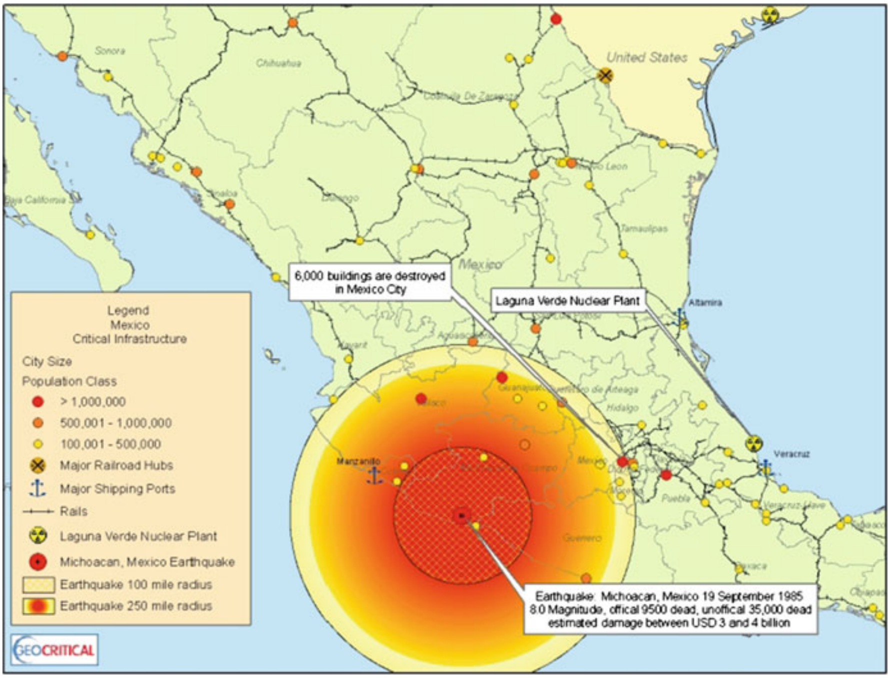


Fig. 3.2 1985 Mexico City earthquake. *Source*: http://www.geocritical.com/gc/Earthquakes/tabid/61/Default.aspx

on the root causes such as poorly conceived ethical standards and accountability, or their complete absence. We also focus on the most obvious dynamic pressures or structural causes such as weak building codes and substandard constructions of buildings. Third, we discuss a developmental example of an urban community, Mexico City, which has reduced its level of disaster vulnerability. At the end of this chapter we offer a summary of the support for vulnerability theory provided by findings from social development research.

Social Development Explanations

Wisner et al. (2004) provide a holistic explanation of the 1985 Mexico City earthquake (Fig. 3.2). After unsafe conditions and the earthquake interacted to cause the disaster, the resistance of residential and other buildings had important impacts on the losses, including deaths. The low frequency of severe earthquakes in this area affected people's attitude regarding the need to prepare for them. Household vulnerability was primarily influenced by the distribution of access to resources. These included the opportunities for income and livelihood. The opportunities to work and the income opportunities were not equitably distributed and were determined by the politics of the city.

A key question is: "Who was where, when?" The earthquake occurred at 7:00 a.m. and many people were going to work and school. The people traveling to work or school were not asleep in buildings which subsequently collapsed, so this saved lives. The spatial structure and urban ecology of the city shaped the patterns of commuting to work, the directions of travel, and therefore the locations of different groups of people. Many areas in the city were characterized by very high residential densities, which put large numbers of people at high risk during the earthquake. These densities contributed to the very high death toll. The impacts included deaths, injuries, property destruction and damage, as well as temporary disruption of livelihoods. Office cleaning and unskilled work stopped for members of poor households. Official measures were taken to reduce vulnerability, which we discuss at the end of the chapter.

Wisner et al.'s (2004) account of the 1979 cyclone in Mozambique further illustrates the importance of access to resources in vulnerability theory. The level of household disaster susceptibility determined how much the storms affected access to livelihoods. Members of poor families disproportionately died and suffered injury. Loss of labor opportunities in poor households made it harder for them to recover economically. The wealthy lost more assets than the poor in absolute terms but they lost less relative to total household assets. In particular, farm buildings, livestock, tree crops, and standing annual crops were lost. These losses, as well as losses from saltwater flooding of fields, severely dampen the revenue of farm households.

Social structures of domination influenced the new array of livelihoods in Mozambique. Poor households were less able to pay off loans or meet their rent and other obligations. Credit provided by government and other sources was less easily obtained by poor households than by more affluent households. Indebtedness and the need for work reinforced the distribution of social power and the structure of dominance. Household budgets were radically changed. Relief workers found that some of the poorest households lost everything. They had little or no money and were largely dependent on social networks, the government, or other outside sources. These dependencies revealed how much better it is to mitigate and prepare within the community before disaster strikes. Decisions concerning consumption, investment, and use of assets will lead to changes in individual and household access to resources. More equitable access to resources will help reduce vulnerability and enhance resilience (Wisner et al., 2004, pp. 252 and 253).

These brief accounts of two disasters show how the social development perspective on vulnerability expands the focus beyond wind, water, and earth disruptions (natural hazards) to consider the social processes that evolve over time through our social, economic, and political systems to create the conditions that end up harming people. Those using this perspective view vulnerability as being determined through social processes unfolding over time through layers of root causes, dynamic pressures or structural constraints, and unsafe conditions. According to development theorists, it is the structural pressures that operate as key causal mechanisms in transforming root causes into unsafe conditions. We turn next to examples of specific variables highlighted in the development perspective.

Developmental Causes of Vulnerability

The foundation of vulnerability theory was set by social development theorists. This research has emphasized economic and social development (Streeter, 1991). Many of the resources needed for recovery are related to household livelihoods, community wealth (Wisner et al., 2004), and other economic variables such as the diversity of economic resources and equity of resource distribution (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008). Community vulnerability results from failed development and a lack of adaptation to the local physical environment (Oliver-Smith, 2004).

The development focus on vulnerability examines variables such as ideologies about economic systems, human capital, local markets, debt repayment schedules, land, labor, and household livelihoods. The operation of these variables over decades or longer time periods leads to increased vulnerability. For example, in Uruguay, neoliberal economic ideologies, debt repayment schedules based on neoliberal structuring, and the loss of land and livelihoods by many rural people, resulted in increased vulnerability to lead poisoning (Renfrew, 2009, 2012). Other variables used in vulnerability assessments include natural, social, and physical capital (Wisner et al., 2004).

As noted above, social development theorists classify these variables into root causes, structural constraints, and unsafe conditions. Collins (2008a, 2008b) found that root causes of vulnerability to wildfires in a Colorado community included the low incomes of households dependent on natural resource extraction as well as service industries. Structural constraints or dynamic pressures are shown in Gillespie, Colignon, Banerjee, Murty, and Rogge's (1993) study of a disaster services network in a U.S. metropolitan area and centered on the American Red Cross (ARC). The ARC was so central in this network that the entire network would be incapacitated if the ARC was lost. Other organizations vital to disaster response were either not connected at all to the American Red Cross, or they were connected by only indirect links to the ARC (Gillespie & Murty, 1994). Next we discuss key variables reflecting root causes, dynamic (structural) pressures, and unsafe conditions.

Root Causes

Wisner et al. (2004) drew from studies of different kinds of natural disasters over many years to uncover root causes of disaster. The kinds of natural disasters studied by Wisner and others and discussed in this chapter include floods, tropical cyclones, earthquakes, and volcanic eruptions. Wisner et al. (2004) identified a large number of specific variables operating as root causes. Root causes for each type of disaster included limited and unequal assets or resources. Though the disaster contexts are less-developed or developing nations, low-income and marginalized people in highly developed nations suffer in similar ways from limited and unequal resources, such as lack of availability of private insurance protection (Collins, 2008a, 2008b; Peacock & Girard, 1997).

Despite the variety of disaster types, most of these variables represent specific dimensions or aspects of limited and unequal assets or resources, and inadequate government. In a study of vulnerability to hurricanes in the Tampa metropolitan area in the USA, for example, limited and unequal assets and resources refer to lower incomes, and lack of a household telephone and automobile needed for evacuation (Chakraborty, Tobin, & Montz, 2005). Finding similar patterns of root causes across different kinds of disasters occurring over different time periods demonstrates the generality of the development perspective.

Data from the Bangladesh floods of 1987, 1988, and 1998 revealed the root causes of extreme income inequality and disparities in household wealth. The nation's elite rely on foreign aid, removing incentive for economic development. The global power structure favors landowners against the poor. A final root cause is the legacy of poor cooperation between India and Bangladesh is the management of the Ganges River, which passes through both countries on its way to the Bay of Bengal (Wisner et al., 2004). Similar patterns of inequities were found following the cyclone in Mozambique in 1979. The root causes of the Bangladesh and Mozambique disasters stemmed partly from limited access to land. These findings show how the natural and social environments are inextricably intertwined (Fig. 3.3).

This limited and unequal access to resources was further established as a root cause with data from the Mexico City earthquake of 1985, the Kobe, Japan, earthquake of 1995, and the Gujarat, India, earthquake of 2001 (Wisner et al., 2004). In Mexico City the low income tenants in the inner-city historical center were a marginalized population, both economically and politically. Elites served as patrons of poor Mexico City residents, many of whom were former rural peasants. In this system, former peasants live under conditions of patronage, in which wealthy families provide goods to peasants during periods of deprivation, but expect extensive services from peasants as reciprocity for aid during crises (Fig. 3.4).

Prejudice toward ethnic minorities and other marginalized social groups have been identified as another root cause underlying the unequal distribution of economic power. In both the Kobe and Gujarat earthquake disasters, economic and political power was stratified along lines of caste and ethnicity. In Kobe the *Buraku* historically have been at the bottom of a caste system similar to that in India. The *Buraku* have historically engaged in "unclean" livelihoods, similar to the "untouchable" castes in India. This caste experienced greater losses in the earthquake because they were segregated in the most unsafe geographic areas, such as hillsides. In Gujarat, though all strata of society experienced losses in the earthquake, similar to the situation in Kobe the lowest caste members were unable to recover adequately due to economic and political marginalization (Wisner et al., 2004). In Gujarat there has also been a long history of conflict between Hindu and Moslem in India, with Muslims having less access to political and economic power.

Inadequate forms of government were identified as root causes in the Montserrat Volcanic Eruptions of 1995–1998. Montserrat is one of the few colonies still held by Britain. The colonial administration is based in London and is both geographically and culturally distant from the local government of the island. The geographic distance and cultural differences between governments of Montserrat and the United Kingdom make close cooperation difficult, and this becomes readily apparent during a crisis such

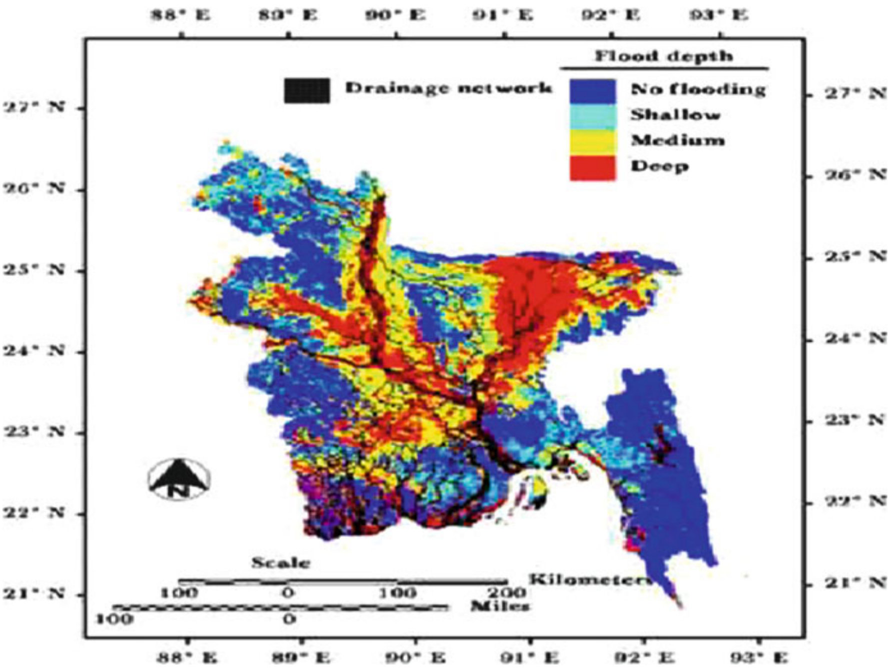
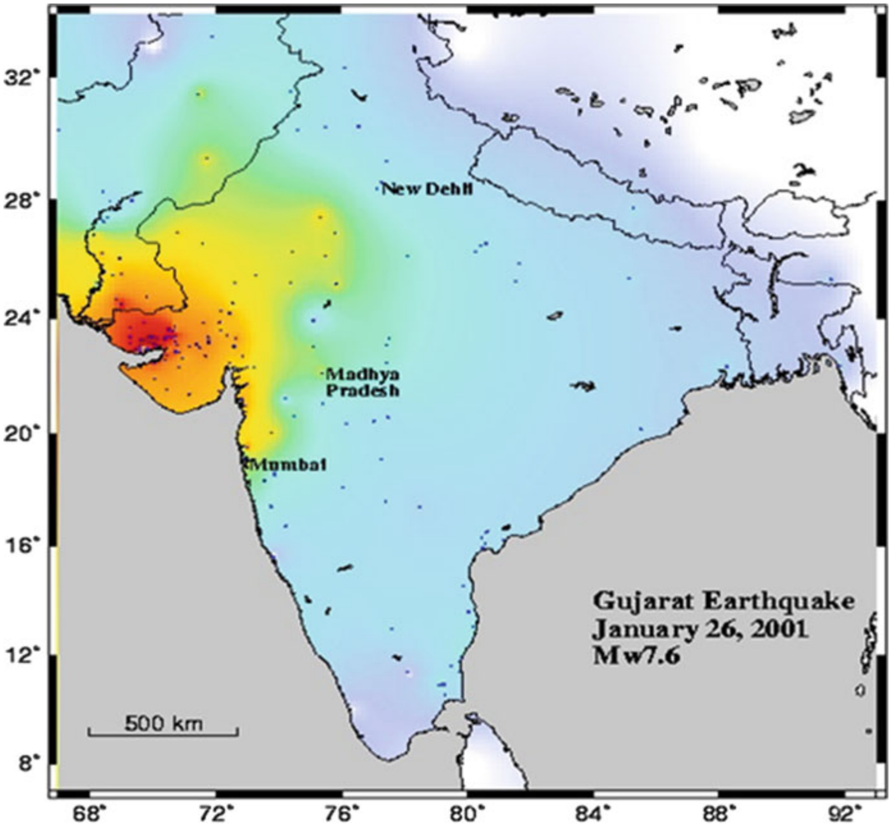


Fig. 3.3 1988 Bangladesh flood. *Source*: http://gisdevelopment.net/application/natural_hazards/floods/floods002a.htm

as the volcanic eruptions. Distant colonial rule prevented coordination of response (Fig. 3.5), relief, and recovery after the volcanic eruptions of 1995 and 1998 (Wisner et al., 2004).

Both Gujarat and Mexico City suffered from a lack of ethical standards and accountability from public authorities and the building industry (Wisner et al., 2004). In Gujarat, because of the failure of ethical standards, many poor residents built their own houses without conforming to engineering or safety standards. In Mexico City, the landlords of rent-controlled buildings did not retrofit their buildings for earthquake resistance. Mexico City was affected also by several unique historical and long-lasting political and economic conditions. First was the historical decision to build Mexico City on a lake bed to replace the Aztec capital city of Tenochtitlan. The bed of old Lake Texcoco has been subject to earthquakes for centuries. The centralism of the Mexican federal government, with most federal governmental functions based in Mexico City, was also identified as a root cause.

Root causes represent the theoretical point of origin in explaining vulnerability through the social development perspective. These causes are embedded deep in the social structure and serve to guide the distribution of resources. Many of the specific root causes are reflected in community economic and political ideologies. Economic ideologies influence the distribution of assets and income opportunities (Renfrew, 2009, 2012). Political ideologies influence the form of ethical standards, the extent of accountability, and prejudices or biases toward categories of people. Over time



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Fig. 3.4 2001 Gujarat earthquake. *Source*: http://connect.in.com/gujarat-earthquake/images-gujarat-earthquake-january-1-236143458318.html

root causes are transformed into safe or unsafe conditions by dynamic or structural causes, which we turn to next.

Structural or Dynamic Causes

The structural and dynamic causes of disaster identified by Wisner et al. (2004) include socioeconomic status, gender roles, and the actions of the state and national government. Lower income individuals are less able to protect themselves from hazards in large part because they cannot afford to pay for the protection. Examples

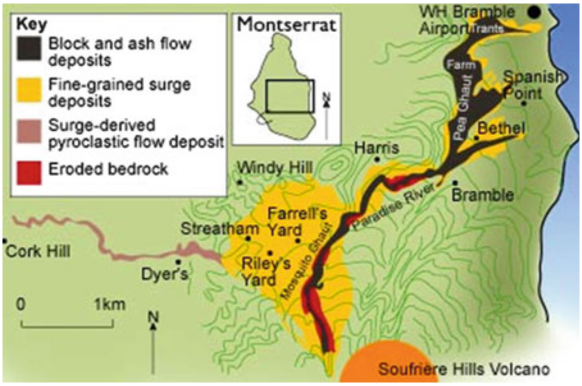


Fig. 3.5 Montserrat volcanic eruption. *Source*: http://www.edu4hazards.org/volcano/eruption.html

of lower income individuals being unable to pay for needed protection include living on flood plain areas in houses below anticipated waterline levels, living in an earthquake zone and in an unreinforced masonry building, and living in any kind of hazardous area without adequate property insurance. A lack of adequate homeowners insurance led to greater losses for blacks living in Miami, Florida, during Hurricane Andrew (Peacock & Girard, 1997). People with adequate income are generally able to afford protected housing and insurance. Lower income people have fewer assets and are thus less able to recover from disasters.

State and national government organizations, along with nonprofit organizations, can contribute to unsafe conditions by failing to develop systems to redistribute resources after a disaster. Emergency Management Assistance Compacts (EMACs) are mutual aid agreements among states. Though EMACs helped coordinate the network of organizations that responded in 2005 to Hurricane Katrina in Mississippi, they were not as effective at doing this for the network in Louisiana (Kapucu, Augustin, & Garagey, 2009).

Wisner et al. (2004) found that in Bangladesh there was a breakdown of the rural economy, resulting in the exodus of low status individuals to cities, embankments, and chars (the small islands in the delta of the Ganges). During this period of urbanization the Bangladeshi government failed to improve access to land ownership for the poor. For people who did not own land, disproportionately high flood losses occurred. Bangladesh has also suffered from inadequate economic progress. Economic progress would provide alternative livelihoods for poor households and serve as a hedge against disaster vulnerability. An important factor slowing economic growth is dependence of the economic elite on foreign aid such as food aid in disasters. This dependence comes partly from a lack of political will to tax high rural incomes or enterprises to provide for survival needs of low-income rural people. In Bangladesh, as in many countries prone to floods, there has been a shortage or lack of public and private insurance needed for complete recovery.

Social developments in the period before the earthquakes in Mexico City, Kobe, and Gujarat led to increasing numbers of vulnerable persons. Mexico experienced a rapid increase in families with young children, Kobe experienced an aging of its population, and Gujarat experienced a 4-year drought which weakened its ability to recover from the earthquake. Each of these three cities had experienced rapid urbanization, resulting in high-density living conditions. High population densities are more vulnerable to disasters, and can be at higher risk for toxic emissions and contamination (Rogge, 1996). In each city, urban in-migration occurred as rural people sought better employment opportunities. In Gujarat, modernization of agriculture resulted in many newly landless people who were forced to migrate to the city. In Kobe and Gujarat rapid industrialization made each city economically central, serving as powerful magnets for rural households (Wisner et al., 2004).

Before the earthquakes in Mexico City, Kobe, and Gujarat, there were weak building codes and little enforcement of the codes, quickly built substandard housing, and many older and poorly maintained buildings. Each of the three city centers suffered from a lack of interest and investment by professional engineers and the larger metropolitan area. These three cities lacked adequate building codes for seismic resistance, did not enforce these codes, and did not retrofit existing structures because of the low return on investment in retrofitting. A lack of seismic resistance of buildings was further promoted by a lack of awareness of the severity of earthquake risk, especially in Kobe and Gujarat (Wisner et al., 2004).

There were competing interests during the volcanic threat prior to the Montserrat eruptions that prevented people from evacuating. At the time of impending eruptions, the incumbent governor did not want people to evacuate because of his desire that they remain in their precincts and vote for him in the upcoming election. There was also a poor working relationship between the local government of Montserrat and the British government during this crisis. Additionally, there was a lack of a common language between scientists and decision makers. Finally, there was out-migration of skilled people from Montserrat, particularly during the 1960s, as well as a lack of economies of scale in this tiny island colony.

Dynamic or structural causes represent the key points of explanation in accounting for vulnerability through the social development perspective. These causes emerge from a lack of needed resources or macro-forces such as population growth, rapid urbanization, or declines in soil productivity. A number of specific structural pressures arise from community changes regarding local institutions, ethical standards, skill sets, and aspects of the environment supporting household livelihoods. Over time structural pressures interact with root causes to create safe or unsafe conditions, which we turn to next.

Unsafe Conditions

Wisner et al. (2004) noted unsafe conditions to include hazardous physical environments, lack of public actions and institutions, a weak local economy, and inadequate public health. Examples of a liability in the physical environment include living in hazardous areas. Land erodes, especially during floods, and this undermines livelihoods as well as housing. The presence and prevalence of oil and gasoline refineries and pipelines, other chemical plants and pipelines, and especially nuclear power plants contribute to the vulnerability of urban communities, in developed and less-developed communities (Borden, Schmidtlein, Emrich, Piegorsch, & Cutter, 2007). Inadequate public actions and institutions include poor warning systems, exclusion of rural areas from mitigation projects, purposeful flooding of rural areas to protect more densely populated cities, and lack of property insurance. Findings of Zakour and Harrell (2003) provide an additional example by showing that the spatial pattern of individuals in urban areas mirror and reinforce the lack of access to disaster mitigation/prevention and response services. In fragile economies lower income households often experience disruption in their livelihoods and are unable to replace assets lost in the disaster. Finally, poor health conditions raise the risk of infections after a disaster. Floods cause waterlogging in and around homes, and this can increase disease vectors such as mosquitoes carrying malaria.

In Mozambique there had been a great deal of deforestation undertaken on the coast. After the 1979 cyclone in Mozambique, a number of changes were made to increase the safety of conditions. Approximately 50,000 people were relocated to higher ground to improve the safety of their physical environment. In Bangladesh there is a general lack of governmental assistance in proper reallocation of land to the poor, resulting in large numbers of households squatting in flood prone areas. In Mexico City, Kobe, and Gujarat, many public and private buildings were old and suffered from a lack of maintenance. Kobe's and Gujarat's physical (built) environment also included many non-engineered dwellings with design faults. In Mexico City alluvial soil conditions in the urban center which is built on a lake bed amplified ground shaking. For all three cities, lifeline resources were unsafe, including bridges, hospitals, schools, and basic services. Plymouth, the capital city of Montserrat, was cited as a high risk zone very close to the volcano. Key lifelines such as the airport and hospital were both cited in high risk zones.

Public actions and institutions which contributed to or are aspects of unsafe conditions include inadequate preparedness planning, poor warning systems, and a lack of evacuation. In Mozambique there was a lack of cyclone shelters and few high quality buildings to act as shelters. Kobe and Gujarat suffered from a lack of disaster planning and emergency operation centers, poor coordination, low search and rescue capacity, and a lack of disaster preparedness at all levels. In Montserrat liabilities in public action prior to the eruptions included the lack of public awareness programs concerning the volcanic threat. Risk assessment and disaster planning by the government was inadequate, and there was a lack of adequate emergency shelter accommodation. Given the social inequality in Montserrat society, differential access to overseas remittance incomes and migration opportunities were liabilities.

In Bangladesh economic aspects of unsafe conditions included a high percentage of households dependent on wages and sharecropping. During flooding, these populations are vulnerable to loss of harvest and wages. Income levels are also very low for most rural inhabitants, making recovery after a flood more difficult. It is also more likely that low-income people will be displaced by flooding, given the disproportionate numbers of poor households living in unsafe conditions. Mexico City was experiencing very high inflation, resulting in fixed rents becoming worthless. One consequence of this inflation was a reduction in building maintenance by landlords (Fig. 3.6).

For Kobe and Gujarat there were low levels of homeowner's insurance and catastrophic insurance protection, and many unsafe industrial buildings and facilities. The economy of Montserrat was dependent on agriculture, fishing, and tourism, all of which were devastated by the long series of eruptions and accumulation of toxic ash and gasses.

Low levels of development and too few or inadequate public health provisions have resulted in most Bangladeshis having low resistance to disease. The rural Bangladeshi population has little access to safe water and suffers from poor nutrition. This, along with low food stocks means that small-scale flooding is likely to lead to long-term negative impacts (Meichenbaum, 1997). Long-term impacts are exacerbated by the absence of health insurance. It is unlikely that relocation or displacement will be to safer living conditions. Displacement or relocation after a flood includes health and mental health risks (Meichenbaum, 1997; Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002).

Developed countries suffer from similar patterns of vulnerability. For example, the distribution of emergency managers in the USA is uneven. Many small rural towns and also municipalities in urban areas do not have a full-time disaster specialist. Emergency managers often work on a part-time basis as fire chief, police chief, public works director, city manager, or mayor. Even in cities, the size and scope of the emergency management function varies widely (Gillespie et al., 1993; McEntire, 2007a, 2007b).

Community disaster services organizations in developed nations can vary a great deal in their evacuation capacities. Organizations with lower levels of social capital have reduced evacuation services capacities (Zakour, 2008a). The number of trusted sources of information available is positively associated with intention to evacuate in a disaster such as a hurricane or flood (Burnside, Miller, & Rivera, 2007). Communities vary in the availability of multiple trusted sources of evacuation warnings and orders, such as governmental officials, television/Internet, or family and relatives.

In the social development perspective, unsafe conditions represent the surface manifestation of vulnerability. These are conditions we observe day in and day out and they provide a key focal point for vulnerability theorists. Unsafe conditions emerge from dangerous physical environments such as living on a steep hillside in unreinforced masonry buildings in an earthquake zone, and from working or not being able to work in weak economic environments unable to support adequate livelihoods. Unsafe conditions also emerge from discriminatory social environments that put certain groups at greater risk for losses and suffering from disaster, and from government actions or inaction such as favoring landowners or not preparing for known hazards. The state of unsafe conditions is continually changing. An important goal for researchers and practitioners alike is to monitor these conditions and work to increase the ratio of safe conditions to unsafe conditions.

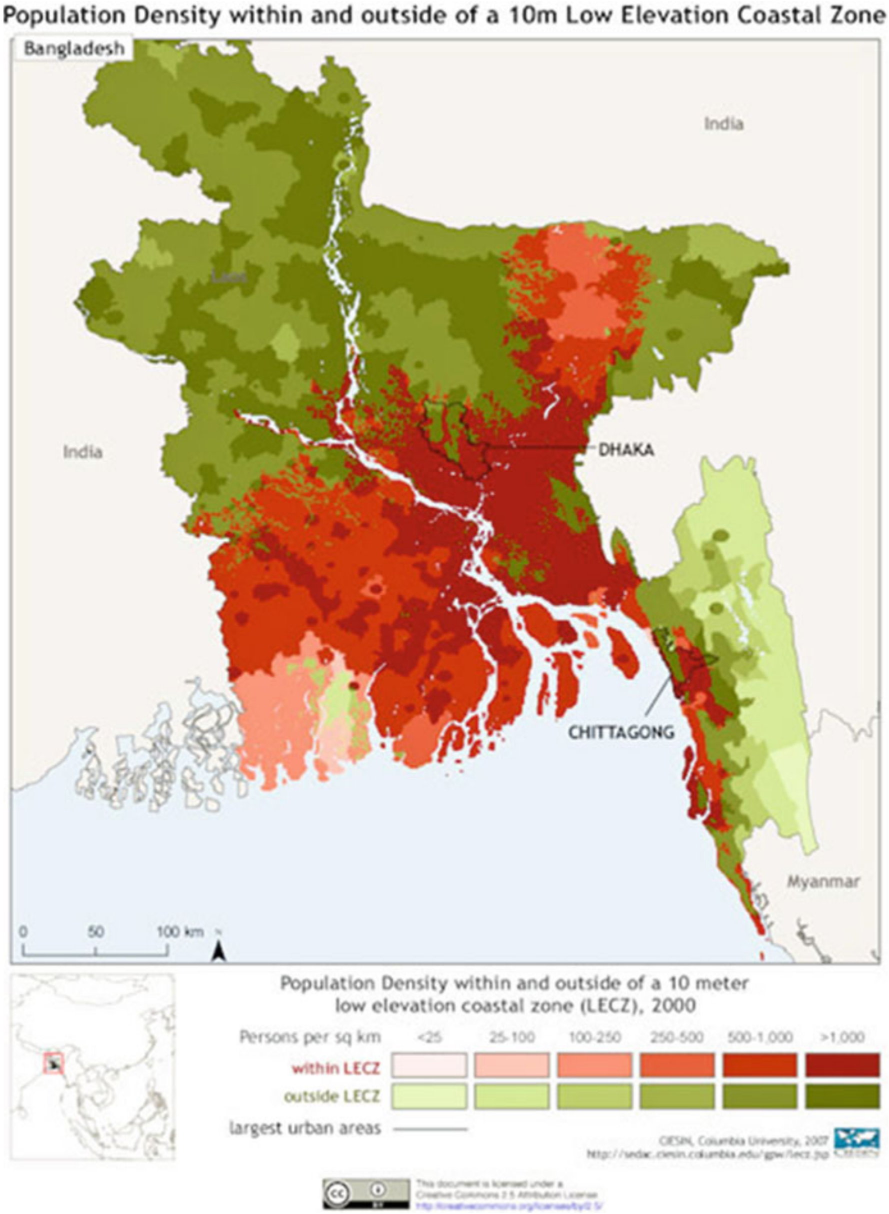


Fig. 3.6 Elevation and population density in Bangladesh. *Source*: http://www.preventionweb.net/english/professional/maps/v.php?id=7513

Developmental Reductions in Vulnerability

Wisner et al. (2004) describe activities in Mexico City to reduce earthquake vulnerability. Following the pressure and release model, seismic hazards were mitigated. These mitigation activities were carried out largely during and immediately after recovery from the 1985 earthquake. One important mitigation activity was improved seismic hazard mapping. Improved mapping was undertaken along with automated event warning designed to provide warning of up to three minutes ahead of earthquake impact. The Mexican federal government undertook hazard mitigation during recovery and reconstruction from the 1985 earthquake, but additional mitigation efforts are needed.

Additional reductions in disaster vulnerability will need to involve modification both of public actions and of the physical environment. To achieve safer living and working conditions in Mexico City, public actions should include improving disaster preparedness planning. Preparedness planning should occur alongside efforts to enhance the safety of Mexico City. A safer, more protected, physical environment means improving seismic building codes and their enforcement, and applying codes to construction and planning issues. Existing buildings should be strengthened by retrofitting. Building use patterns should be further modified to reduce habitation densities in certain vulnerable structures. Many people were killed during the 1985 earthquake because of the very high densities of factories, businesses, and residences in deteriorating sectors of Mexico City (Wisner et al., 2004).

Further reduction of vulnerability to earthquakes in Mexico City could occur through modification of structural and dynamic pressures. These pressures could be lessened by the development of local citizens groups to demand effective reconstruction. Pressures could also be reduced through legal provisions to allow citizen groups to own the reconstructed buildings. Macro forces in the reduction of structural pressures could include improved rural economic opportunities to reduce urbanization. Another potential means to reduce structural pressures is to decentralize certain government facilities to other sites in Mexico. Decentralization should not only reduce the vulnerability of the federal government, but also additional economic opportunity would be generated by locating government jobs in rural areas (Wisner et al., 2004).

Finally, seismic vulnerability reduction in Mexico City should take place through modification of root causes, though this is a long-term process. Root causes could be addressed through a democratization of the city and federal government. Democratization could facilitate a decrease in historical centralism and in patron–client systems in Mexico. Both centralism and patron–client systems lead to the marginalization of a large portion of the Mexican population, especially in Mexico City. Greater democratization, along with promotion and empowerment of citizen groups, will help in reducing the social and economic marginality that leaves many Mexicans with a lack of resources for coping and recovering from disasters (Blaikie & Brookfield, 1987).

Reducing a community's vulnerability to disaster involves decreasing unsafe conditions or increasing safe conditions. The complex social structures that cause

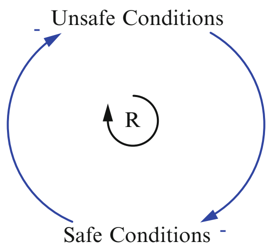


Fig. 3.7 A virtuous cycle of reducing vulnerability by changing safe and unsafe conditions

vulnerability offer many potential points of intervention. The most powerful leverage points are the root causes. However, these causes are the most distal from the actual conditions of vulnerability and they are the most resistant to change (Blaikie & Brookfield, 1987). In addition, change initiatives at this level typically require a long time frame. Structural pressures also offer strong leverage points for intervention, but as macro-forces they are difficult to influence and like root causes require a long time frame.

Focusing directly on the safe and unsafe conditions is probably the best place for social work researchers to begin because positive results can be produced more quickly. Positive results will help inspire additional efforts and create a cycle of positive feedback, as shown in Fig. 3.2. The loop shown in this figure is called a reinforcing loop. Reinforcing feedback loops, or positive loops, are what drive system growth or decline. The loop shown in Fig. 3.2 is commonly referred to as a virtuous cycle. The two variables in this loop are negatively and inversely related to each other. When safe conditions are increased, unsafe conditions are reduced. Reducing unsafe conditions in turn increases safe conditions. As the cycle continues vulnerability is reduced (Fig. 3.7). In Chap. 9 we have more to say about the importance of cycles and system dynamics methods for understanding vulnerability.

Summary

The social development perspective provides useful insights and explanations for community disaster vulnerability. After the Mexico City earthquake of 1985, the distribution of at-risk buildings was mapped. The vulnerability of households was influenced by the distribution of access to resources such as land, labor, capital, tools, information, social networks, and the expectation of resource provision from networks. Social status, human capital, and income opportunities were not equitably distributed across Mexico City, but instead were determined by the political system of the city. Many areas in Mexico City were characterized by very high residential densities, which put large numbers of people at high risk during the earthquake, contributing to the high death toll.

Social development research on community disaster vulnerability has focused on the inequitable distribution of social and economic development. Many of the resources needed for recovery depend on distribution of household livelihoods and assets. Root causes include inequitable access to resources, unequal economic and political power, locations in hazardous areas, sovereign debt crises, and environmental degradation. Structural causes of disasters include unequal distribution of resources by class and gender, an inability of poor people to afford flood-resistant housing, lack of skills, inadequate building codes, poor communication, low participation by women and children, and a lack of public social protection and private property insurance (particularly for rural populations). Population growth, population aging, rapid urbanization, loss of land for rural populations, and a lack of political will for evacuations are additional structural causes. Unsafe conditions, especially in rural areas, include lack of disaster-resistant buildings, lack of public health measures, inadequate warning, inadequate shelters, lack of disaster planning and coordination, lack of full-time emergency managers, and lack of emergency operation centers. Additional unsafe conditions are lack of evacuation, low search and rescue capacity, little recovery aid for low-status populations, fragile and non-diversified local economies, and a lack of access to public and private property insurance.

The inequitable patterns of household assets and income found by Wisner et al. (2004) following the Bangladesh floods of 1987, 1988, and 1998 supports the second assumption of vulnerability theory, that vulnerability is not evenly distributed (Chap. 2, pp. 17 and 18). These researchers found wide income inequality and disparities in household wealth, with the poorest households suffering disproportionate losses from the floods. Similar patterns of inequities were found following the cyclone in Mozambique in 1979, and the (1985) Mexico City, (1995) Kobe, and (2001) Gujarat earthquakes.

Wisner et al. (2004) found that prejudice toward ethnic minorities and other marginalized social groups acts as a root cause underlying the unequal distribution of economic power, which supports the fourth assumption of vulnerability theory concerning the role of social processes in affecting the availability and distribution of resources (Chap. 2, p. 19) and also the eighth assumption of vulnerability theory regarding sociocultural variables as root causes of disasters (Chap. 2, p. 23). This finding was substantiated in Kobe and Gujarat. In Gujarat there has been a long history of conflict between Hindu and Moslem in India, with Muslims having access to fewer resources for recovery. The finding that cultural differences between governments of Montserrat and the United Kingdom made close cooperation difficult after the volcanic disasters further substantiates this assumption.

Wisner et al.'s (2004) findings regarding building codes in Mexico City, Kobe, and Gujarat support the seventh assumption of vulnerability theory regarding unsafe conditions as immediate causes of disaster (Chap. 2, p. 22). Prior to the earthquakes, each of these cities had weak building codes and little enforcement of their codes. The consequence from weak codes and lax enforcement was a high proportion of substandard housing and a lot of old and poorly maintained buildings at high risk for seismic destruction or damage.

The "pressure and release" model created by Wisner et al. (2004) represents an expression of the ninth assumption of vulnerability theory (Chap. 2, pp. 23 and 24), which states that disasters result from causal processes originating with root causes that interact with dynamic factors to produce unsafe conditions (Blaikie & Brookfield, 1987). This model is based on findings from numerous case studies of seven kinds of disasters occurring in different countries over time throughout the last century. The pressure and release model is compatible with many different kinds of theories, providing a useful framework for vulnerability theorists of various orientations.

The research reported through a social development perspective on community disaster vulnerability has revealed how political and economic ideologies that promote limited and inequitable distributions of social and economic resources operate as root causes of disasters. Many of the specific variables representing environmental liabilities and capabilities studied by social development scholars are also used in research from a resilience perspective. However, in contrast to the social development perspective, the resilience researcher focuses more sharply on community trajectories, noting that at any given time a community can be moving toward or away from adequate functioning; vulnerability is continually changing. Chapter 4 covers the resilience perspective.

Chapter 4
Resilience Complements Vulnerability

In this chapter we discuss the perspective on resilience as it relates to vulnerability. Resilience refers to the ability of an individual, group, or community to cope with adversity. Resilience emerges after a disaster or stressful event. Coping with adversity means to recuperate or return relatively quickly to a previous state of normal functioning, or to recover better than expected. Resilience is most widely understood as a process and not as a characteristic of individuals, groups, or communities. References to resilience in the literature are often inspirational but unfounded. We agree with Raphael and Maguire (2009, p. 17) who state that "…theory, conceptualization, and research are required to develop the resilience field and its complex interfaces with disaster …" In order for the process of resilience to become recognized in vulnerability theory and useful in disaster recovery it needs to be more carefully conceptualized and reliably measured (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008).

One way to approach the measurement of a process like resilience is to identify the resources needed to implement it and then to focus on the key attributes of those resources. Access to resources is critical for a community to respond to disaster in a resilient manner. The attributes of robustness, redundancy, and rapidity affect the extent to which resources can be mobilized. Each of these resource attributes can enhance or hamper the emergence of community resilience or its implementation. Enhancing the resources that make resilience possible has the desirable effect of reducing vulnerability (Norris et al., 2008).

Robustness is the strength of a resource or its ability to withstand stress without deterioration. Resource robustness is particularly important in disasters that require a long recovery period. The provision of social resources and the altruistic community typically diminish over time and come to an end before the recovery period is completed (Kaniasty & Norris, 2009). Both the objective reality and the subjective perception of resource deterioration contribute to higher levels of distress, psychological disorders (Meichenbaum, 1997), and nonadaptive coping strategies (Norris, Friedman, Watson, et al., 2002). The nature of the altruistic community over time is shown in Fig. 4.1. Social support deteriorates before recovery is

M.J. Zakour and D.F. Gillespie, *Community Disaster Vulnerability: Theory, Research, and Practice*, DOI 10.1007/978-1-4614-5737-4_4,

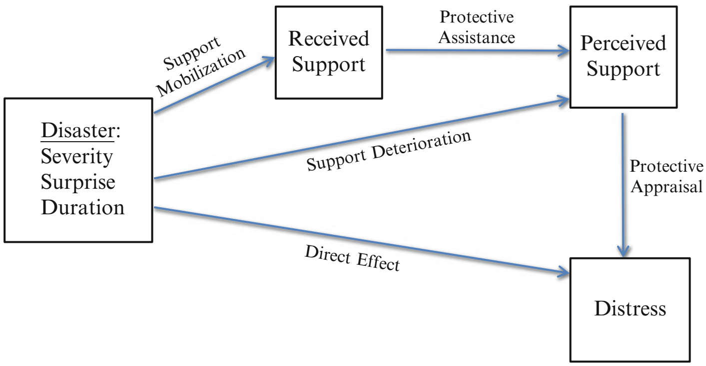


Fig. 4.1 Support mobilization and deterioration (adapted from Norris & Kaniasty, 1996)

complete, leading to a perceived lack of expected support. This process increases distress and decreases the chances for a resilient recovery.

Redundancy is the extent to which elements in a system are substitutable for each other (Streeter, 1992). If one element is incapacitated, then another element of the same kind can take its place and the system will continue to operate (Norris et al., 2008). Backup batteries for emergency radios are a good example of redundant elements. For social resources such as the support provided to individuals after a disaster, an individual has redundancy in their network by having more than one other individual or organization which provides the same type of resource (e.g., tangible, emotional, or informational). Redundancy is particularly important when a disaster is so severe that it damages the disaster response and recovery system of government and community organizations. Also, regional disasters make it more likely that the local community will have to rely on its own disaster response capacity for several days or even weeks in some parts of the world.

The rapidity of a resource refers to how quickly the resource can be mobilized during and after disasters. Timely provision of resources is very important in the initial hours and days after a disaster. Rapidity is important for disaster resilience not only because many needs after a disaster must be met within a short time period (e.g., medical treatment, debris removal, safety precautions, water and utility restorations) but also because socially marginalized groups are less likely to be provided resources for recovery in a timely fashion (Meichenbaum, 1997; Norris, Murphy, Kaniasty, Perilla, & Ortis, 2001). If some people receive resources in a less timely fashion than others, then the community is less likely to be on a resilient trajectory (Norris et al., 2008).

Resilience is a post-disaster process that can counter the debilitating effects from disaster vulnerability. Resilience and vulnerability tend to be inversely related, so that the factors enabling resilience tend to reduce vulnerability and vice versa. Because of this relationship the theory of vulnerability can be expanded and enhanced by explicitly incorporating resilience. Vulnerability can be reduced by reducing liabilities while strengthening capabilities in a community (McEntire, 2004a, 2004b, 2005). Promoting opportunities for resilience to emerge and thrive in disaster response and recovery periods helps reduce community disaster vulnerability

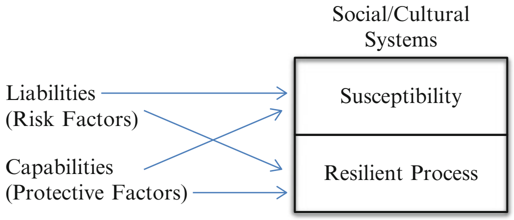


Fig. 4.2 Risk and protective factors in vulnerability. *Note*: The *horizontal arrows* indicate a positive relationship, while the *slanted arrows* indicate a negative relationship (adapted from McEntire, 2007a, 2007b)

for future disasters. Figuring out ways to ensure the robustness of resources used in disaster recovery, develop resource redundancy across the community, and increase rapid mobilization would help increase the probability of resiliency (Norris et al., 2008), and at the same time contribute viably to vulnerability theory.

This chapter is organized into two main sections and a summary. We begin with an account of the risk and protective factors that operate at various levels to either constrain or facilitate the probability of resilient recoveries. These factors are discussed in two subsections, one covering factors that affect the likelihood of resilient recoveries but cannot be changed and the other covering factors amenable to change and thus candidates to consider for community intervention programs. Next we consider community adaptive capacities, including important facets of economic development, social capital, information and communication, and collective action. We conclude this chapter with a summary of the way that the process of resilience complements vulnerability theory.

Risk and Protective Factors

A variety of risk and protective factors have been found to either increase or decrease the impact of disaster effects (Meichenbaum, 1997). Factors that increase the negative consequences from disasters diminish the prospects of resilient recoveries, while factors that decrease the negative consequences enhance the likelihood and process of resilience. Figure 4.2 shows the relationships among risk factors, protective factors, susceptibility, and the process of resilience (McEntire, 2004a, 2004b, 2005). In this section we discuss eight risk and protective factors that affect the process of resilience. The first three of these factors are conditions to be acknowledged and accepted. They represent attributes of the disaster itself or pre-conditions of the survivors and thus cannot be manipulated or changed. The remaining five factors represent conditions that over time can be changed to improve the probability and functioning of resilient recoveries.

Factors to Acknowledge

The resilience process is affected by the severity of exposure to disaster. Exposure reflects the ways and degree to which individuals, households, or communities have been impacted by disaster. Exposure at the individual level includes bereavement, injury to self or family members, threat to life, panic attacks, viewing horrific or grotesque scenes such as large masses of mutilated or dismembered bodies, encounters with toxic substances, and property damage or financial loss (Norris et al., 2001). The more severe the exposure the more difficult it becomes for resilience to emerge.

Both survivors and recovery workers are affected by exposure. The exposure of recovery workers is related to the intensity and duration of their work with the survivors and families of survivors, identification with the survivors, and role conflict. Role conflict is pronounced for those who have suffered personal loss in the disaster. Exposure at the community level is reflected in survivor accounts of post-disaster conditions, aggregated individual data, and archival data of collective losses (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002). When community destruction is widespread, survivors tend to feel less positive about their physical surroundings, less enthusiastic, less energetic, and less able to enjoy life. Each of these conditions dampens the prospect of resilient recoveries.

Pre-disaster states of health and mental health affect the probability of a resilient recovery. In their study of evacuation needs in New Orleans, McGuire, Ford, and Okoro (2007) found that self-appraised health was negatively correlated with need for assistive devices during evacuation among people 65 and older with a disability. Those people who needed assistive devices were more likely to suffer from serious deterioration of their health and functioning during Hurricane Katrina. Individuals who experienced psychiatric symptoms before disaster are more likely to experience *new* symptoms or to experience a relapse in existing disorders (Meichenbaum, 1997). Additionally, personality traits such as neuroticism (the opposite of stability), worry, and anxiety are correlated with post-disaster symptoms (Norris, Friedman, Watson, et al., 2002). Given the relationships between pre- and post-disaster health and mental health, epidemiological block surveys of community health and mental health statuses can be useful additions to area hazard analyses (Galea & Norris, 2006).

Resilience is encouraged in response to natural disasters and discouraged in response to technological disasters. Traditionally, natural disasters were seen as "acts of God" and not the fault of people, and this generally inspired altruism. The altruistic community that emerges in natural disasters is less likely to emerge in technological disasters. Technological disasters involve acts of omission, in which accidents occur because of desires to save money, increase profits, cut corners in safety measures, or inadequate attention to long-term safety of industrial and technological facilities. Unlike "acts of God," acts of omission are characterized by a lack of social cohesion, conflict, and often litigation. Technological/industrial disasters tend to separate groups of people, and the affected groups are not open to outside volunteers (Kaniasty & Norris, 2009, p. 183).

Factors Amenable to Change

Resilience is affected by coping strategies. A counterintuitive finding is that higher levels of coping behavior tend to be associated with higher levels of distress after disaster. Norris, Friedman, Watson, et al. (2002) note that coping could be conceptualized as a response to distress or as an indicator of distress. Because individuals often use different kinds of coping simultaneously, it is very difficult to determine what type of coping works for which individuals, in what context, and at what time period after disaster. What is adaptive in one situation may not be in another, and what is adaptive at a particular point in time may not be adaptive at another point in time. However, avoidance and blame assignment are two kinds of coping that have been found to be particularly problematic. After controlling for severity of disaster exposure, North, Spitznagel, and Smith, (2001) found that coping methods of active outreach, informed pragmatism, and reconciliation were associated with decreased likelihood for psychiatric disorders. Encouraging these three coping strategies increases the probability of a resilient recovery.

Belief in one's ability to cope as implied in such constructs as self-efficacy, personal mastery, self-esteem, optimism, and hope have been consistently shown to lead to more positive outcomes and thus to underwrite resilience. How individuals perceive their coping capacity and level of control over outcomes is apparently more important than the actual coping behaviors. Children whose peers viewed their coping efforts as effective are less depressed after disasters (Norris, Friedman, Watson, et al., 2002). Lower distress has also been linked to higher self-efficacy, perceived control, self-esteem, trait hopefulness, future temporal orientation, and optimism. Hardiness, or dispositional resilience, has also protected family assistance workers and other adults from the effects of disaster-related bereavement. The shared meanings and beliefs in a community that underscore effective individual and community coping in disaster facilitate resilient recovery (Norris et al., 2008).

A predictor of social support following disasters is the willingness of people to ask for help, and social support lubricates the resilience process. Interestingly, the relationship between the extent of disaster exposure and help-seeking is counterintuitive. Persons who experience the highest exposure to disasters tend to be the least willing to ask for help (Kaniasty & Norris, 2009). Since support and aid resources after a disaster are limited, those willing to ask for help tend to receive the largest share of support. Younger adults, those with more money, and people with higher levels of psychological and social functioning are more likely to seek help. Widespread social support helps to enable and sustain resilience (Ronan & Johnston, 2001, 2005).

The contacts that people have are critical to the process of resilience. In disaster recovery, the altruistic community fades as social relationships deteriorate (Kaniasty & Norris, 2009, p. 184). The most severe cause of social support deterioration is the loss of important contacts through death, injury, and relocation (Meichenbaum, 1997). The deterioration of support networks begins shortly after disaster onset. There is less time for people to socialize, both because they are busy with the pressing demands of response and recovery and because social meeting places have been damaged or destroyed. Those who are most affected by the disaster suffer distress, loss of functioning, and mood problems, and these individuals are often isolated from potential sources of support. Insensitive, uninterested, or dismissive reactions from others impede the process of recovery for disaster victims (Kaniasty & Norris, 2009). The resilience process can be supported by facilitating contacts between people.

Resilience is constrained in communities that deploy a military strategy in responding to and recovering from disasters. Media reports that reinforce myths of looting, lawlessness, and the "war zone" metaphor make it more difficult for communities to recover by working together in a collaborative manner. The war zone metaphor is associated with curfews, limits on travel, and restrictions on movement around the community. A military emphasis discourages efforts at altruism, mutual aid, reaching out to marginalized groups, and community cohesion. Instead, the community is portrayed as an "armed camp" (Kaniasty & Norris, 2009, pp. 187–188).

Improvements in disaster resilience pay back in double since they expedite recovery from disasters and reduce vulnerability to future disasters. It is necessary to acknowledge the type of disaster, preexisting health conditions, and disaster severity because these conditions directly affect resilience. It is most useful to focus on coping strategies, beliefs, help-seeking, contacts, and organizational response and recovery strategies because these factors are amenable to change (Norris et al., 2008). Thus, they provide potential leverage points of opportunity for social work researchers, emergency managers, and other disaster workers seeking to minimize the negative consequences from disasters. Next we turn to community adaptive capacities which focus on resources that have the potential to reduce vulnerability and facilitate resilience.

Adaptive Capacities

Community adaptive capacity is a key concept in dealing with disaster vulnerability and resilience. Adaptive capacity is the ability of a community to work with evolving hazards in ways that reduce the likelihood of the occurrence and the magnitude of harmful disaster outcomes (Norris et al., 2008). The types of resources that can be helpful are wide ranging. When designing and implementing strategies to enhance resilience, communities need to consider what resources are needed and available (Cutter, Boruff, & Shirley, 2003). In this section we discuss four broad categories of resources, covering economic development, social capital, information and communication, and collective action.

Economic Development

Economic development can facilitate resilience (Norris et al., 2008). Researchers and practitioners alike view a community's level of economic development as a primary determinant of resilience as well as vulnerability (Wisner, Blaikie, Cannon, & Davis, 2004). Each of the various facets of community economic development plays a role in resilience. Peacock, Morrow, and Gladwin (1997) found that African-American survivors of Hurricane Andrew were less able to recover because of a lack of adequate property insurance (Girard & Peacock, 1997; Peacock & Girard, 1997). In their study of Blacks who survived Hurricane Katrina, Lee, Shen, and Tran (2009) found that having adequate insurance was negatively related to distress over the hurricane, and income was positively related to resilience.

The overall level of economic development determines the amount of resources available, the diversity of economic resources influences how quickly the community mobilizes, and the relative fairness in distributing disaster mitigation projects affects resilience. Collins (2008b) found that uneven economic development led to the inability of working class households to afford property insurance. Without adequate and fairly distributed economic development, it is difficult for a community to move in a resilient fashion toward disaster recovery and safer conditions (Meichenbaum, 1997).

The diversity of the local economy is related to community disaster resilience. Resilient recoveries are more likely in communities where households have assets and more than one means of livelihood. Communities with a limited range of teconomic diversity are more susceptible to losses from disasters. For example, communities that depend on resource extraction or tourism tend to have a non-diversified economy, and are thus more vulnerable in disasters. For these communities disaster generally disrupts natural resource extraction such as fishing, farming, mining, and other types of resource acquisition (Collins, 2008b). Tourism is most easily disrupted. Potential tourists do not want to risk cancelation of vacations because of disasters, or staying in hotels and resorts which may be damaged by disasters. In communities which have many different means of livelihood, such as industry, health care, education, and other services, some individuals can earn cash by helping in the cleanup or helping with the rehabilitation of persons who have been injured in disaster (Wisner et al., 2004).

Community resilience is also affected by distribution of economic resources, tangible and intangible (e.g., credit) during day-to-day conditions. Most societies are stratified in terms of distribution of economic resources. Sociodemographic categories such as very young children, female-headed households with young children, girls and women, ethnic minorities, recent immigrants, people of color, and older individuals are more likely to be concentrated in geographic areas with aging or inadequate infrastructures (Bolin, 2007). These people have less access to high quality resources and they are economically marginalized. With unfair and stratified access to economic resources on a daily basis, what would otherwise be a hazard with a minor impact becomes a devastating disaster for poor and socially marginalized groups (Oliver-Smith, 2004). After a disaster these groups will have diminished chances for resilience

Community resilience is further affected by the distribution of disaster mitigation (prevention) projects and tangible resources. If these resources are not fairly distributed, there has been a failure of economic development and a reduction in the community's ability to adapt to the local environment. Uneven distribution of tangible economic resources and projects for disaster mitigation has been observed in countries all around the world. Geographic areas differ greatly in disaster mitigation projects such as the quality of levees, retrofitting of infrastructures for earthquake and wind resistance, and evacuation planning (Cutter, 2006; Zakour & Harrell, 2003). Such disparities are particularly extreme in less-developed countries. High technology projects such as hydroelectric dams may provide additional energy for more affluent populations in a developing county, but these economic development projects greatly reduce the chances for resilience for poor populations who reside downstream (Wisner et al., 2004).

Social Capital

Social capital refers to the value of social relations in generating collective or economic results. In general, social capital consists of expected benefits from preferential treatment and cooperation between individuals and groups. Social capital is a valuable resource and vital for community disaster resilience. Social capital is the backbone of support received in disaster recovery Hurlbert, Beggs, & Haines (2001), and this support typically leads to a perception of high levels of available social support among those receiving it. Not surprisingly disasters can destroy social capital, usually through the death, incapacitation, and relocation of network members (Kaniasty & Norris, 2001). After the World Trade Center attack in 2001, Bonanno, Galea, Bucciarelli, and Vlahav (2008) found that social support was an important predictor of resilient outcomes. In addition to received and perceived support (Fig. 4.1), other aspects of social capital can be increased to enhance resilience and disaster recovery (Norris et al., 2008).

Two additional aspects of social capital are citizen participation and information searching. Citizen participation refers to individuals within the community taking on leadership and other valuable roles. In a disaster there are excessive demands on first responders, but many important and urgent needs cannot be addressed by first responders alone. Through what is called the mass assault individuals, bystanders, and survivors often take the initiative to care for themselves and others (Barton, 1969, 2005). Citizen participation helps to fuel resilience. A concerted effort at search and rescue, case finding, outreach, and leadership in voluntary and governmental agencies increases the likelihood of a resilient disaster response and recovery.

Citizen participation includes volunteering and voluntary association memberships. These actions increase the capacity of a community for resilient disaster responses and recoveries. Well-managed volunteer programs with effective citizen leadership and trained volunteers are an important resource for a community, especially in disaster (Zakour, 1996). If large numbers of individuals are actively engaged in their community, then contingent and emergent programs will provide support in a disaster. It can take days or even weeks for adequate help to come from outside the community or region hit by disaster. Disaster services from outside the local community are unlikely to be adequate or even available for the entire recovery period. Only with sufficient numbers of local people trained in disaster response and service provision will survivors of disaster receive adequate social support (Zakour, Gillespie, Sherraden, & Streeter, 1991).

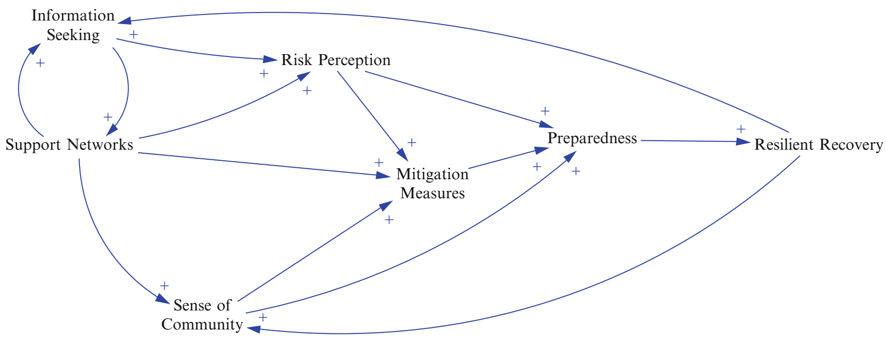


Fig. 4.3 Information seeking and resilient recovery

Information seeking is the active process of gathering information about risks and ways of mitigating risks. Information searching occurs through informal conversations, email exchanges, web searches, attending neighborhood and other community meetings, and reaching out to experts on the web (blogs), in universities, government agencies, and NGOs. Information seeking takes place through support networks and helps to strengthen those networks. Strong support networks contribute positively to a sense of community. Information obtained through social networks influences risk perception and mitigation measures such as planned evacuation routes (Gladwin, Gladwin, & Peacock, 2001). Risk perception and mitigation measures are both associated positively with disaster preparedness (Ronan & Johnston, 2005) as is the sense of community. And higher levels of preparedness yield more resilient responses and recoveries (Banerjee & Gillespie, 1994). Resilient recoveries feed back to strengthen the sense of community and promote continued information seeking. Figure 4.3 illustrates the process of information seeking and resilient recoveries.

A problem with the hypothesized process between information seeking and resilient recoveries is that all of the relationships are positive, and there are three reinforcing feedback loops within the process. Information seeking and support networks directly reinforce each other. Sense of community, mitigation measures, preparedness, and resilient recoveries reinforce each through two loops since sense of community is related to both mitigation measures and preparedness. All positive relationships indicate continuous and indefinite improvement. We know that this is not possible because there are limits to system growth. No system can exceed the boundary of its capacity. Social work researchers need to identify these limits and figure out ways of removing or reducing them.

When organizations in the community have cooperative ties with each other, resources of all kinds can be more quickly mobilized and delivered to geographic areas most in need of disaster aid. Cooperative links among organizations in disasters allow organizations to leverage their resources through resource exchange. A formal kind of relationship among organizations is coordination. If the disaster response and recovery efforts are coordinated, organizations exchange a variety of different kinds of resources and their frequency of interaction is likely to be high (Gillespie, Colignon, Banerjee, Murty, & Rogge, 1993; Gillespie & Murty, 1994). We describe various types of networks in Chap. 8. It is not known at present which levels and types of coordination are best for each type of disaster context. There is a lack of knowledge about the match of relationship types with specific disaster contexts. Given the current state of knowledge, flexibility and creativity are emphasized in forming organizational relationships in disasters (Norris et al., 2008).

Local emergency planning committees (LEPC) facilitate disaster preparedness and thus enhance the likelihood resilient recoveries. The LEPC assess risks, acquire resources, develop hazmat teams, and identify evacuation routes. Cities may use several LEPC to monitor development, enforce building codes, establish warning systems, enhance bioterrorism preparedness, plan drills, carry out exercises, and protect critical infrastructure. Local governments are major players in emergency management, but they are not the only actors. Regional partnerships are needed among organizations to promote maximum effectiveness. Grants for emergency managers are now provided on a regional basis to promote organizational cooperation (McEntire, 2007a, 2007b). Increasing organizational volunteerism is another way to promote regional cooperation (Zakour, 1996). The more such cooperation is established the easier it becomes for resilience to emerge and succeed.

Two closely related aspects of social capital are a sense of community and place attachment. A sense of community includes shared values and mutual concerns among community members, as well as a perception that needs are fulfilled. A strong sense of community is promoted by social support networks with high levels of accessibility and reciprocity among its members (Wellman & Frank, 2001). These networks govern the acquisition and exchange of resources needed to prepare for, respond to, and recover from disasters (Benight, McFarlane, & Norris, 2006). Disasters sometimes lead to a diminished sense of community, but other times they strengthen identification with the community (Norris et al., 2008). Closely related to a sense of community is community-mindedness, which is reflected in things like involvement with community organizations, length of residence in a neighborhood, and attachment to place (Ronan & Johnston, 2005). Another similar concept is the bond people have with their community. This refers to a strong affiliation and commitment to residence and also workplace communities. High levels of community-mindedness, sense of community, or community bonds facilitate the dissemination of preparedness measures. As noted above, higher levels of preparedness increase the probability of a resilient response and recovery.

Place attachment refers to an emotional connection to one's community as a geographic place. This kind of attachment is based mostly on attachment to the natural, physical, or built environment, rather than the social environment. This makes place attachment different from a sense of community and related concepts. Place attachment is a valuable resource in neighborhood and community revitalization projects. The pride of place associated with these projects also supports resilience. At the community level, attachment to place leads to greater efforts at community revitalization, as well as altruism and community spirit. Place attachment is especially salient in disasters, which have spatial dimensions and disrupt the spatial patterns of neighborhoods (Norris et al., 2008). These disruptions threaten definitions of self and community identity. Individuals and communities with strong pre-disaster place attachments will often mourn for a place largely destroyed in disaster (Oliver-Smith, 2004).

Place attachments can inhibit resilient recoveries in some disasters, while in others resilience is enhanced. Disaster resilience will be enhanced when disaster survivors come together after a disaster in a spirit of altruism and tcommunity-mindedness to pursue neighborhood or community revitalization. Such revitalization projects are usually based on the vision of one or a few individuals. If the vision is realistic and potentially achievable, and the leaders are politically adept at minimizing or avoiding conflict, then a satisfying social pattern and culture is likely emerge (Wallace, 1956/2003). The revitalization project may even result in recovery to a level of community functioning that exceeds pre-disaster functioning. This condition represents the best of a resilient recovery and has been referred to as “adversarial growth” (Tedeschi & Calhoun, 2004) or the “Phoenix Effect” (Dyer, 1999).

Information and Communication

Opportunities for self-disclosure in an emotionally supportive setting are important for cognitive processing of disaster losses. Cognitive and emotional processing facilitates resilient recoveries because they generally lead to a sense of purpose related to recovery and rebuilding, as well as new meanings, new assumptions, and more realistic worldviews (Wallace, 1956/2003). Working through or resolving trauma has to do with integrating and constructing a revised or new worldview, moving beyond the event, and gaining a coherent framework for cognitive processing. This cognitive reprocessing also includes making sense of what happened, searching for meaning, and pursuing comprehensibility through meaningful responses (Tedeschi & Calhoun, 2004). To the degree this cognitive processing is absent, psychological distress and psychiatric symptoms will occur, resilience will be compromised, and hence the recovery will be slower (Meichenbaum, 1997).

Cognitive reprocessing at both the individual and community level is promoted through community narratives about the disaster. Community narratives construct and reinforce shared meaning and purpose. Group accounts of the situation, which include narratives and symbols, can act as a mechanism for empowerment. Cognitive reprocessing of the situation often forms the core of a revitalization project (Wallace, 1956/2003) thus enhancing the recovery. A resilient recovery is also directly enhanced by community narratives, and feeds back to enrich those narratives. Narratives which emphasize community efficacy in response to disaster, and a belief that pre-disaster social customs and practices will be restored or replaced with something better are associated with higher levels of wellness (Norris et al., 2008). Figure 4.4 illustrates the reinforcing process of community narratives and resilient recoveries.

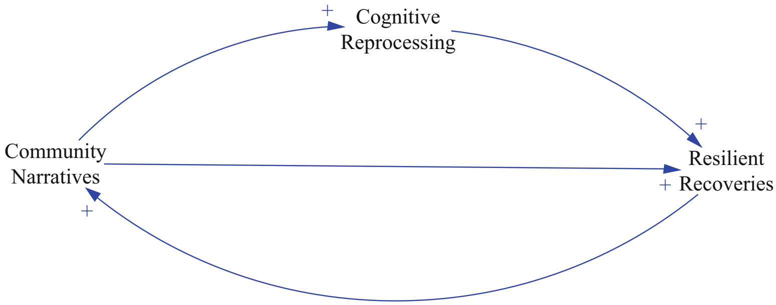


Fig. 4.4 Community narratives and resilient recoveries

When a segment of the community has a high level of skills related to disaster preparedness (readiness), these individuals and organizations can serve as exemplars for others when disaster strikes. The presence of exemplars is a definite boost to a resilient recovery. Modeling the resilience-relevant behaviors of others facilitates the recovery. Modeling includes seeing other people such as friends, family, neighbors, work associates, nonprofit organizations, government agencies, and businesses dealing effectively with problems caused by disaster. Modeling appears to have at least some role in education efforts, perhaps most importantly in motivating people to consider taking some initial action (Ronan & Johnston, 2005, p. 26).

Research has identified a number of obstacles to preparedness (Drabek, 1986; Gillespie et al., 1993, pp. 35–46). Among these barriers are warning messages that do not provide specific guidance, messages that are inconsistent, messages that are not repeated over time, and messages that do not emphasize controllable and preventable aspects of hazards. If community members do not have multiple trusted sources for information on disaster preparedness, they are less likely to initiate disaster readiness and household mitigation such as evacuation, and this dampens the probability of resilience (Burnside, Miller, & Rivera, 2007). Also, if information emanates from a single trusted source, then repetition of preparedness information will be less effective than multiple trusted sources repeated the same information using different types of media such as weather radio, television, radio, the Internet, the printed media, and public information campaigns based in organizations (Meichenbaum, 1997; Ronan & Johnston, 2005). Resilience is facilitated through a wide base of trusted sources of information using many different types of communication media (Simonovic & Ahmad, 2005).

In non-disaster periods, media sources that sensationalize the massive destruction that disasters can cause are ineffective in encouraging preparedness within a community, and as such reduce the prospects for resilient responses and recoveries. Though scenes of total destruction may improve ratings, such information can cause community members to become resigned to the possibility that little can be done. If, however, the media emphasizes practical steps that can be taken to minimize disaster losses, and shows people taking these steps, they serve to increase both preparedness and the probability of a resilient recovery (Ronan & Johnston, 2005).

Collective Action

Collective action is the pursuit of a goal or set of goals by more than one person. Community resilience depends on collective action. Collective action in the community context draws on the human capital and organizational skills of a community. Community organizers and developers work through ideologies and other root social causes to foster collective action and build community capabilities, each of which enhance the emergence of resilience following a disaster. Collective action manifests through collective efficacy, community action, political partnerships, flexibility and creativity, and critical reflection and problem solving skills (Norris et al., 2008).

Collective efficacy is the ability of members of a community to organize into networks and make decisions that will improve the quality of life for the community. The higher the quality of life the more likely resilience will emerge when needed. Communities with collective efficacy tend to succeed in the community change process. This is because collective efficacy helps to bring about an increase in resources or access to resources previously denied (Norris et al., 2008). Collective efficacy is a key resource that helps to enable resilience after a disaster strikes. Collective efficacy promotes self-efficacy at the individual level, and both types of efficacy facilitate wellness (Benight, Ironson, & Durham, 1999). Improved access to resources represents a progression toward safety for a community, and collective efficacy plays a key role in determining whether a community will follow a resilient trajectory or become increasingly vulnerable to disasters (Wisner et al., 2004).

Community action refers to the ability of people to organize for a specific purpose and if necessary engage in adversarial action to achieve their purpose. When such organizing happens in response to disaster, it bolsters the resilience process. The general goal of community action is to gain access to more resources, to a wider range of resources, or to higher quality resources. Social action is one model of community practice in social work. In social action models, a community leader or a professional organizer works for a segment of the community which suffers from relative deprivation of money, status, or social capital. Community action typically involves the organized segment challenging those who are benefiting from the status quo. When community action succeeds, it strengthens the likelihood of a resilient recovery, distributes community resources more equitably, and lowers vulnerability (Norris et al., 2008).

Political partnerships within the community, among different communities, and between local, regional, and national governments are an important type of resource for disaster vulnerability and resilience. Within the community, political partnerships will enable coordination among different governmental and other organizations. Conflict, which can result from attempts to cooperate in a disaster, will be minimized. If political partnerships are already present among communities before disaster occurs, then cooperative exchange of resources including information is more likely to take place. Because of the regional nature of many disasters, partnerships with state, regional, and national governments are essential for the recovery process

(Sundet & Mermelstein, 2000). In the response to Hurricane Katrina the lack of political partnerships between the affected region and state and federal governments greatly slowed the recovery. The continued lack of these political partnerships in South Louisiana increases the area's vulnerability and reduces the probability of a resilient recovery from future disasters.

Flexibility and creativity are extremely important for resilient recoveries from disaster. If a community is not flexible and relies on traditional authority and bureaucracy to meet the needs of the community, the community is less likely to recover in a resilient manner. Low levels of flexibility and a lack of creativity are limitations that many rural communities share. These communities often have a backward-looking worldview which inhibits the flexibility and creativity needed to cope in disasters (Sundet & Mermelstein, 2000). Major disasters have synergistic effects which are difficult to fully anticipate. Disaster planning will be inadequate unless flexibility and creativity is built into plans. Communities with flexible and creative disaster plans are more likely to experience resilient recoveries from disasters (Norris et al., 2008).

Another kind of collective action, closely related to the locality development model of community organization, is disaster problem solving. In the locality development model community members organize and make decisions about pressing problems or opportunities presented by disasters. In disaster problem solving, participants make decisions about their problems, opportunities, goals, and methods for addressing important community issues. Problem solving may be facilitated by a professional community practitioner. Critical reflection and problem solving, both central to locality development, are evidence-based. Sustainable community change can be promoted by maintaining leadership skills within the community, and forming an organization to sustain the achievements of community development.

We have shown in this section how the adaptive capacity of a community operates across a wide spectrum of resources to reduce disaster vulnerability and enable resilient recoveries. Community resources come from economic development, and the likelihood of resilient recoveries is increased with adequate and fairly distributed economic resources. Social capital is another adaptive capacity vital for disaster resilience. Resilient recoveries are made possible through citizen participation and cooperating organizations along with the sense of community and attachment to place. Communication and information are adaptive capacities that facilitate resilience through narratives that create shared meaning, skills training, and trusted sources of information. Community collective action is an adaptive capacity that draws on human capital and organizational skills to build collective efficacy, promote community action, develop political partnerships, create flexible and creative disaster plans, and facilitate problem solving.

Summary

In this chapter we have discussed how the concept of resilience expands and complements vulnerability theory. Although the nature of these two concepts is very different, they are complementary. Vulnerability is a state variable based on

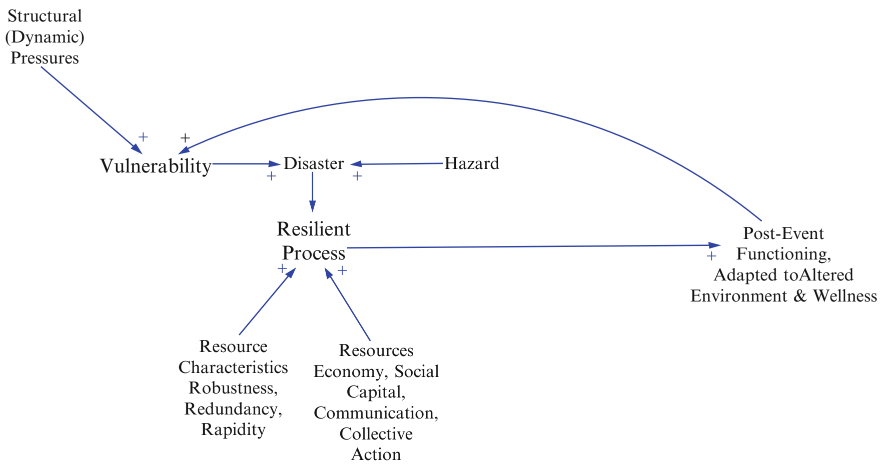


Fig. 4.5 Vulnerability and resilience

unsafe conditions that accumulate and interact with hazards to create disasters. Resilience is process based on resources implemented in response to disasters. Thus vulnerability happens before disaster while resilience happens after disaster. The probability of disaster is higher in communities characterized by high levels of vulnerability. Recovery from disaster is slower in communities lacking in the resources needed to energize and sustain a resilient recovery. Reducing the level of vulnerability tends to increase the probability of a resilient response and recovery (Fig. 4.5).

Adequate resources are essential for community disaster resilience. Important attributes of resources are robustness, redundancy, and rapidity of resources. Robustness is the strength of a resource. Robust resources mean they will be accessible throughout the recovery process. Redundancy is the extent to which elements in a system are substitutable for each other. Redundancy is particularly important when a disaster is so severe that it damages the disaster response and recovery system in a community. The rapidity of a resource is how quickly the resource can be mobilized in a disaster. This is important because socially marginalized populations are less likely to quickly receive recovery resources.

Risk and protective factors in disaster operate to increase or decrease the impact of disaster effects, which correspondingly enhance or dampen the likelihood and process of resilience. Some of these factors are attributes of disaster (severity of exposure, disaster type) or pre-conditions of the survivors (health) and therefore can only be acknowledged and accepted as part of the situation. Other factors are conditions or processes that can be changed to improve the probability and functioning of a resilient recovery. These factors include coping strategies, beliefs, help-seeking, contacts (networks), and community response strategy.

Community resilience is "a process linking a set of networked adaptive capacities to a positive trajectory of functioning and adaptation in constituent populations after a disaster" (Norris et al., 2008, p. 131). In other words, a resilient recovery makes effective use of community resources. Four types of community adaptive capacities are economic development, social capital, information and communication, and collective action. Economic development refers to the level and diversity of economic resources, and the fair distribution of economic resources, including disaster mitigation projects. If a community has a diversity of economic activities and industries, some industries can be emphasized when others are destroyed in a disaster.

Social capital refers to the value of social relations in generating collective or economic results. It consists of received and perceived support, organizational linkages and cooperation, citizen participation, and a sense of community and attachment to place. Citizen participation and leadership includes volunteering, active membership in voluntary associations, and the mass assault in disasters. Cooperative links and coordination of interorganizational networks allows relief aid to be rapidly mobilized and delivered. A sense of community includes shared values and mutual concerns among community members, as well as a perception of needs fulfillment. Place attachment refers to an emotional connection to one's community as a geographic place. At the community level, attachment to place encourages community revitalization, as well as altruism and community spirit.

Information and communication includes community narratives, skills and infrastructure, trusted sources of information, and a responsible media. Narratives which emphasize community efficacy in disaster response and a belief that pre-disaster social customs and practices will be restored or improved are associated with resilient community recovery from disaster. A second aspect of information resources is infrastructure and skills. When some members of a community have high skill levels relevant to disaster response and recovery, these individuals can serve as examples to expand community capability. Multiple trusted sources of information can reinforce each other's messages, promoting community disaster preparedness. Finally, when the media emphasize specific steps to be taken to minimize disaster losses and avoid sensational disaster reporting, communities are more likely to prepare for disasters.

Collective action includes political partnerships, flexibility and creativity, critical reflection and problem solving skills, collective efficacy, and community action. Political partnerships facilitate coordination among governmental and other organizations. Flexibility and creativity are important given the emergent nature of disaster impacts. Problem-solving in disasters is closely related to locality development in community organization. Through problem-solving community members identify pressing problems or opportunities in disaster recovery. Collective efficacy is the ability of members of a community to organize and make decisions to improve their quality of life. A sense of collective efficacy is belief in the ability of a group or social network to achieve community change.

Norris et al.'s (2008) finding that resilient community recoveries from disaster are facilitated by shared meanings and beliefs regarding effective individual and community coping supports the tenth assumption of vulnerability theory regarding the central importance of culture, ideology, and shared meaning (Chap. 2, pp. 24–25). Also Oliver-Smith (2004) found that disasters can disrupt place attachment which compromises identity with the community. This assumption is also supported by Tedeschi and Calhoun (2004)) finding that cognitive reprocessing helps people make sense of what happened and facilitates a search for meaning (Chap. 2, p. 24).

In Chap. 5 we introduce the linear methods used in vulnerability research. These methods include ordinary least squares regression, logistic regression, hierarchical regression, path analysis, and structural equation modeling. Each of these methods is designed to address certain kinds of questions. Our examination of these methods and questions reveals the points of greatest interest in vulnerability theory. Almost all of the support that currently exists for vulnerability theory has been produced with linear methods.

Chapter 5
Cross-Sectional Design and Linear Statistics in Vulnerability Research

In this chapter we examine the cross-sectional research designs and linear statistics used in community disaster vulnerability research. The foundation of vulnerability theory is based on cross-sectional data and linear statistics. Cross-sectional designs are by far the most popular type of research done on vulnerability. Similarly, linear statistics account for the vast majority of empirical results reported in the vulnerability literature. The advances in linear statistical modeling over the past several decades have made it possible to squeeze more value out of cross-sectional designs.

This chapter is structured with two main sections and a summary. We begin with an overview of cross-sectional design. A brief account of the characteristics distinguishing cross-sectional design is given, and the advantages of this design for vulnerability research are discussed. We compare cross-sectional designs to experimental designs and note some of the reasons for choosing a cross-sectional design over an experimental design. We also consider the utility of cross-sectional designs for both descriptions and hypothesis testing. Next we consider linear statistical models. We discuss and give examples of disaster vulnerability research using linear regression, logistic regression, hierarchical regression, path analysis, and latent variable structural equation modeling (SEM). We conclude this chapter with a summary of the linear methods used in developing vulnerability theory.

Cross-Sectional Design

Cross-stated designs are the most widely used type of research in the study of disaster vulnerability and resilience. The primary characteristic of cross-sectional design is data collected at one point of time; this is the basis for the name "cross-sectional design." Because the data are collected at one point in time none of the variables are manipulated. Similarly, all variables are assumed to vary naturally. Like other kinds of research designs, measures are taken on at least one variable and most often a set of independent variables and one or more dependent variables (de Vaus, 2001).

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The cross-sectional design is well suited for exploring or testing the relative importance of different variables. This design is also appropriate to describe clusters of interrelated variables. For example, considerable disaster vulnerability research has examined patterns of association among community socio-demographic variables. This research has found that race, gender, age, and socioeconomic status are associated with disaster vulnerability, susceptibility, resilience, wellness, and access to resources such as social capital (Bolin, 2007; Kaniasty & Norris, 2009; Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008).

The cross-sectional design has a number of practical advantages. First, data can be collected more quickly because as noted above the data are collected at just one point in time. Most often this point in time has been after a disaster has occurred. There is no need to wait any amount of time for data collection, for example until an intervention has been performed. Second, with a cross-sectional design data can be analyzed shortly after data collection. Third, cross-sectional designs are typically less costly to execute than longitudinal or experimental designs. In a cross-sectional design there are no costs from applying an intervention, repeated sampling, or tracking respondents over several data collection points. Only a small percentage of vulnerability research studies use longitudinal designs (Norris, 2006; Norris & Elrod, 2006), and very few disaster vulnerability studies have used experimental designs (Galea & Maxwell, 2009).

When research with a cross-sectional design is cross-cultural or cross-national, the investigator must clearly specify the nature of the concepts in both cultures/societies. If such research is descriptive in nature, the variables can be measured with a high degree of specificity. Cross-cultural designs help to establish one dimension of generalizability among variables. Cross-cultural designs can accommodate the full range of variation characterizing variables, and higher degrees of variation allow for more precise parameter estimation. Finally, comparative cross-sectional designs allow for the development of new concepts, theoretical insights, and hypotheses.

Cross-Sectional Compared to Experimental Designs

In cross-sectional design independent and dependent variables need not be temporally contiguous, although in testing hypotheses careful attention must be paid to causal ordering. Careful thought must be given to causal ordering because the design provides no help in determining the direction of causal effects. It is impossible to include a control group in cross-sectional designs (Warwick & Lininger, 1975). On the other hand, observing the effects of race on life experiences can require a long time, making longitudinal and experimental designs less feasible than cross-sectional designs. In addition, certain attribute variables such as race, gender, and age cannot be manipulated by investigators.

Another difficulty with using experimental designs in vulnerability research is the impossibility of random assignment of individuals into racial, ethnic, or gender groups to form comparison or control groups. An added complication is that many independent variables of interest to investigators in vulnerability research, both attribute and relational, are associated together. For example, a person's age is positively associated with having disaster experience (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002), and negatively associated with size of the individual's social support networks as well as access to tangible social support after a disaster (Kaniasty & Norris, 2009). These associations make experimental control of extraneous variables difficult if not impossible.

Certain analyses in conjunction with cross-sectional designs can loosely approximate the design advantages of experimental research. Cross-sectional designs which use elaboration can partially address the issue of group comparability through control of extraneous variables. The problem of temporal continuity can be addressed through theoretical specification of intervening variables. Even when experimental designs are used, it is difficult to establish causal relations because it is impossible to identify or control all extraneous variables (Blalock, 1964). Reality is messy, and our attempts to develop linear approximations to aspects of this reality are invariably to some degree incorrect. As Deming (1994) noted, "all models are wrong; some are useful."

Description and Hypothesis Testing

Cross-section designs can address both description and hypothesis testing. With designs for description the primary goal is precise measurement of a phenomenon using validated instruments. Description sometimes leads to the creation of hypotheses. Such hypotheses are often examined initially using the development sample even though this does not and cannot constitute a test of the hypothesis. Eventually and necessarily hypotheses must be tested with data from a new sample. Hypothesis testing goes beyond the empirical evidence of relationships among variables by explaining why or how it is that those relationships exist. Theory is expressed through hypotheses. Hypotheses state causal direction, relationship polarity, and a reason for the relationship. Often the logic underlying the reasons for the relationships reflects the theory.

Theory requires multiple independent studies carried out by different researchers. A researcher at a given point in time may initiate theoretical inquiry by stating and testing one or more hypotheses. Only when these initial findings and the reasons for them are upheld by other researchers we do have the beginning of theory. Theory is supported by replication through numerous independent research studies in a variety of contexts (Zakour & Gillespie, 2010). Theories persist by resisting refutation. That is, theory is considered valid as long as data continue to support its hypotheses. Since the data from any sample may be consistent with and support more than one hypothesis, it sometimes happens that the data support both the original hypothesis and a competing hypothesis. When this happens, it is necessary to refine the theory.

In cross-sectional designs, much can be learned about the nature of the relationship between any two variables by controlling for a third variable, traditionally called a test variable (Rosenberg, 1968). This kind of analysis yields convincing support for vulnerability theory. Theory and previous research is used to guide the selection of variables for inclusion. The theory implies a certain pattern of relationships among the variables.

Linear Statistics

In this section we describe a series of linear statistical models. Each of these models is part of the same statistical family, called the general linear model (McCullagh & Nelder, 1989). We begin with multiple regression and logistical regression, then progress through hierarchical regression, path analysis, and latent variable modeling. Except for logistical regression, which is an adjustment to accommodate categorical data, each step of this progression reveals an expansion in model capability, giving researchers increasing flexibility in testing hypotheses. While the more advanced statistical models allow testing of complex structures, the basic assumptions of the general linear model apply to all of these models.

An early and critical consideration for all statistical models is the selection of variables. Careful selection of variables is arguably the single-most important aspect in addressing any research question. There is no method that can correct or overcome the error and distortion introduced by choosing irrelevant or inappropriate variables or by omitting relevant and appropriate variables. It is the content of the variables that connects directly with the questions about disaster vulnerability. These questions reflect particular aspects of the theory. Each of the statistical models discussed has the capacity to answer a variety of research questions.

Regression

Linear regression describes the relations of a continuous dependent variable on a linear combination of independent variables. Regression is particularly useful in naturalistic settings with continuous variables that cannot be manipulated. Multiple regression coefficients indicate the amount of explained variance in a single dependent variable; the variance accounted for by the set of independent variables. Sequential regressions indicate how much of the variance in a dependent variable is accounted for by each independent variable, after the variance accounted for by the independent variables already entered into the regression equation are controlled for (Tabachnik & Fidell, 1996).

Regression can be used to predict within a limited time frame. Multiple regression coefficients are directional. For example, if we estimate the relationships between three variables in two alternative models—Model A, $x1 = a + b2 \times 2 + b3 \times 3 + e$, and Model B, $x2 = a + b1 \times 1 + b3 \times 3 + e$—we will find that the relationship between $x1$

and $x2$ will be different in the two models. Generally, the model selected as most accurate is the one most consistent with the theory. Although the directionality of multiple regression coefficients is suggestive, the fact that cross-sectional data is collected at a single point in time means that predictions cannot be established through the use of regression alone. Additional evidence supporting or failing to support prediction can be produced by dividing samples into subgroups where various levels of the dependent variable can be examined to more precisely specify the pattern of associations between each independent variable and the dependent variable.

Several recent studies have used regression analysis to find ways of facilitating the resilience and psychosocial functioning of persons with disabilities. Arlikatti, Lindell, Prater, and Zhang (2006) measured the lowest category of hurricane that respondents intended to evacuate for. This variable is a dispositional variable associated positively with actual behavior in a hurricane disaster. The authors included contextual variables such as warnings from public officials and from informal networks of family, friends, and neighbors. Though this study surveyed respondents at a single point in time, prediction of future behavior was possible through the use of a dispositional variable known to be positively associated with the future behavior of interest (Lindell, Lu, & Prater, 2005).

McGuire, Ford, and Okoro (2007) used 2003–2004 data from the Behavioral Risk Factor Surveillance System to estimate the number of individuals in the New Orleans Standard Metropolitan Statistical Area with a disability who needed assistive equipment during disaster evacuation. As Fig. 5.1 shows, evacuation before a hurricane is critical, given the large percentage of the city below sea level (shaded in blue). The focus of this research was not only to provide information for emergency planners regarding the need to evacuate disabled individuals with their equipment, but also to estimate the need for this equipment during evacuation by the categories of respondents. Their sample consisted of 47,840 individuals aged 65 and older with a disability. Of this number over half—24,938 (52%)—required the use of special assistive equipment. The investigators found that the need for assistive equipment was positively associated with being female, unmarried, and white, and negatively associated with self-reported health status (from poor to excellent). This finding is consistent with the sixth assumption of vulnerability theory that demographic variables are associated with vulnerability but do not cause vulnerability (Chap. 2, p. 12).

Logistic Regression

Logistic regression is similar to linear regression, except that logistic regression provides the probability of a case being in one condition versus another. Logistic regression is often used when the outcome variable is a health condition, such as the presence or absence of illness in a population. This means that the dependent variable in logistic regression is either dichotomous, nominal, or ordinal with only

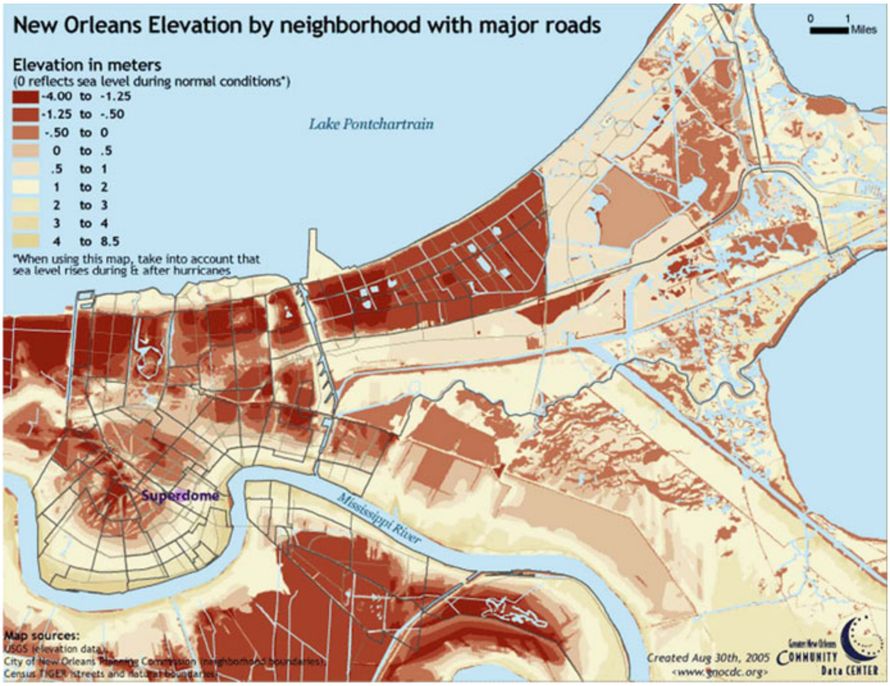

Fig. 5.1 Elevation of New Orleans, Louisiana. This figure shows the elevation of areas of New Orleans with elevations below sea level are in a darker shade. *Source*: http://www.flickr.com/photos/maitri/2232651989/sizes/o/in/photostream/

a few categories. Logistic regression is particularly useful when the relationship between the dependent variable and one or more of the predictor variables is assumed to be nonlinear. Like linear regression, logistic regression is useful because a linear combination of a set of two or more predictor variables can be measured as continuous, discrete, or dichotomous variables. Unlike linear regression, logistic regression makes no assumptions about predictor variables in terms of normal distribution or linear relationships among predictor variables.

The major goal of logistic regression is to predict the category of outcome on a probabilistic basis. For example, the two categories might be "resilience trajectory" and "progression to vulnerability." The investigator may wish to understand the probability of selected communities being assigned to the resilience versus the vulnerability conditions. The predictors could be the characteristics of resources useful for disaster response and recovery, such as robustness, redundancy, and rapidity of mobilization. Another potential set of predictors involves the nature of exposure to the hazard, including severity, duration, and the degree to which the disaster was a surprise.

The investigator may also want to understand which predictors, and interactions among predictors, are related to the probability of placing cases in the resilience category as compared to the vulnerability category. Because not all of the predictors or interactions among predictors will be related to the dependent variable, the investigator

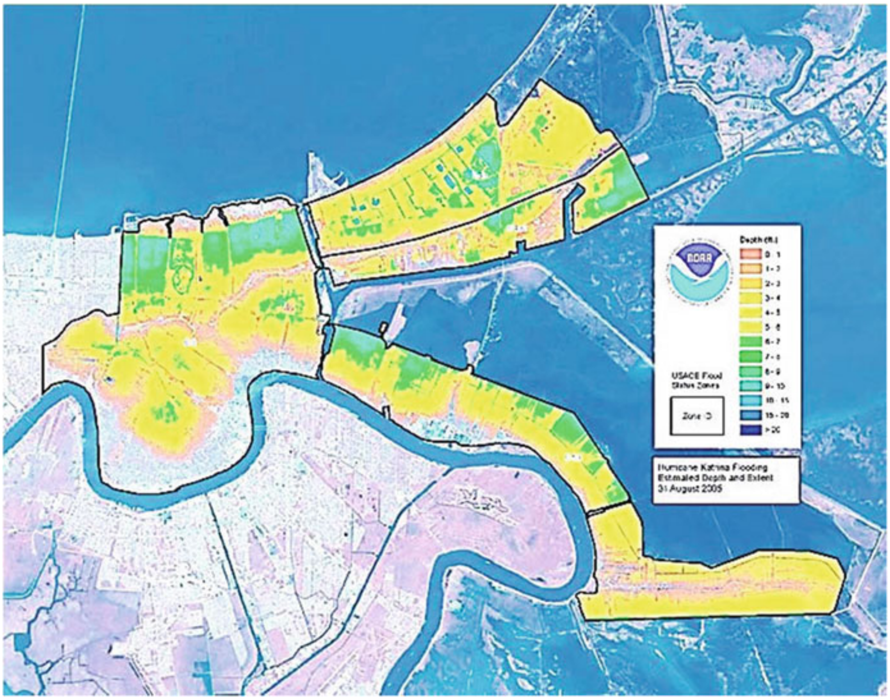

Fig. 5.2 Flooding in New Orleans after Hurricane Katrina. *Source*: http://www.katrina.noaa.gov/maps/images/katrina-flood-depth-estimation-08-31-2005b.jpg

can use goodness-of-fit tests to choose the logistic regression model which best predicts the outcome, with the fewest number of predictors. Logistic regression methods can also help in finding the relative importance of independent variables in predicting the outcome. Some two-way or higher order interactions among predictor variables may contribute to predicting the outcome of either resilience or vulnerability. For example, rapidity of resource mobilization may interact with the degree of unexpectedness of the hazard to increase the probability of either resilience or vulnerability.

Burnside, Miller, and Rivera (2007) examined the determinants of disaster evacuation in New Orleans several years before Katrina occurred. Figure 5.2 is a depiction of the depth of flooding in Hurricane Katrina, and the figure emphasizes the necessity for accurate hurricane and flood risk assessment by residents of New Orleans. Because there were two values for the dependent variable (1 = evacuate, 2 = shelter in place), logistic regression was used to analyze the data. One dispositional independent variable in this study was assessment of significant personal risk from major hurricanes. Data were collected over a 6-week period using random digit dialing to interview respondents by phone. There was a single wave of phone interviewing. Several demographic variables, a number of dummy variables which indicated whether respondents relied on different potential sources of information, and a risk assessment variable were all part of the interview schedule.

The risk assessment variable along with several of the information source dummy variables (reliance on governmental officials, television/internet, or family and relatives for evacuation warnings) were shown to add significantly to prediction of intention to evacuate in a category-3 hurricane. Because intention to evacuate is a dispositional variable shown to be strongly related to actual evacuation in a major hurricane, the cross-sectional design in this study showed support for the hypothesis that evacuation behavior is predicted and likely caused by the use of trusted sources of information.

Hierarchical Regression

Hierarchical linear models extend regression analysis. This technique goes beyond regression by testing the causal connections among exogenous, intervening, and outcome variables of interest. Methods for using regression analysis to understand the impact of variables at one level of analysis on variables at another level of analysis have been useful in vulnerability research on social capital and social networks (Zakour & Gillespie, 2010).

Hierarchical logistical regression methods use betas obtained at one level of analysis as error coefficients for regressions examining relationships among variables at another level of abstraction (Wellman & Frank, 2001). This technique is consistent with the idea that disasters are multidimensional and affect systems at all levels (Soliman, 1996; Zakour, 2008b). The network of an individual is often studied to understand which aspects of the network affect the amount of social support the individual receives. Hierarchical models assess the effects of others on social support at the first level, and the effects of the whole network on social support at the second level. We can also examine the interaction effects of variables at the different levels.

In their multilevel analysis of social support, Wellman and Frank (2001) were able to distinguish the effects of particular others from the network effects on social support in an emergency. Relationships among parents and adult children were shown to be more likely to involve social support in an emergency. Networks with a higher percentage of parents and adult children were also more likely to involve social support among parents and adult children. Relationships with people who were accessible were associated with provision of social support in an emergency. Additionally, networks with higher percentages of people who were accessible were more likely to involve the provision of social support in an emergency.

Networks of women were more likely to involve provision of social support in an emergency. At the network level, networks with a high percentage of women as actors were especially likely to involve provision of social support in an emergency. Finally, the effect of reciprocity on the provision of social support represents a different pattern of relationships than shown with parents and adult children. The reciprocity of individual ties does not add any unique and significant explanation of variance (Wellman & Frank, 2001). The authors suggest that exchange relationships and the frequency of exchange are important for building shared meaning within networks, and especially norms of reciprocity and social support in emergencies.

With contextual variables we can explore the conditions under which relationships among variables exists. For example, relative need in a disaster may determine the amount of social support and aid that the altruistic community provides to individuals, but this relationship might only hold in rural communities of developed nations, but not in urban communities or in rural communities in less-developed nations. When the original interpretation of the correlation among variables is challenged by seeking conditional relationships, the danger of excessively global or inexact generalizations is reduced. If interpretation of a relationship is radically revised through finding conditional relationships, this revision can press theory in new directions. Use of designs which can potentially reveal conditional relationships facilitate comparative research which includes several different kinds of communities in a single research project. Conditional relationships can provide new theoretical insights and hypotheses.

Path Models

Path analysis facilitates testing theoretical models. While regression models explain variance in a dependent variable by a linear combination of independent variables, path analysis goes beyond regression to determine indirect and direct relationships among a set of variables. Path models are developed to gain a more complete understanding of the relationships between all of the variables, regardless of whether they are independent, mediating, or dependent variables in a regression. The pattern of relationships in a theoretical model goes beyond the contribution of each independent variable to the dependent variable's variance, to more precisely describe the set of relationships (Zakour & Gillespie, 2010).

Path diagrams display a set of related variables with unidirectional arrows among the variables. By convention the unidirectional arrows are between two variables, with the arrows pointing to the right side of the diagram or sometimes upward or downward. The unidirectional arrows represent the direction of causality from one variable to another, so that the exogenous variable(s) is (are) on the left side of the path diagram. Most of the variables will have direct or indirect relationships to other variables on the right side of the diagram. When one variable has a single arrow pointing to a second variable, the first variable has a direct effect on the second variable.

Figure 5.3 shows the direct effects of rapidity of resource mobilization on the network of first responders and vulnerability. If one variable has an effect on a second variable, but only through a mediating variable, then this effect is indirect. Figure 5.3 shows the indirect effect of rapidity of resource mobilization on vulnerability through the network of first responders. It is possible for a variable with a direct effect on another variable to additionally have an indirect effect on this variable. Figure 5.3 shows both the direct and indirect effects of rapidity of resource mobili-

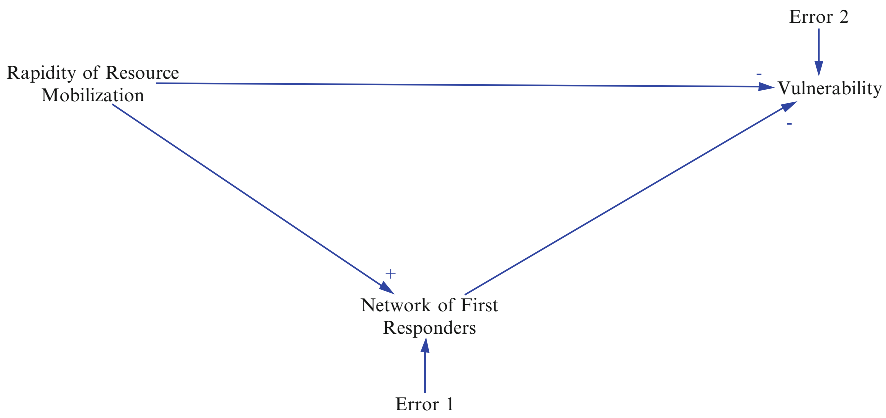

Fig. 5.3 Effects of rapidity of resource mobilization and network of first responders on vulnerability

zation on vulnerability. The direct and indirect effects of independent variables on other variables can be summed to reproduce the zero-order correlation matrix for the variables in the path model (Zakour & Gillespie, 2010).

Variables in path models are ordered causally, and the paths (represented by lines with one arrow) are unidirectional. A first step in path analysis is to determine the causal order for the variables that are to be included in the model. The process of ordering variables should be based on theory (Zakour & Gillespie, 2010). Not only must a causal chain of variables be postulated, but also branches may occur in the causal chain. Theory can describe which variables cause other variables, which variables are associated but have no causal relationship to each other, and which variables are outcomes of other variables. There are typically no feedback loops in path models. Most published path models are recursive, which means that the causal flow is entirely unidirectional.

An exogenous variable in a path model is the first variable in the causal chain and appears by convention on the left side of a path diagram. Exogenous variables are independent variables; the variance of exogenous variables is not explained by any other variable or set of variables. Because the variance of exogenous variables is unexplained by the model, it is desirable to have as few exogenous variables as possible, ideally just one. The exogenous variable is antecedent to other variables in the path model.

Endogenous variables are mediating and dependent variables. An endogenous variable is one that is explained by one or more variables in the path model. Some endogenous variables will be both independent and dependent variables in a causal chain. These variables are called intervening or mediating variables. Path models not grounded in theory are worthless (Freedman, 1992). Careful consideration of theory and empirically informed order of causality is essential to useful applications of path modeling.

There are at least five types of potential test factors which need to be considered in developing path models: (1) extraneous, (2) intervening, (3) antecedent, (4) suppressor, and (5) distorter variables (Rosenberg, 1968). It is important to understand which of these types of test variables is represented among the variables included in a study design. Extraneous, antecedent, and intervening variables are best understood through development of path models or structural equation models. Intervening variables in cross-sectional research can partially address the issue of lack of temporal contiguity among independent and dependent variables. Suppressor and distorter variables may reveal that the association between two variables is shown to be greater, less, or even reversed in valence when the test variable is controlled for (Zakour & Gillespie, 2010).

In determining causal sequences, some variables in a path model will be antecedent variables. Introduction of a variable as an antecedent variable is an effort to clarify influences which precede a relationship between independent and dependent variables. Some antecedent variables will have a direct effect on both independent and dependent variables. These antecedent variables are interpreted as being proximate causes in the relationship between independent and dependent variables. Proximate causes are direct causes of one variable on another. Other antecedent variables are among the first variables in a causal chain, and can be interpreted as distal or ultimate causes. Distal causes trigger a process that ultimately changes the value of an endogenous variable. To interpret any variable as an antecedent variable, the test variable and the independent and dependent variables must all be related to each other.

Several recent studies have used path models related to vulnerability research and social capital in disasters. Zakour (2008a) studied the effects of the social capital of disaster-relevant organizations in a southern metropolitan area. Information on disaster social service and emergency management organizations was collected using a mail survey questionnaire. The items in this mail survey included (a) the organizational level of capacity to provide evacuation services, (b) organizational location in the metropolitan area, and (c) cooperative links with other disaster-relevant organizations. Organizations that employed client-centered methods of service delivery and enjoyed higher levels of social capital had higher evacuation service capacities and larger geographic ranges in a disaster.

Latent Variable Structural Equation Models

SEM is a form of statistical analysis that examines causal relationships among variables more effectively than regression and path analysis. It is more effective because it estimates measurement error and removes this error from the estimates of theoretical parameters. There are two parts to an SEM model: the measurement parameters and the theoretical parameters. Figure 5.4 shows three measurement parameters for each of two latent variables and one theoretical parameter, namely the effect of rapidity of resource mobilization on vulnerability. Unlike traditional regression methods, in SEM there may be one or more dependent variables. Both independent and dependent variables may be either discrete or continuous.

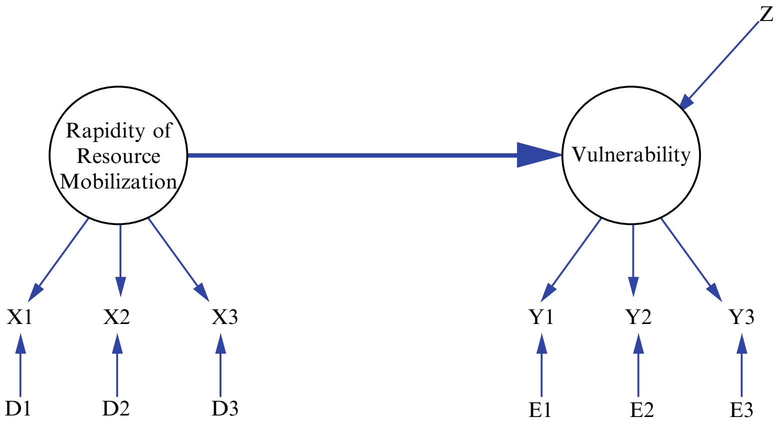

Fig. 5.4 Structure equation model of relationship between rapidity of resource mobilization and vulnerability

The variables in full SEM models are combinations of observed variables and latent factors (unobservable variables). SEM includes confirmatory factor analysis which estimates factors from sets of measured variables (Zakour & Gillespie, 2010). Figure 5.4 shows how rapidity of resource mobilization is implied by the pattern of associations among X1–X3, and vulnerability is implied by the pattern of associations among Y1–Y3. The arrow pointing toward a dependent variable and from an independent variable in the path model developed through SEM represents the direct or main effect on the dependent variable. Notice in Fig. 5.4 that the latent variables of rapidity of resource mobilization and vulnerability are direct causes of the observed variables X1–X3 and Y1–Y3; the variance not explained by the latent variables is represented in the error terms d1–d3 and e1–e3 for each of the observed variables. The main interest in Fig. 5.4 model would be the effect of rapidity of resource mobilization on vulnerability.

SEM with latent variables extends linear methods to enable more complex models of relationships among sets of independent and dependent variables. SEM is superior to the other linear techniques in this chapter (Ullman, 1996) because it encourages the use of multiple indicator concepts, establishes the reliability and validity of the variables used, extracts measurement error from theoretical parameters, assesses all parameters simultaneously, and easily handles reciprocal feedback relationships (Gillespie & Perron, 2007).

The ability to estimate latent variables simultaneously with the testing of theoretical parameters is a huge advancement for vulnerability and resilience research. Factor analysis reveals latent variables (factors), which can then be used either as independent or dependent variables in a structural equation model. Latent variables are inherently theoretical in the sense that they account for the pattern of correlations among a set of observed variables. Validity coefficients are now routinely reported in tests of confirmatory factor models as well as in fully specified

SEM models. Precise specification of unobservable constructs such as vulnerability, effectiveness, and many others is now possible.

The complexity of relationships can be further examined by elaborating these relationships with mediating variables. Mediating variables account for a part of or all of the variance shared between an independent and a dependent variable. In SEM, identification of a mediating variable means that either the independent variable has either only an indirect effect on the dependent variable, or that the independent variable has both a direct and indirect effect; this is called partial mediation. The use of mediating variables along with antecedent variables in SEM allows the investigator to more precisely trace out causal sequences. Theoretical reasoning and logic allow the investigator to determine if a variable is a mediating variable rather than an extraneous variable.

Rogge (1996) compared counties in eight southern states. Data from 330 counties in eight states were compared by census variables (e.g., population density) and by toxic risk. Data was at the county level only. All census data was from the 1990 U.S. Census and all data on toxic risk was from the EPA's 1992 Toxic Release Inventory. Toxic risk was operationalized as the pounds of fugitive emissions per square mile in each county. Though data was from 1990 and 1992, the 2 years do not represent a time series, because different variables came from 1990 versus 1992. An important result from this study was that population density was most strongly associated with toxic risk. More urban counties and their communities were found to be the most vulnerable to toxic emissions. This finding supports the second assumption of vulnerability theory regarding the uneven distribution of vulnerability (Chap. 2, p. 9).

Summary

Much has been learned about disaster vulnerability and resilience through cross-sectional research designs in combination with a wide range of linear statistical models. Multiple regression, logistic regression, hierarchical regression, path analysis, and SEM with latent variables each facilitate assessing particular kinds of questions. It is important to craft the research design for each kind of question and the circumstances prevailing at the time of the study (Gillespie & Streeter, 1994). The statistical methods discussed in this chapter cannot correct or adjust for a poor research design. However, appropriately selected and applied statistical methods complement the research design and facilitate increased precision. We anticipate the increasing use of SEM across the vulnerability and resilience fields.

Four of the studies discussed in this chapter produced results which support an assumption of vulnerability theory. Rogge's (1996) study of toxic emissions supports the second assumption of vulnerability theory that "Vulnerability is not evenly distributed among people or communities" (Chap. 2, p. 18). Urban counties with the highest population density were more vulnerable to toxic emissions than rural counties.

Further study is needed to find out the mechanisms by which population density increases vulnerability.

Burnside et al. (2007) provide support for the fourth assumption of vulnerability theory, which states that equitable distribution of resources decreases vulnerability (Chap. 2, p. 19). Reliance on trusted sources of information such as government, television, Internet, family, and relatives was positively associated with intention to evacuate in a category-3 hurricane. These communication sources provide information as a social resource relevant to making the decision to evacuate. The more widely available and evenly distributed these communication sources are, the less vulnerable is the community.

Research on functional needs of persons with a disability by McGuire et al. (2007) supports the sixth assumption of vulnerability theory, which asserts that "Social and demographic attributes of people are associated with but do not cause disaster vulnerability" (Chap. 2, p. 22). White females tend to live longer than other categories of people, and they are more likely to require assistive equipment in a disaster evacuation. Unmarried older women may have outlived their husbands and are less likely to have social support in coping with a disability. This appears to be an age effect since as noted above networks of women were more likely to involve provision of social support in an emergency.

The work of Wellman and Frank (2001) support the tenth assumption of vulnerability theory that "Culture, ideology, and shared meaning are of central importance in the progression to disaster vulnerability" (Chap. 2, pp. 24 and 25). Exchanges of social support within networks help to build shared meaning and norms of interaction among the actors. From their interaction in networks actors develop and are influenced by norms of support among adult children and their parents, and among non-related actors. Norms of social support in emergencies also develop in networks with higher percentages of accessible ties, women, and ties of reciprocity.

This chapter covered the characteristics of cross-sectional design and introduced the most frequently used statistical models in vulnerability research. In Chap. 6, we provide a more detailed account of the types of relationships in vulnerability theory, more in-depth information about the statistical models, and more findings from the research using these models. Chapter 6 is an extension of Chap. 5 and further acknowledgement of the critical role played by linear statistics in vulnerability theory.

Chapter 6
Linear Accounts of Vulnerability

This chapter takes a closer look at the kinds of relationships found in vulnerability theory and deepens our discussion of the linear statistical models used in developing and testing aspects of vulnerability theory. The developmental state of a theory is reflected in its relationships. Vulnerability theory is at an embryonic stage with most of its relationships having been established through linear statistical models. Vulnerability theory offers social work researchers a solid foundation in need of refinement, extension, and further testing.

This chapter is organized into two main sections and a summary. The first section provides a brief overview of different types of relationships reported in the literature on vulnerability. We illustrate each type and give examples relevant to vulnerability theory. The second section extends our discussion of the statistical models introduced in Chap. 5 with additional details about the statistics and by reporting on the results of recent studies that used each type of model. We end this chapter with a summary of the empirical support for vulnerability theory from linear statistical models.

Types of Relationships Among Variables

Three types of relationships are commonly encountered in examining and interpreting the results of data analysis in vulnerability research: asymmetrical, symmetrical, and reciprocal relationships. Asymmetrical relationships involve an independent variable with causal effects on a dependent variable, and the dependent variable does not have any effect on the independent variable. In symmetrical relationships, two variables are correlated with each other, but neither variable has a causal effect on the other. In reciprocal relationships, two variables have causal effects on each other in an iterative fashion. Figure 6.1 illustrates the three kinds of relationships.

In vulnerability research, asymmetrical relationships are the primary focus. In asymmetrical relationships, an independent variable causes a dependent variable. This means that a unit of change in the independent variable produces a

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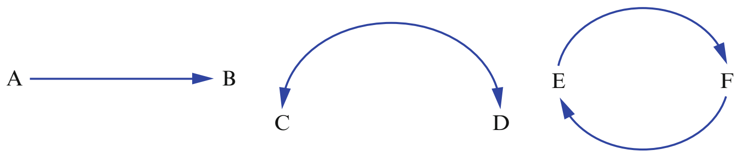

Fig. 6.1 Three kinds of relationships. A one-direction *arrowhead* symbolizes a causal or asymmetrical relationship: A causes B. A bi-direction *arrowhead* symbolizes association, correlation, or symmetrical relationships: C and D are associated but there is no assumption of causality and no attempt to explain the association. Two one-direction *arrowheads* also symbolize causal or asymmetrical relationships: E causes F and F causes E

specified amount of change in the dependent variable. Asymmetrical relationships are fundamental to theory and statistical elaboration. An important type of asymmetrical relationship is a permanent or stable property of subjects which acts as an independent variable, influencing the dependent variable, typically a disposition or behavior. An example of this type of relationship is the association between gender and risk perception of hazards. To a greater extent than men, women tend to perceive hazards as more destructive, and they subjectively appraise their exposure to disasters as more severe (Norris, Friedman, Watson, et al., 2002).

A second type of asymmetrical relationship is the immanent relationship, such as Michels' "Iron Law of Oligarchy" (Michels, 1962). This law states that all forms of organization regardless of how democratic at the start will inevitably develop into oligarchies. Oligarchies eventually emerge because of the need for leadership, the tendency of groups to defend their interests, and the passivity of most individuals, who are for the most part happy to be led. Applied to vulnerability research, this law predicts that social movements and organizations working to improve community resources and promote resilience will become less democratic and more oligarchic over time. Gillespie, Perry, & Mileti's (2004) case study of Neighbor's in Need provides an interesting illustration of this process.

A final type of asymmetrical relationship is the means-end relationship. In this type of relationship if the purpose resides in the mind of a subject/actor the end will determine the means. The reverse is true if the purpose resides in the mind of the investigator. In the disaster vulnerability context, if actors are seeking to build exchange relationships with others in the community, these actors will choose means they believe will strengthen their social relationships, such as developing mutual aid agreements. On the other hand, if an investigator is seeking to study the strength of exchange relationships in a community, she will ask questions of community members or observe exchanges among them.

Symmetrical relationships are a focus in vulnerability research when the goal of analysis is exploration or description. Symmetrical relationships include (a) variables that are part of a common complex (e.g., indicators of community well-being), (b) variables associated by historical accident (e.g., food costs in an area affected by disaster), and (c) two variables correlated because of a common relationship with a third variable (e.g., snow plows and part-time laborers because of heavy snow fall).

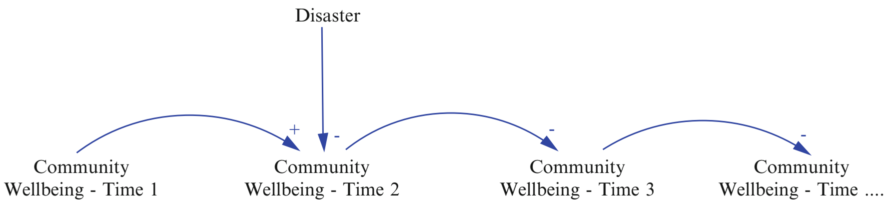

Fig. 6.2 Reciprocal relationship. This figure depicts community well-being at several points in time to reveal how a positive reinforcing relationship can change from positive to negative as a result of disaster. Before the disaster community well-being is a positive self-reinforcing process, but the disaster disrupts community functioning so that the self-reinforcing process reverses and as a result community well-being begins to deteriorate over time

When variables are part of a common complex, principal components analysis can produce a linear combination. However, it is essential to distinguish principal components analysis from factor analysis. Principal components analysis is a linear summation of the indicator variables including the error associated with those variables. In contrast, factor analysis identifies the substantive variance common to the set of variables and separates the error variances of these variables. Principal components analysis is a data reduction technique, while factor analysis is a hypothesis testing method. The dramatic and important difference between principal components analysis and factor analysis is described and illustrated clearly by Bollen and Bauldry (2011) with their account of effect (reflective), causal (structural), and composite indicator models.

Reciprocal relationships are most appropriately understood through nonlinear methods such as statistical models in longitudinal designs or simulation methods like systems dynamics (covered in Chap. 9). An example of a reciprocal relationship is when a disaster triggers a reinforcing deterioration of a community's resilience. In Chap. 4 we discussed community wellness as a correlate of resilience. Community wellness includes a high level of functioning. When disasters strike, the processes of community functioning are destabilized and can deteriorate over time. This is illustrated with a negative reinforcing feedback loop as shown in Fig. 6.2.

Reciprocal relationships are also exemplified by relationships among different variables. For example, unemployment and social capital are related to each other in a reciprocal fashion: as the level of unemployment goes up the level of social capital drops, and as social capital drops unemployment rises yet further.

Types of relationships reflect how much we know about a given phenomenon. Patterns of correlation are descriptive but indicate little understanding of the phenomenon. Linear patterns of causation are explanatory but lack much predictive power and are generally weak on insight and understanding. Nonlinear patterns of two-directional causation among a set of variables are explanatory, predictive, and offer insight and understanding as to how and why the relationships evolve as they do. Advanced theories are made up mostly of variables interrelated in nonlinear patterns. Vulnerability theory is still at an early stage of development as represented in its mostly linear relationships. We turn next to a discussion of the linear support for vulnerability theory.

Linear Support for Vulnerability Theory

Vulnerability theory has been developed through various linear statistical models, including regression, logistical regression, hierarchical regression, path analysis, and latent variable analysis. These models were briefly introduced in Chap. 5. In this chapter we describe the assumptions underlying these models and then provide additional information on the distinctive features of each model. Of course, the value of these models results from the utility of the findings they produce. Accordingly, we discuss findings from recent applications of each model.

All of the models discussed in this section are based on four assumptions: normality, linearity, homoscedasticity, and independence of observations. The assumption of normality means that the values of the variables are arranged around the mean in a symmetrical pattern. The assumption of linearity means that the relationship between two variables when plotted on a graph forms a straight line. The relationship forms a straight line because the direction of change in the dependent variable is constant with respect to changes in the independent variable. The assumption of homoscedasticity means that the variances for each value of the dependent variable are homogeneous across the range of values represented in the linear combination of independent variables. Finally, the independence of observations means that the values recorded for each case are unaffected by the values of every other case in the sample. Results will be distorted to the extent that these assumptions are not met.

Regression

Regression helps to sort out the relative importance of independent variables when two or more independent variables are moderately related to each other. Regression is a least squares solution which means that it produces predicted dependent variable scores which minimize the sum of squared deviations between predicted and measured values of the dependent variable. In linear regression, both dependent and independent variables are assumed to be at interval or ratio levels of measurement. With categorical predictor variables, independent variables can be recoded into multiple dummy variables. If all of the independent variables are dummy variables, then regression becomes very similar to analysis of variance.

The regression coefficient, beta (unstandardized) or β (standardized), for each independent variable in the regression equation indicates how strongly each independent variable is related to the dependent variable (Tabachnik & Fidell, 1996). The beta or β in linear regression is the partial slope of the relationship that each independent variable has with the dependent variable. The slope is partial because all the other independent variables in the linear combination have been statistically controlled for (statistically held constant). The R^2 is the overall multiple correlation coefficient or the amount of variance in the dependent variable explained by the linear combination of independent variables (Fig. 6.3).

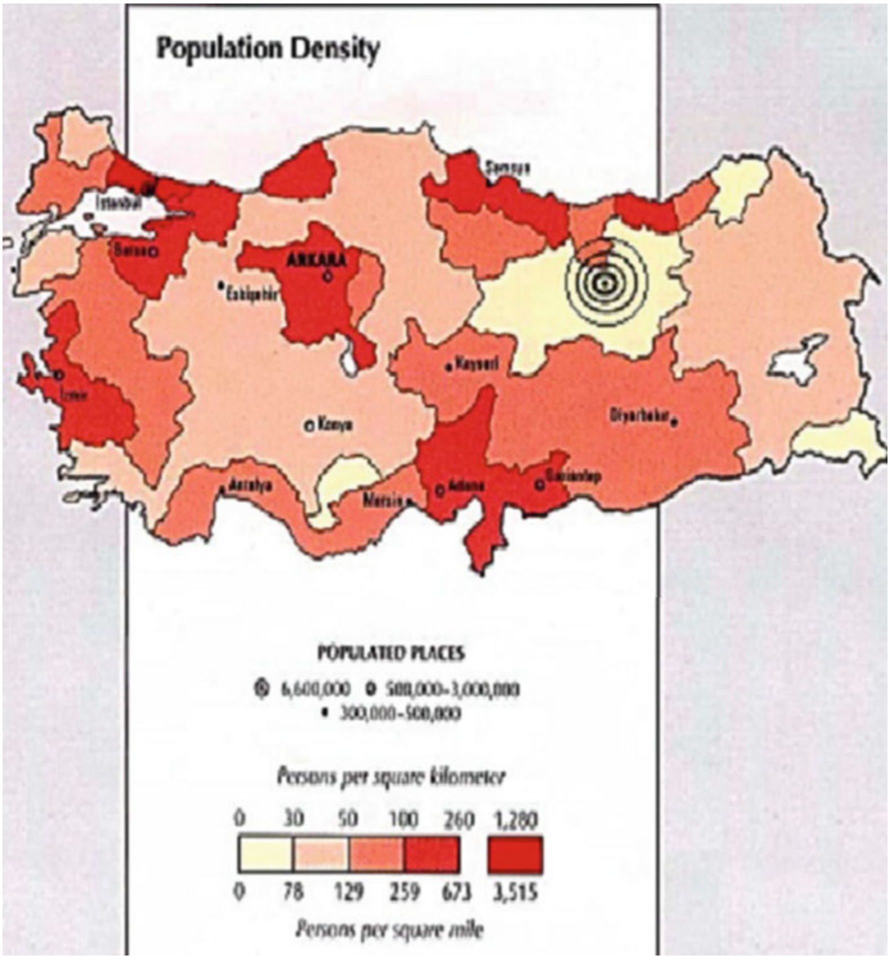

Fig. 6.3 Erzincan 1992 earthquake overlaid on map of Turkey's population density. *Source*: http://mapas.owje.com/maps/8733_turkey-population-density-map.html

The study of a town in Turkey prone to earthquakes offers a good example of using regression (Rüstemli & Karanci, 1999). Erzincan is an Eastern Anatolian town with a population of about 150,000. The region surrounding Erzincan is sparsely populated and is in a high-risk zone for seismic activity. An earthquake occurred on March 13, 1992, resulting in the deaths of 541 people and injuries to another 850. More than 5,500 buildings in the town were destroyed or severely damaged. A survey of earthquake victims ($N=461$) was conducted 16 months after the earthquake. Three standard linear regression analyses were run to predict (1) earthquake expectation in the next year, (2) amount of damage anticipated, and (3) belief in the efficacy of damage mitigation. In each regression, the remaining 13 independent variables were statistically controlled to obtain a β coefficient for each of the independent variables in relation to each of the three dependent variables.

Though none of the zero-order correlations between availability of social support were significant at the $p<0.05$ level, the standardized beta in the regression with social support as an independent variable and amount of damage anticipated was small ($\beta=0.09$) but statistically significant. For the independent variable, trust in officials to do the right thing in a future earthquake, the standardized betas with dependent variables earthquake expectation ($\beta=-0.09$), damage anticipation ($\beta=-0.12$), and damage mitigation ($\beta=-0.09$) were each significant at the $p<0.05$ level, although again each of these betas was small in magnitude. Level of education was positively associated with belief in the efficacy of damage mitigation practices.

For the two social capital variables—availability of support and trust in officials—standardized betas indicated small, negative associations with belief in mitigation measures. It is possible that availability of social support and trust in government officials both influence households to depend on the mobilization of social capital after an earthquake rather than engaging in household mitigation actions before an earthquake occurs (Rüstemli & Karanci, 1999). The problem with this thinking is that social capital is best accumulated before disaster during mitigation and preparedness phases and spent after disaster during the response and recovery periods. It is generally too late to develop social capital when disaster strikes.

Logistic Regression

In logistic regression, the linear combination of independent variables is used to calculate the probability that a particular case is in one of a few categories. The initial part of the logistic regression equation is called the logit, which is used to find the odds of a case being in one of the categories of the dependent variable. In logistic regression the linear regression equation is the natural log of the probability of being in one group divided by the probability of being in another group. Logistic regression models are evaluated by assessing the natural log likelihood for each logistic model. The magnitude of the relationship between outcome and predictors in the model is the proportion of variance in the outcome variable accounted for by each predictor variable.

Similar to linear regression, logistic regression allows for the identification of the most important predictors. One way to accomplish this is to eliminate a single predictor from the equation and then examine how much the model has changed by the elimination of that predictor. A second way of determining importance of predictors is to apply the Wald test to assess the statistical significance of the regression coefficients associated with each variable. The most highly significant regression coefficients are assumed to be most important.

Logistic regression suffers from inclusion of too many variables given the sample size. Over-fitting will occur with too few cases and too many variables. To avoid over-fitting aim for the largest possible sample and the smallest number of variables needed to answer the research question. If one of the categories of a variable has no cases, then that category should be collapsed or deleted, or else the variable itself can be deleted.

Burnside, Miller, and Rivera's (2007) study of New Orleans examined the effects of information source, preparation/risk, and demographic variables on peoples' intention to evacuate if public officials called for a hurricane evacuation. Regression coefficients from their logit model indicated that demographic variables did not have a statistically significant effect on intention to evacuate for a hurricane. Three variables regarding sources of information did have statistically significant regression coefficients with intention to evacuate: information from public officials ($B=0.782$, $p<0.001$), advice from family and friends ($B=0.285$, $p<0.05$), and viewing images from the media of hurricane damage ($B=0.330$, $p<0.01$). Also three preparation/risk variables had statistically significant regression coefficients with intention to evacuate: perceived risk ($B=1.720$, $p<0.001$), respondent evacuated more than once in last 10 years ($B=0.727$, $p<0.001$), and respondent has a definite evacuation plan ($B=1.269$, $p<0.001$).

The size of the regression coefficients represent the percentage of people who intend to evacuate, from those who selected the lowest value of the independent variable to those who indicated the highest value of the independent variable. For example, among respondents who relied the least on information from public officials, 56.6% intended to evacuate in a hurricane; while among respondents relying the most on public officials as an information source, 86.2% intended to evacuate ($B=0.782$). For those relying the least on advice from family and friends, 71.5% stated they would evacuate; while among those respondents relying the most on family and friends, 81.6% would evacuate ($B=0.330$). The authors calculated a pseudo R^2 of 0.346 ($N=1207$, $p<0.01$) from their logit model, showing that 34.6% of the variance in respondents' intention to evacuate was explained by the model.

Hierarchical Regression

Hierarchical regression analysis differs from nonhierarchical regression because variables are entered into the regression equation in an order determined by the investigator. The order of variables entered into the regression is determined through theory and relevant data. The first variable entered into the equation is assigned all of the variance it shares with the dependent variable. Variables entered into the equation subsequently are assigned that part of the remaining variance in the dependent variable which each independent variable contributes uniquely at that point in the regression process. In determining the relationships between the dependent variable and the independent variables entered at each step, hierarchical regression statistically controls for the independent variables entered into the equation at earlier steps.

Both stepwise and hierarchical regressions are a type of sequential regression. Sequential regression analysis indicates how much of the variance in a dependent variable is accounted for by each independent variable, controlling for independent variables already entered into the regression equation at a particular step. Stepwise and hierarchical regressions differ in the way order of entry of variables into the regression equation is determined.

In stepwise regressions, the variable order of entry into the regression is determined statistically by first entering the independent variable with the highest zero-order correlation with the dependent variable. The next variable entered has the highest semipartial correlation with the dependent variable at that step in the regression, and this statistical criterion is applied through each subsequent step until all variables have been entered. Hierarchical regression is statistically the same as stepwise regression. However, there is a huge difference between stepwise and hierarchical regression: hierarchical regression involves the use of theory to determine order of entry of variables in the regression equation. Hierarchical regression is extremely useful for testing regression models; while stepwise regression is only useful for initial exploration and even then most researchers find little value in depending on a statistical algorithm to tell them which variables are important.

When all independent variables have been entered into a hierarchical regression, the standardized betas are the same as for a nonhierarchical regression with the same set of independent variables all entered into the equation on the same step. However, the semipartial correlations of each independent variable or set of independent variables in a hierarchical regression differ from the semipartial correlations of a nonhierarchical regression. In a hierarchical regression, the semipartial correlations reflect the order of entry of variables. The independent variable entered first will have a semipartial correlation comparable to the zero-order correlation between the independent and dependent variable. Assuming independent variables in a regression are correlated with each other, those independent variables entered on subsequent steps of the regression will have a semipartial correlation smaller than their zero-order correlations with the dependent variable (Fig. 6.4).

Benight, Ironson, and Durham (1999) studied survivors of Hurricane Andrew ($n=165$) and Hurricane Opal ($n=63$). They examined the effects of hurricane coping self-efficacy on intrusive thoughts and avoidance behavior. Hurricane coping self-efficacy was operationalized as a summative measure including confidence in one's ability to (1) maintain personal security, (2) financial security, (3) housing and food, (4) intimacy and calm within the family, (5) going back to a normal routine, (6) dealing with personal loss, and (7) dealing with the emotions experienced since the hurricane. Two hierarchical regressions were run for each of the two samples (Hurricane Andrew and Hurricane Opal). One regression was run with intrusive thoughts as dependent variable, and a second regression used avoidance behavior as the dependent variable. For each of the four regressions, social support, level of lost resources, and optimism were entered on the first step. In the second step for each regression, the hurricane coping self-efficacy variable was entered.

Hurricane coping self-efficacy contributed in a statistically significant manner to each regression R^2 with the exception of the Hurricane Andrew sample using avoidance as the dependent variable. Because of the relationship between individual self-efficacy, community competence, and collective self-efficacy in a disaster, this study and others (Benight et al., 1999; Norris, Stevens, Pfefferbaum, Wyche, &

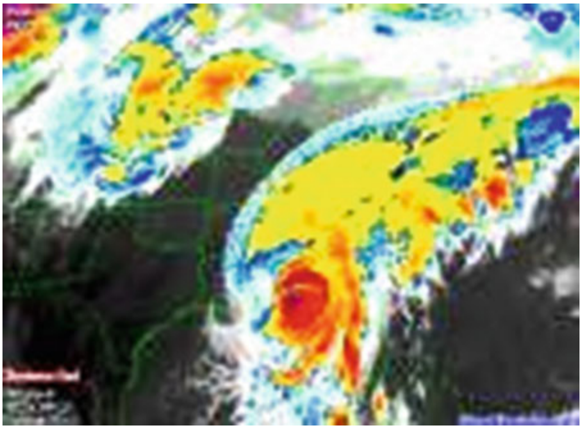

Fig. 6.4 Satellite image of Hurricane Opal as it makes landfall in Florida Panhandle. *Source*: http://www.kflsebas1.com/images/Hurricane/Satellite%20Pictures/1995/hurricane_opal_1995_goes_ir_1.gif

Pfefferbaum, 2008) suggest the importance of building community competence/self-efficacy as well as positive community narratives of recovery and resilience. Perceived coping efficacy is likely to contribute to resilience, defined partly as an absence of disaster-related distress, independent of the level of available social support and degree of property loss after a disaster.

In a more recent study, hierarchical logistic regression analysis was used to understand the effects from social resources on resilience. After the World Trade Center attack in 2001, Bonanno, Galea, Bucciarelli, and Vlahov (2007) studied predictors of resilience. Demographic variables were entered in the first step of regression analysis. After controlling for the effects of demographic variables, social resources and current and past life stressors were entered in subsequent steps of the analysis. Social support and life stressors were found to be predictive of resilience after the terrorist attack on the World Trade centers.

Path Analysis

Path analysis was the original form of structural equation modeling (Wright, 1960; Duncan, 1966) and continues to enjoy widespread use today, although it is in decline as latent variable modeling becomes increasingly accessible with point-and-click contemporary software. Variables in path models are ordered causally and the paths (represented by arrowhead lines from cause to effects variables) are unidirectional. The order of variables in a path model is determined by theory. Theory assures the investigator that what appears to be cause and effect is truly a causal sequence, and not a coincidence due to correlation for an unknown reason.

Path coefficients are regression coefficients (β) from a series of simultaneous equations (Pedhazur, 1982). Because path models can be used to examine direct and indirect relationships among variables, path analysis facilitates elaboration of relationships among variables and the testing of theory. Elaboration is the introduction of a third variable, traditionally called a test factor (Rosenberg, 1968) to more fully understand the relationship between two other variables. Today the idea of elaboration is subsumed under the process of mediation (Mackinnon, Fairchild, & Fritz, 2007).

Conditional relationships refer to relationships among variables that exist when certain conditions are present. Understanding the nature of conditional relationships is facilitated through grouping cases according to a contextual variable and developing different path models for each subset of the data. Conditional relationships may call into question the interpretation of zero-order correlations among variables or they may support or strengthen the original interpretation of correlations. Conditional relationships make it possible for an investigator to choose between alternate interpretations or theories about a zero-order correlation. When the original interpretation of the correlation among variables is challenged by seeking conditional relationships, the danger of excessively global or inexact generalizations is reduced. If interpretation of a relationship is radically revised through finding conditional relationships, this revision can refine theory or move it in a new direction.

After theory is used to establish the order of variables in a path model, it can be helpful to obtain partial correlations among variables in the model. A test variable which is adjacent to other path model variables is controlled for, and the partial correlations among other variables of interest are obtained. Partial correlation analysis can reveal that some variables are suppressor, distorter, or extraneous variables.

Suppressor variables reduce the magnitude of the direct relationship between an independent and a dependent variable. When statistically controlled for suppressor variables eliminate irrelevant variance in the independent and dependent variables, allowing the relationship between these variables to emerge. Suppressor variables are helpful in determining if an independent variable and dependent variable are causally related to each other.

Use of a distorter variable as a test factor reveals that two other variables have a relationship which is the reverse of their zero-order correlation. When a distorter variable is statistically controlled for the partial correlation between two variables of interest has a similar magnitude as the zero-order correlation, but the polarity is reversed.

Finally, it is customary to speak of a spurious relationship when there is no meaningful relationship between a hypothesized independent and dependent variable. A spurious relationship occurs when the correlation between two variables turns out to be due solely to the relationship of the two variables to a common third variable. The interpretation of a relationship as spurious is appropriate when the third variable is statistically controlled for and the partial correlation between the other two variables is zero or close to it. When an antecedent variable is controlled for the partial correlation between the independent variable and dependent variable should not be zero. However, when the independent variable is controlled for the relationship between the antecedent and the dependent variable should approach zero.

The path coefficient is represented by the symbol P_{ij} which represents the amount of change in the dependent variable as a result of one unit change in the independent variable.

The first subscript (*i*) represents the dependent variable associated with the path coefficient. The second subscript (*j*) represents the independent variable. In the path model, an arrow points away from each independent variable and toward each dependent variable. Each variable except exogenous variables in a path model is represented by an equation consisting of variables upon which the endogenous variable is assumed to be dependent along with a residual term; the residual term represents error (e_n).

Path coefficients are standardized betas from a series of regression equations estimated simultaneously. Except for the exogenous variable(s) and the final dependent variable at the end of the causal chain, each variable in a path model serves as both an independent and a dependent variable in different regression equations. The last variable in the causal chain serves only as a dependent variable in a regression. The variables which have the highest correlation with each other are usually adjacent to each other in the path model and are usually directly related to each other. Variables with lower correlations are likely to be related to each other indirectly, through one or more intervening variables (Pedhazur, 1982).

Exogenous variables in path models are only independent variables and are not explained within path models. Except for exogenous variables, for each variable in a path model there are residual variables. Residual variables represent the amount of variance in a variable which is not explained. It is assumed that some external variable (a latent variable) not included in the path model explains the variability in the residual variable. The residual variables are assumed to be uncorrelated with other variables in the model, including the other residual variables. It is also assumed that there is no measurement error for the variables in the model.

One means of evaluating goodness of fit for path models is to compare the zero-order correlations among variables to a reproduced correlation matrix. This matrix is the sum of the direct, indirect, and spurious parts of path coefficients between each pair of variables in the path model (Blalock, 1964, 1969). Along with each path diagram, a decomposition table is constructed, in order to help determine the goodness of fit of the model. This decomposition table partitions the effects of each variable on all other variables for which it acts as an independent or causal variable. Direct effects are the effects of one variable on another which do not depend on an intermediate variable. In the path diagram, these effects are represented by an arrow which is a direct link between two variables. Indirect effects are the effects of one variable on another which rely on a causal chain including at least one intermediate variable. Finally, the spurious component of the zero-order correlation between two variables is the result of the effects of a third variable, related to both variables, on the two variables (Zakour & Gillespie, 2010).

Direct, indirect, and spurious components of the relationship between each pair of variables are summed to reproduce a correlation matrix (Zakour & Gillespie, 2010). Path coefficients are substituted into decomposition equations to produce a decomposition table of correlations among variables. Using these decomposition formulas, in which path coefficients and products of coefficients are summed, correlations between variables are reproduced. In each correlation table, the original correlations are presented in the upper half of the correlation matrix. The reproduced correlations are presented in the lower half of the matrix.

The goodness of fit of path models can additionally be evaluated using the chi-square distribution. The goodness of fit for a path model with the data is measured by the *Q* statistic. This statistic is the quotient of the variance explained by the model, divided by the total variance explained by the independent variables. The total variance is the generalized variance from a series of regressions using all but the first variable in a model (an exogenous variable) as a dependent variable. The variance explained by the model is represented by the product of the model's error terms. These are represented in a path diagram for each variable as e_n. The generalized variance is the product of the error terms of a fully recursive version of the model, in which all possible unidirectional arrows between variables are present. In a fully recursive model, each variable has a direct effect on all other variables following it in the causal chain. The value of *Q* ranges from 0 (no goodness of fit) between the model and the data to 1 (perfect goodness of fit) between the model and the data (Zakour & Gillespie, 2010).

The measure of goodness of fit *Q* can be further evaluated using the chi-square distribution. A measure *W* is calculated using the following formula:

$$W = -(N - d)(\log_e Q)$$

Where *N* is the sample size and *d* is the number of over-identifying restrictions or the number of path coefficients hypothesized to be zero. When a coefficient is hypothesized to be zero no arrow is drawn between two variables in a diagram, and there is hypothesized to be no direct effect between these two variables. As *Q* nears 1, the log of *Q* approaches 0, so that W in turn approaches 0. Using a chi-square distribution, a smaller *W* will allow us to reject the null hypothesis, which states that a model does not fit the data. Theory is very important in determining the causal order of variables in a path model. Two path models with the same variables and paths, but in opposite causal order, will have exactly the same goodness of fit statistics and reproduced correlation matrices (Zakour & Gillespie, 2010).

In a study of networks of disaster social services and emergency management organizations, Zakour (1996) elaborated on the negative relationship between geographic distance and cooperative links among organizations ($r = -0.24$) in a mid-west metropolitan area. A path model was developed using the percentage of volunteers among an organization's workers as the exogenous variable. The type of organization—social services and emergency management—was then entered after percentage volunteers in the causal order of the model. Two other variables—geographic range of service delivery and types of appreciation shown volunteers—were entered into the path model after organizational type and before geographic distance. In this model, cooperative links is the final dependent variable.

The effects of range of services and volunteer appreciation on both geographic distance and cooperative links were found to account for almost half of the relationship between geographic distance and cooperative links variables (Zakour, 1996). Percentage volunteers had a direct effect on cooperative links of 0.18 and an indirect effect of 0.09 (through organizational type, range of services, volunteer appreciation, and geographic distance). The *Q* coefficient for the model is 0.99 indicating a high level of goodness of fit.

Latent Variable Modeling

Latent variable modeling extends and enriches path analysis by incorporating factor analysis. The primary advantage of using latent variable structural equation modeling is that it includes the measurement of factors (called latent variables) and their error simultaneously with the testing of relationships between factors. Importantly, the error associated with each factor is removed from parameter estimates of each factor's relationship with other factors. In other words, parameter estimates are assumed to be error-free when testing hypotheses. This is a tremendous advantage over traditional linear modeling techniques, where reliability and validity were assessed apart from hypothesis testing and the variables used in models constructed to test theory were unrealistically assumed to be measured without error.

Structural equation modeling is a confirmatory type of analysis. Information and hypotheses regarding relationships among variables is needed to make proper use of structural equation modeling. Theory is essential for testing hypotheses and confirming models in SEM. SEM allows researchers to determine how much of the variance in the dependent variables, both latent and observed, is accounted for by the independent variables. While SEM helps determine which paths have the strongest effects by comparison of standardized regression coefficients, this is typically not the focus. Instead, when testing theory, it is the pattern of relationships and not their magnitudes that is of primary interest. The primary concern is to establish that the pattern of direct and indirect effects is consistent with the pattern hypothesized. This is another aspect of SEM that has helped to advance theory in social science.

Reliability is defined as the proportion of true variance out of the total variance. The variance of each measured variable is a function of its latent variable and an error term. The amount of variance in the measured variable caused by the latent variable shows how strongly the measured variable reflects, represents, or indicates the latent variable. The magnitude of this coefficient is often referred to as a "validity coefficient." The reliability of a measured variable is of course a direct function of its validity: the larger the validity coefficient the smaller the amount of error and thus the higher the reliability.

Reliability in SEM is assessed through the use of a squared multiple correlation. The factor is the independent variable and the measured variable is the dependent variable. All other variables in the model are held statistically constant in assessing the relationship between a given measured variable and the latent variable it reflects. SEM output yields an R^2 for each measured variable. Because these R^2 coefficients are squared multiple correlations they do not correspond directly to traditional reliability coefficients such as alpha (α). However, it is easy to make comparisons: the square root of SEM reliability coefficients correspond to traditional reliability coefficients. For example, an SEM R^2 reliability of 0.49 is the same as an alpha of 0.70 for a summative measure.

Goodness of fit for structural equation models is determined using χ^2 distributions and a host of fit statistics. The goodness of fit of a structural equation model can be tested by comparing the sample covariance matrix and the estimated population covariance matrix. A good fit is indicated by a nonsignificant χ^2. A limitation of this method of assessing goodness of fit is that very large or very small samples are unlikely to provide accurate χ^2 probability levels. Inaccurate probability levels can also occur when the underlying assumptions for the χ^2 statistic are violated (Joreskog & Sorbom, 1993).

A closely related assessment of goodness of fit for structural equation models is examination of the ratio of the χ^2 value to the degrees of freedom. A model with a good fit should produce a ratio of 2 or less. This goodness of fit test may suffer from the same limitations as the nonsignificant χ^2 value. Other goodness of fit indices that have been proposed are comparative fit indices, absolute fit indices, degree of parsimony fit indices, residual-based fit indices, and indices of proportion of variance accounted for. Except for the last two indices, all of the other indices use χ^2 values in their formulas for goodness of fit, and may suffer from the limitations of the first goodness of fit test using χ^2 values. Good-fitting models should have similar results on a number of these indices. If the results of goodness of fit tests are inconsistent for a particular model, the model should be reexamined (Ullman, 1996).

Lee, Shen, and Tran (2009) tested a structural equation model which is based on previous research about the determinants of resilience and psychological distress. Resilience was measured by asking African-American evacuees from Hurricane Katrina in New Orleans about the level of confidence they had regarding their ability to recover at some point in the future from the disaster. Psychological distress was measured by asking respondents if they felt frightened, angry, or depressed because of Katrina.

In this structural equation model, the coefficient (B) for the relationship between psychological distress and resilience was –0.29 ($p<0.001$). Two important socioeconomic variables in the model are income and being insured for property losses. Human loss was defined as experiencing the injury or death of family, friends, or neighbors. Human loss was significantly related to both psychological distress ($B=0.28$, $p<0.001$) and resilience ($B=-0.19$, $p<0.01$). Having property insurance was negatively related to distress ($B=-0.25$, $p<0.01$). Income is strongly and significantly related to resilience ($B=0.19$, $p<0.01$).

Summary

This chapter described the types of relationships expressed in vulnerability theory, extended our discussion of linear statistical models, and discussed the findings from four studies that support six of the assumptions from vulnerability theory. While most of the existing support for vulnerability theory is based on traditional linear statistical models, we anticipate increasing use of latent variable modeling to refine and extend vulnerability theory. Latent variable modeling subsumes regression, hierarchical, path analysis, and factor analysis. These forms of statistical analysis, each powerful in their own way, are now even more powerful together. The integration of these traditional types of analysis is a significant advancement because it enables empirical assessment of the linkages between imperfectly measured variables and theoretical constructs of interest.

The Benight et al. (1999) study provided support for the first assumption of vulnerability theory that the "vulnerability of social systems is the reduced capacity to adapt to environmental circumstances" (Chap. 2, pp. 7 and 8). These theorists found that coping self-efficacy is related to lower levels of vulnerability and a higher likelihood of a resilient recovery.

In their study of an earthquake in Turkey, Rüstemli and Karanci (1999) found that age was negatively associated with receiving social support, while education and family income were positively associated with reception of social support. These results support the second assumption of vulnerability theory that "vulnerability is not evenly distributed among people or communities" (Chap. 2, p. 18).

Burnside et al. (2007) provide support for the fourth assumption of vulnerability theory that "the availability and equitable distribution of resources in a community decreases disaster vulnerability and facilitates resilience" (Chap. 2, p. 19). Through the provision of an important resource (reliable information) people reduced their vulnerability to disasters through their heightened intention to evacuate in a hurricane. The more sources of information people relied on the higher was their intention to evacuate.

Bonanno et al. (2007) provide support for the fifth assumption of vulnerability theory that "vulnerability is largely the result of environmental capabilities and liabilities" (Chap. 2, p. 11). In their study of survivors of the attack on the World Trade Centers in 2001, they found that social support and absence of previous life stressors were positively associated with resiliency.

Burnside et al. (2007) also provide support for the sixth assumption of vulnerability theory that "social and demographic attributes of people are associated with but do not cause disaster vulnerability" (Chap. 2, pp. 20 and 21). Age is associated with intent to evacuate in some studies, but only because older individuals have had the opportunity to evacuate sometime in the past. If the evacuation was for an event of similar intensity this experience translates into appropriate action in a present disaster threat (Ronan & Johnston, 2005).

Rüstemli and Karanci (1999) also provided support for the tenth assumption of vulnerability theory that "culture, ideology, and shared meaning are of central importance in the progression to disaster vulnerability" (Chap. 2, pp. 24 and 25). In their study of evacuation beliefs, level of education was positively associated with belief in the efficacy of household disaster mitigation measures.

In this chapter we have described the linear statistical models used to establish vulnerability theory. In Chap. 7 a different perspective on vulnerability theory is revealed through the use of geographic information systems (GIS). GIS offers a powerful way to describe the location, depth, and distribution of vulnerability. Chapter 7 covers the findings from several studies using GIS, and similar to Chap. 6 relates those findings to the assumptions of vulnerability theory.

Chapter 7
Vulnerability Described Geographically

In this chapter we discuss how geographic methods are used to describe the locations, depth, and extent of disaster vulnerability. These methods produce descriptive information. Identifying specific locations of vulnerability, describing how these locations are distributed, and documenting trends provide support for five of the general assumptions underlying vulnerability theory. This work has helped refine vulnerability theory and contribute in direct, practical ways to the mitigation, preparedness, and recovery efforts carried out by emergency managers and human service professionals.

We begin this chapter with a brief introduction to the conditions that define the hazards of place. These conditions represent risks to human safety. The main part of this chapter is devoted to discussing selected results of key studies that have described the hazards of place and identified characteristics associated with hazardous locations. These studies have been conducted at various levels of analysis. This diversity reflects the scope of the vulnerability concept. We close with a summary of the support for vulnerability theory provided by findings from geographic research.

Hazards of Place

Geographic researchers identify vulnerability by specifying the hazards of place or geographical location. Three types of risks or potentially unsafe conditions are used to describe the hazards of places: (1) biophysical risk estimated as the historical frequency of disasters from the physical hazards in a geographical location, multiplied by the severity of those hazards; (2) risk from the built environment reflected in the age, deterioration, and structural weaknesses of buildings and infrastructure; and (3) social risks manifest in the challenges related to getting and using the resources needed to absorb the shock of disaster and recover from it (Borden, Schmidtlein, Emrich, Piegorsch, & Cutter, 2007; Cutter, Boruff, & Shirley, 2003).

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Geographic methods are ideal for identifying unsafe areas and also for displaying distributions of potentially useful resources. These areas and resources are represented on maps of geographic space where people and places are located. This hazard of place approach yields a consistent operational definition of vulnerability (Cutter, Mitchell, & Scott, 2000).

Biophysical Risk

Biophysical risk is conceptualized as having two domains. The first domain is the kind of potential hazard, such as hurricanes, floods, tornados, industrial accidents, and many other types of hazards (for a relatively complete list, see the International Disasters Data Base: www.emdat.be). The level of risk associated with these hazards includes the expected consequences to a community from a disaster. Variables related to biophysical risk exposure include proximity to the source of threat, as well as the likely magnitude, duration, and social impact from a disaster. Distance from an identified hazard is a primary measure of the vulnerability in a region.

This first domain of biophysical risk is modified by the amount of disaster mitigation in an area. Disaster mitigation serves to reduce the level of biophysical risk in the areas when mitigation adjustments are made. Disaster mitigation involves land-use planning and management, building codes and standards, insurance coverage, infrastructure engineering, as well as prediction, forecasting, and warning systems (Mileti, 1999).

The second domain of biophysical risk is an estimate based on the history of disasters from known hazards. The probability of a 100-year flood in a specified area is an example. Communities with a diversity of hazards and with a history of destruction from those hazards are considered at high risk for disasters. For example, New Orleans has the greatest diversity of hazards and disasters from those hazards in the twentieth century of any city in the USA (Borden et al., 2007). The number and types of disasters that have occurred over the past 100 years in a given community or geographical area is a reasonable basis for estimating the probability of a future disaster event in that community or area. Of course, these probabilities must be updated frequently as the conditions that cause disasters are always changing.

Built Environment

Characteristics of the built environment most relevant to the vulnerability of a place include the disaster resistance of buildings and infrastructure (roads, bridges, sewer systems), the strength of lifelines (water, electricity), and the availability of energy sources (oil, gasoline). Certain characteristics of buildings are collected by the U.S. Census in county and municipal records. These include building age, building retrofits to withstand hazards, and the economic value of homes and business structures. While vulnerability of buildings and physical infrastructures results largely from their ability to withstand disaster shocks, researchers have been most interested in how characteristics of the built environment contribute to the vulnerability of individuals, groups, and communities.

Social Risks

The social (cultural, political, economic, demographic) forces governing the distribution of vulnerability is mirrored by and inscribed in the physical and geographic environment (Oliver-Smith, 2004). Geographers in the USA frequently use census data for vulnerability analysis because these data allow relatively accurate identification of households, cities, counties, and state boundaries. The variables most used in this research are household wealth, number of households below the poverty level, and number of individuals under the age of 5 or over the age of 65. Other variables considered in assessment of social risk include levels of disaster readiness and preparedness, as well as availability of resources and institutions for disaster response, recovery, and reconstruction (Cutter et al., 2003).

Identifying the vulnerability of places establishes a platform for research questions about the social causes of vulnerability. Identifying vulnerability as a combination of biophysical, built environment, and social risks facilitates research on the relative disaster vulnerability of specific locations (Cutter et al., 2000). Geographic methods map the distribution of disaster vulnerability and resource availability at various levels from individuals to entire countries. The detailed and location-specific nature of this information makes it useful for emergency managers in promoting disaster mitigation, preparedness, response, and recovery (Cutter, 2006).

Findings in Support of Vulnerability

Geographic research on the hazards of place has been done at different levels of analysis. Here we discuss studies with findings in support of vulnerability theory. These studies have been carried out at the individual, household, block, city, county, and country levels of analysis. The geographic research relevant to vulnerability theory has been mostly cross-sectional and comparative examining differences across individuals, households, blocks, cities, counties, and countries. However, several longitudinal studies add depth to the support for vulnerability theory. In this chapter we give brief accounts of this research for each of these levels.

Individual Level

Cutter (2006) claims that the most vulnerable people are unevenly distributed in relation to disaster-relevant resources. Zakour and Harrell (2003) support this claim with their finding that, as more affluent individuals moved to suburban areas, the service organizations followed, creating a service gap in inner-city jurisdictions. Human service organizations, including disaster services organizations, typically serve individual clients living within a radius of several miles around the organization's location (Bielefeld, Murdoch, & Waddell, 1997).

The findings of Zakour and Harrell (2003) show that the spatial pattern of individuals in urban areas mirror and reinforce the lack of access to disaster mitigation/prevention and response services. The individuals affected included low-income people, Black people, persons over 65 years of age, and single female-headed households with children below 5 years of age. Individuals with the greatest need for disaster services tend to be geographically located away from the organizations providing these services. This geographic distance is reflected in patterns of segregation and exclusion of low-income individuals, and so acts as an additional barrier to disaster services. These findings are consistent with the fourth assumption of vulnerability theory that vulnerability results from social processes affecting the availability and distribution of resources (see Chap. 2, pp. 18 and 19).

Household Level

In geographic analyses of households in the Arizona White Mountains, Collins (2008a, 2008b) assessed determinants of mitigation and the process of marginalization with certain households becoming more vulnerable to disaster. Data came from questionnaires completed by 493 households in three communities, a field-based fire hazard assessment, and secondary data on housing value and length of occupancy. These data were integrated into a geographic information system (GIS). Multiple regression analysis was used to predict the adoption of mitigation measures. Results of the regression analysis were supplemented through unstructured interviews with 33 households over a 2-year period as well as participant observation during a 4-month residence in the area. Synthesis of the historical and archival materials documented social, ecological, and economic changes. These changes helped identify root causes, structural pressures, and unsafe conditions.

The timber and other extraction industries had for a long time dominated the White Mountains, but by the 1980s market trends led to the collapse of these industries. This coincided with an urban to rural migration of affluent households. As often happens in population shifts the service workers followed the money. These service workers were low-income and mostly Hispanic. Those working in the extraction and service industries were at risk to wildfires. The more affluent migrants were at a comparatively lower risk and vulnerability to fires (Collins, 2008b).

Following a disastrous fire in 2002, the government began requiring household mitigation efforts. However, these requirements were at odds with development efforts in the White Mountain region, which put an emphasis on privacy, natural beauty, exclusivity, and dense forests. This emphasis increased the vulnerability of locals in the service industry and also those in the remaining extraction industries. Essentially, according to Collins (2008b), households employed in the extraction and service industries were marginalized. The affluent households were protected by private fire insurance and public fire suppression services. The adjacent working class households were unable to afford insurance, were underserved by public services, and were constrained by renter–landlord arrangements.

Household adoption of wildfire mitigation measures was predicted by a preference for natural beauty and a preference for property fire prevention and fire suppression capability. Though not statistically significant, a preference for privacy was positively related to mitigation. Indices of social vulnerability (housing tenure + household income + retirement status) and place dependence (length of residence + full-time versus part-time residency + livelihood dependent on forest) were also positively and significantly related to the number of mitigation measures adopted. Place dependency was considered important because longer term, full-time, and forest-dependent residents implement more mitigation measures than shorter term, part-time, and less forest-dependent counterparts. Finally, residing in a gated enclave or an apartment complex was negatively and significantly related to the number of household mitigation measures adopted, while dwelling value was positively related to adoption of mitigation measures. The level of hazard exposure was negatively but not significantly related to mitigation measures (Collins, 2008a).

Because local insurance carriers required mitigation adjustments to obtain fire insurance, fire insurance and mitigation adjustments are complementary. There is, however, an increased danger that households without the means to meet the mitigation requirements will not purchase fire insurance. Semi-structured interviews with households revealed that the affluent were relatively unaffected by resource constraints, but working class locals and fixed-income retirees experienced considerable hardship in making mitigation adjustments. These marginal households lacked access to the resources needed for mitigation, and thus exemplify issues of social vulnerability.

After Hurricane Andrew, Peacock, Morrow, and Gladwin (1997) examined household relocation patterns of Dade County, Florida at four different time periods. First, the 1990 U.S. Census was used as a baseline on the number of Anglo (white, non-Hispanic), black, and Hispanic households living in Dade County, Florida. Second, interviews were completed in December 1992 4 months after the hurricane with a sample of 484 households who lived in the high impact zone of South Dade before the hurricane. Third, another survey of South Dade was completed in July 1993 nearly 1 year after Hurricane Andrew. This study divided the area into impact zones: Zone 1 was in the path of Hurricane Andrew's eye and sustained the highest damage; Zone 2 was split into two different zones (2A and 2B) because losses differed substantially between the two parts; and Zone 3 was outside the eye wall. Fourth, a final telephone interview of households was completed in December 1994. This survey focused on the City of Homestead in Zone 1, and contained data only about race/ethnicity and relocation.

Comparing the 1990 U.S. Census with the July 1993 survey, Girard and Peacock (1997) found that Black and Hispanic households in Dade County had increased by 4.44% and 3.47%, respectively, while white households decreased by 7.91%. Three logistic regression models were assessed. In the first model, housing characteristics (mobile home, multiple unit structure, homeowner), level of damage, and damage zone were statistically controlled. If the household was Black, it was less likely to relocate after Andrew, and this difference between White and Black households was statistically significant ($p < 0.05$). In the second model, residence in an area with 25–75% Blacks and residence in an area with the same percentages of Hispanics were statistically controlled. The third model controlled whether or not the house was insured. In both of these models, racial status remained a significant predictor of permanent relocation. When rents were also controlled being Black was no longer a significant predictor and residence in a block in which 25–75% of the households were Black was no longer statistically significant ($p < 0.10$). Results of the relocation studies suggested that Black households were less able to relocate because of inadequate homeowner insurance and greater damage from Hurricane Andrew. Hispanic ethnicity of a household was significantly and positively related to the amount of damage as was residence in a zip code with 75% or more Black residents (Peacock et al., 1997; Peacock & Girard, 1997).

Logistic regression techniques were used to examine whether being a black versus white homeowner affected the chance of being covered by one of the top three homeowner insurance carriers (Peacock & Girard, 1997). State Farm, Allstate, and Prudential were the top three carriers of homeowner insurance. The results indicated that Black homeowners were less likely to be covered. This assumption is consistent with the second assumption of vulnerability theory regarding the unequal distribution of vulnerability (Chap. 2, pp. 17 and 18). These regression analyses using geographic data revealed that racial segregation of blacks in Miami was an important predictor of being covered by top homeowners' insurance companies.

Block Level

Chakraborty, Tobin, and Montz (2005) used 2000 U.S. Census block level data to examine evacuation needs before a hurricane in Hillsborough County, Florida. This region contains the metropolitan Tampa area and was chosen for study because it incorporates a variety of hazard types with a range of probabilities and includes areas subject to storm surge, coastal flooding, and other hurricane-related hazards.

An index of social vulnerability was constructed with three components: (1) population and structure, (2) differential access to resources, and (3) populations with special evacuation needs. Population and structure included the total population, number of housing units, and number of mobile homes in a census block. Differential access to resources was made up of the percent of population below poverty level, occupied housing units with no telephones, and occupied housing units with no vehicles. Special evacuation needs included people institutionalized in group quarters, those age 5 years or under, persons over 85 years of age, and persons over 5 years of age with a disability (Chakraborty et al., 2005).

Geophysical risk was measured as a summative variable comprised of the annual probability of a tropical storm plus each category of hurricane (Safir-Simpson categories 1–5) plus the risk of flooding. Geophysical risk zones were defined using criteria of the National Hurricane Center Risk Analysis Program, which allowed calculation of the probabilities of a hurricane at Egmont Key located at the entry to Tampa Bay from the Gulf of Mexico. Flood probability was derived from flood insurance maps of 100-year flood areas and the 100–500-year floodplain. An index of geophysical risk (GPRI) represented the total probability of the hazards threat by summing the two probabilities: hurricanes + floods (Chakraborty et al., 2005).

Ten 2000 U.S. Census variables were collected for the 795 block groups in Hillsborough County to compute a social vulnerability for evacuation assistance index (SVEAI). This was computed in three steps: (1) the ratio of the variable in the census block to that variable in the entire county was calculated, (2) a standardized SVEAI for the variable was computed using the maximum ratio value for census blocks in Hillsborough County, and (3) the social vulnerability variables were combined by calculating the arithmetic mean of the vulnerability ratios for the set of variables. The standardized ratios for the ten variables were summed and divided by 10, giving a result ranging from 0 to 1, with 1 indicating a comparatively high social vulnerability level (Chakraborty et al., 2005).

Overall vulnerability was operationalized as the geophysical risk index (GPRI) times the SVEAI. Using this product, five evacuation zones were classified from lowest to highest evacuation need and shown on a GIS map. Four separate sets of variables were used to calculate the social vulnerability for evacuation assistance index. These sets were population and structure (total population + number housing units + number of mobile homes), access to resources (percentage of population below poverty level + occupied housing units with no telephones + occupied housing units with no vehicles), those with special evacuation needs (people institutionalized + number age 5 years or under + persons over 85 years of age + persons over 5 years of age with a disability), and the composite set made up of all 10 of these variables.

Results from Chakraborty et al.'s (2005) study show that the highest risk zones had the lowest percentage of the population of Hillsborough County, and that the third set (special evacuation needs) and the fourth set (combination of all ten variables) contained lower percentages of the entire county's population, compared to the first set (population and structure) and the second set (access to resources). These results show that vulnerability measured in block units is not evenly distributed across the county (see Chap. 2, pp. 17 and 18). Also the finding that vulnerability results from reduced capability (less access to resources) and increased liability (closer to hazard zone) supports the fifth assumption (see Chap. 2, p. 20).

City Level

Borden et al. (2007) examined the social, built environment, and hazard risk vulnerability of 153 cities in the USA. The variables used to measure the social vulnerability of cities were U.S. Census demographic variables, such as percentages

Table 7.1 Most and least vulnerable cities in USA

Most vulnerable	Least vulnerable
New Orleans, LA	Juneau, AK
Baton Rouge, LA	Helena, MT
Charleston, SC	Barre-Montpelier, VT
New York, NY	Colorado Springs, CO
Norfolk, VA	Concord, NH

of Hispanics and African Americans in the urban population, the percentage of children under 5 years of age, and percentage of adults above 65 years of age. Built environment vulnerability was measured by the value of property and real estate, and the number of energy-producing plants such as nuclear plants proximate to the metropolitan areas. Hazard risk was measured as the past frequency and diversity of hazards affecting the metropolitan areas.

Out of a pool of 78 variables, Borden et al. (2007) used principal components analysis to identify variables that represented social vulnerability, built environment, and hazard vulnerability. The index of social vulnerability (SoVI) includes ethnicity, age, race, gender, and wealth (subtracts from hazard of place). The index of the built environment (BEVI) includes urban density, age, and compactness of buildings. The index of hazard risk (HazVI) includes human casualties and property losses, hazard diversity and occurrence, and crop loss. A GIS map of these indices was created to display the vulnerability of urban areas in the USA.

The three indices were standardized and combined to form an overall place vulnerability index (PVI). This index reveals New Orleans, Louisiana, as the most vulnerable city in the USA. The least vulnerable urban area is Juneau, Alaska. Table 7.1 shows the five most and least vulnerable cities in the USA.

The findings from Borden et al.'s (2007) study show that the greater the density and value of built structures on land at-risk for hazards the greater is the vulnerability of the built environment. The built environment was found to be the primary contributor to vulnerability for northeastern urban areas, such as New York City, Washington, DC, and Philadelphia. The value of private and public property, real estate, and other buildings is high in these areas, compared to urban areas in other regions. In addition to property and real-estate values, the presence and prevalence of oil and gasoline refineries and pipelines, other chemical plants and pipelines, and especially nuclear power plants contribute to the vulnerability of urban communities. Cities such as Philadelphia have numerous nuclear power plants within 100 miles of the metropolitan area, and Gulf Coastal communities such as New Orleans and Baton Rouge in Louisiana have a high number of petrochemical plants and pipelines surrounding their metropolitan areas. These findings support the seventh assumption of vulnerability theory that unsafe conditions in which people live are the most proximate and immediate causes of disaster (Chap. 2, p. 22).

Table 7.2 Components of social vulnerability and their correlates

Components	%SoVI	U.S. Census variable
Personal wealth	12.4	Per capita income
Age	11.9	Median age in a county
Density of built environment	11.2	Number of commercial establish-ments/square mile
Sector economic dependence	8.6	% of county employed in extractive industries
Housing stock	7.0	Housing units that are mobile homes
Ethnicity—African American	6.9	Percent black in county
Ethnicity—Hispanic	4.2	Percent Hispanic in county
Ethnicity—Native American	4.1	Percent native American in county
Race—Asian American	3.9	Percent Asian American
Occupation—service	3.2	% of workers employed in service occupations
Employment—infrastructure	2.9	% in transport/communication/public utilities jobs

County Level

In their geographic study of all 3,141 counties in the USA, Cutter et al. (2003) created an index of social vulnerability. They used a cross-sectional design with variables drawn from the U.S. Census City and County Data Books for 1994 and 1998. Choice of variables for their social vulnerability index was determined by theoretical relationships and empirical findings concerning causes and indicators of vulnerability. Forty-two variables were eventually selected and normalized through calculation of percentages or density functions. A principal components analysis of these 42 variables yielded 11 components. These components explain 76.4% of the variance in social vulnerability among U.S. counties. The index of social vulnerability (SoVI) was created by summing the 11 components without weighting them. Personal wealth is negatively related to the vulnerability index, while age is related in a nonlinear manner. The percentages of children under 5 and adults over 65, and the birth rate are all positively related to the overall index, while median age is negatively related. All other components are positively related to the SoVI. Table 7.2 lists each component, the percentage of variance it explains among counties, and the variable the component is most highly correlated with.

The SoVI ranges from −9.6 (low vulnerability) to 49.51 (high social vulnerability) with an average score of 1.54 and standard deviation of 3.38. County vulnerability was categorized into five levels of the SoVI and displayed on a GIS county map. The most vulnerable counties have an index value greater than 1 standard deviation above the SoVI mean (>4.92). The least vulnerable counties have an SoVI score greater than 1 standard deviation below the mean (< −1.84). With some important

Table 7.3 Most and least vulnerable counties (not in order)

Most vulnerable	Least vulnerable
Manhattan Borough, NY	Yellowstone National Park, MT
San Francisco, CA	Poquoson, VA
Bronx, NY	Los Alamos, NM
Kalawao, HI	Tolland, CT
Benton, WA	Moore, TN

exceptions (e.g., Manhattan Borough, NY) the most vulnerable counties are generally in the southern half of the country, from southern California to Florida. These regions have the greatest ethnic and racial inequalities and the fastest population growth. However, the most vulnerable county is Manhattan Borough, part of New York City. The county with the lowest SoVI is Yellowstone National Park County. Table 7.3 lists the five most and least vulnerable counties in the USA.

Northeast and West Coast counties in Table 7.3 are vulnerable largely because of the density of their built environments. The remaining two most vulnerable counties have high levels of poverty and a larger population of older persons and ethnic minorities (i.e., Kalawao) or a very low tax base (i.e., Benton). The five least vulnerable counties all have homogeneous, White, middle- to upper-income populations, with low unemployment rates in these counties.

Three of the components in the SoVI are related to socioeconomic status: (a) personal wealth, (b) housing stock, and (c) percentage population in service industries. These three components explain 22.6% of the variability among vulnerability of counties. Two components are related to resource availability: sector economic dependence (% in extractive industries) and employment in infrastructure (% employed in transport, communication, public utilities). Both components are indicators of low levels of resources available for disaster response and recovery. These two components explain 11.5% of variability in the SoVI among counties. The five remaining components are sociodemographic in nature, and refer to percentages of demographic groups among the population of a county: (a) age, (b) race—African American, (c) Hispanic ethnicity, (d) Native American ethnicity, and (e) Race—Asian American. These demographic components explain 31% of the variability among counties in vulnerability.

Results from studies using the SoVI show support for the fourth assumption of vulnerability theory, which states that availability and equitable distribution of resources decreases vulnerability and increases resilience (Chap. 2, pp. 19 and 20). Personal wealth, housing stock, and percentage employment in low-paying service jobs are related to low-socioeconomic status. Also, the percentage employed in extractive industries, as well as in communications, transport, and public utilities are variables related to low levels of resources available in a disaster.

The results of this study are also consistent with the sixth assumption of vulnerability theory, namely that social and demographic attributes are correlated with disasters but not causal agents (Chap. 2, pp. 21 and 22). High percentages in a county of very young and very old persons, African Americans, Hispanics, Native

Americans, and Asian Americans are correlated with disaster vulnerability, but these demographic groups are likely to experience language and other barriers (e.g., de facto segregation) that contribute to their disaster vulnerability.

Mitchell, Thomas, and Cutter (1999) used a retrospective longitudinal design to examine the process by which industrial facilities are located near low-income and minority populations. The research question they asked was "Did the residents come to the hazardous site or was a hazardous site imposed on them?" The geographic areas compared were incorporated areas and counties from the U.S. Census of Population and Housing. The Toxic Release Inventory was used to identify 82 facilities that exceeded an average of 100,000 pounds for the 6-year study period (1987–1992). These data were put into a GIS map to examine regional variations in vulnerability, facility locations and age, and also to examine racial and economic differences between the state of South Carolina and the facility host area.

Facilities in the state are concentrated in the upstate region of South Carolina near Spartanburg and Greenville. The facilities established earliest are located in incorporated areas. Beginning in the 1950s facilities were built in the periphery of incorporated areas, but by the 1960s most facilities were being built in rural areas. This trend continued through the 1980s and 1990s. Between 1987 and 1992, major emitters of toxic chemicals were concentrated mostly in the upstate region, with smaller concentrations clustered around Columbia and Charleston, South Carolina.

Differences between the state and facility host areas were compared to find out if facilities were originally built in predominantly African-American jurisdictions or if host areas demographically shifted through migration of lower income and African-American populations into the host jurisdictions (Mitchell et al., 1999). Host areas for facilities were divided into urban, suburban, and rural areas. The investigators then used *t*-tests to determine if facilities were originally built in host areas with higher percentages of minority populations than the state average. These statistical tests were performed for jurisdictions in which facilities were originally built in each decade from 1930 to 1980.

Statistically significant differences were found in the percentages African Americans in host areas compared to state averages, but only for suburban jurisdictions in which facilities were originally built in the 1950s and 1960s. In those host areas, the percentages of African-Americans were lower than for the state of South Carolina. Results of *t*-tests to determine differences in income between host areas and the state for urban and suburban areas found that, in about half of the decades examined, income in host areas was higher than for the entire state. Only for rural areas in which facilities were built in 1960 and 1970 was average income significantly lower than for the state as a whole.

By 1990 the demographic composition of the host areas had changed dramatically, consistent with the hypothesis that migration into host areas accounted for the higher percentages of African Americans and lower average incomes (Mitchell et al., 1999). By 1990, for urban and suburban host areas the percentage of minority persons in host areas was significantly higher than the percentage in the state as a whole. For suburban and rural host areas in this decade, the average income was significantly lower than the average income in the state of South Carolina.

Urban and suburban host jurisdictions had experienced a shift from either higher percentages of white populations or percentages similar to those of the state, to higher African-American population percentages. Suburban host areas had changed in 1990 from above average incomes to lower average incomes. Rural host areas had average incomes in 1990 lower than the state average, similar to previous decades (the 1950s and 1960s) when the facilities were originally built.

Country Level

Renfrew (2009, 2012) studied widespread exposure to lead in Uruguay. The actions of government, domestic, and trans-national corporations were traced over decades as root social causes of increased vulnerability to lead poisoning. Renfrew was able to document the impacts of neoliberal reforms on Uruguay's economy. Neoliberal structuring of Uruguay's economy has been mandated by the World Bank and the International Monetary Fund (IMF) since the 1980s. Neo-liberal reforms have included reducing the size of government and public expenditures, privatization of many governmental functions and services, opening Uruguay to foreign investment, and export-led growth (Mascarenhas & Wisner, 2012). Over several decades, neoliberal structuring in Uruguay has favored large land holdings and farm production consisting of heavy technological inputs, genetically modified seed imports, and agro-toxic chemical use. Larger companies and landholders could afford these changes and qualify for international credits and loans. As domestic and multinational corporations have possessed and invested in arable land, small farming enterprises had been squeezed out. These small farm owners and former workers of shuttered industries have moved to cities and settled in squatter settlements.

Neoliberal structuring and socioeconomic decline in Uruguay have resulted in new and intensified lead exposure rates (Renfrew, 2009). New productive and consumptive practices have coincided with a dismantling of welfare services, as well as crises in the economic, housing, and public health spheres. These crises, arguably linked to neoliberal reforms, have increased the urban population's exposure to lead and vulnerability to other environmental toxins. Heavy tariffs on imports have led to an industrial boom in which all phases of the production cycle are covered. An important example of this is batteries, which are recycled with the lead waste dumped on nearby land (Renfrew, 2012). Growing unemployment and impoverishment has fueled a housing crisis. These trends have been compounded by reforms mandated by the IMF of the heavily indebted Uruguayan Mortgage Bank. As a result, housing credits have been drastically reduced, contributing to the movement of people from solid housing into makeshift squatter settlements.

Squatter settlements emerged beginning in the 1980s on landfilled lots along riverbanks and on the grounds of abandoned scrap metal industries. Many squatter settlements have been built on marginal lands long contaminated by industrial waste. In the capital city, Montevideo, the center and eastern sectors of the city contain relatively healthy environments. In contrast, the rivers bordering the northwestern and the northeastern edges of the city carry high levels of industrial and domestic waste, and a high load of waterborne illnesses. Squatter settlements follow these rivers, and these impoverished communities are susceptible to flooding and to the multiple poisons carried by the rivers. The rivers in northern Montevideo are highly polluted with lead, chromium, mercury, copper, and other heavy metals. Consistent with the second assumption of vulnerability theory, children, pregnant women, and the newly poor in these areas face higher levels of vulnerability (Chap. 2, pp. 17 and 18). These increased levels of vulnerability have been accompanied by a decline in the quality of health care and human services to low-income families (Renfrew, 2009).

The dynamics of lead poisoning are revealed when placed in the context of social exclusion and the dissolution of the urban free market. Environmental conditions largely coincide with socioeconomic ones. Contaminated communities are superimposed upon polluted landscapes in poor sections of the city. These areas inversely mirror the cleaner environmental conditions of the wealthy urban sectors. Urban environmental degradation further stigmatizes residents of these areas by linking them symbolically to their environmental surroundings. This stigmatization is combined with the serious negative health outcomes of living in proximity to pollution and having few means of reducing exposure or mitigating impacts (Renfrew, 2009).

Summary

Geographic methods describe disaster vulnerability by geocoding demographic variables to indicate the locations of vulnerability. As discussed in Chap. 2, vulnerability theorists assume that disasters result from social causes with the people most susceptible to disasters being geographically clustered together; that is, geographic patterns of vulnerability reflect social patterns of stratified resource distribution and social inequality. Various levels of analysis have been used to study these patterns: individual, household, block, city, county, and country. The results of these diverse studies show support for the second, third, fourth, sixth, seventh, and twelfth assumptions of vulnerability theory.

The finding that facilities processing toxic chemicals are unevenly distributed in South Carolina (Mitchell et al., 1999) is consistent with the second assumption that vulnerability is not evenly distributed (Chap. 2, p. 18). Also the finding that vulnerability is not evenly distributed across Hillsborough County in Florida is consistent with this assumption (Chakraborty et al., 2005).

Zakour and Harrell's (2003) finding that individuals most in need of disaster services are located at distances far from the agencies providing these services is consistent with the fourth assumption, indicating differential availability and distribution of resources among different categories of people (Chap. 2, p. 19). Additional support comes from Cutter et al.'s (2003) findings that census variables indicating a lack of resources explain a substantial amount of variability in social vulnerability among counties, Collins' (2008b) finding that working class locals and fixed-income retirees experienced difficulties in making mitigation adjustments, and from Renfrew's (2009, 2012) finding that neoliberal structuring in Uruguay caused more exposure to lead.

The indices of vulnerability uniformly contain a number of variables representing multiple dimensions, which supports the third assumption stating the multidimensional nature of vulnerability (Chap. 2, p. 20). The index created by Chakraborty et al. (2005) included ten variables representing three components. Borden et al. (2007) combined measures of social vulnerability, built environment risk, and hazards risk for an overall index of place vulnerability and each of the three parts of this measure is multidimensional. The index of social vulnerability (SoVI) created by Cutter et al. (2003) has 42 variables representing 11 domains.

The finding that the most vulnerable counties in the USA have the greatest ethnic and racial inequalities (Cutter et al., 2003) is consistent with the sixth assumption, which states that demographic variables are associated with but do not cause disaster vulnerability (Chap. 2, p. 22). In addition, the findings that racial status predicted permanent relocation (Girard & Peacock, 1997) and the racial segregation of blacks in Miami predicted coverage by top insurance companies (Peacock & Girard, 1997) further supports this assumption.

The finding that the greater the density and value of built structures on land at-risk for hazards, the greater the vulnerability of the built environment (Borden et al., 2007) is consistent with the seventh assumption, which states that the unsafe conditions where people live and work are the most proximate and immediate societal causes of disaster (Chap. 2, pp. 22–23). People create unsafe conditions through the policies they create and actions they carry out, and these conditions interact with physical hazards to create disasters.

Renfrew's (2009, 2012) findings also support the twelfth assumption of vulnerability theory, which states that "The environments of communities are growing in complexity and are increasingly global in scale" (Chap. 2, p. 26). Renfrew argues that the environment of Uruguay's poor has increasingly included the global economy, which has influenced the nation's economy largely through neoliberal reforms imposed by the World Bank, multinational corporations, and the Global North on many nations part of the Global South.

In this chapter we have drawn on geographic methods to describe the location, depth, and distribution of vulnerability. In Chap. 8 a different perspective on vulnerability theory is revealed through the use of network analysis. Network analysis focuses on the patterns of relations between agents. Chap. 8 covers the findings from several network studies, and similar to Chap. 7 relates those findings to the assumptions of vulnerability theory.

Chapter 8
Vulnerability Described Through Networks

In this chapter we discuss research findings from social network analysis relevant to vulnerability theory. Although the invention and use of network methods predates the creation of vulnerability theory by 40 years (Moreno, 1934; O'Keefe, Westgate, & Wisner, 1976) the application of network analysis to vulnerability theory has been quite recent and limited. Nevertheless, network methods are well suited to address several of the general assumptions underlying vulnerability theory. We expect vulnerability researchers in the future to make increasing use of network methods.

Networks are comprised of two or more actors and the relations between them (Scott, 2000). Social networks are more abstract than geographic locations because we do not directly see the relations between actors in the way we actually see people living in geographic places. The abstract nature of social relations has led network theorists to draw on spatial analogies to communicate some of the key network ideas. For example, the idea of social distance is analogous to geographic distance, although the two ideas are clearly distinct in that actors can be socially close while being many geographic miles apart. The studies covered in this chapter report on aspects of social distance and other variables having relevance to disaster vulnerability.

This chapter begins with an overview of network analysis and the reasons that social networks are so critical to understanding vulnerability. We define networks, describe the three basic assumptions made by network analysts, discuss types of networks, and point out the very special importance of network boundaries. Following this overview, we turn to a discussion of several key organizational studies with findings about capacity and coordination. Each of these studies support one or more of the assumptions underlying vulnerability theory. We finish up this chapter with a summary of the empirical evidence from network analysis in support of vulnerability theory.

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Overview of Social Network Analysis

Networks affect the level of vulnerability in communities. The structure of both individual social support and organizational networks play active roles before, during, and after disasters (McEntire, 2002; Hurlbert, Haines, & Beggs, 2000). These networks govern the acquisition and exchange of resources needed to prepare for, respond to, and recover from disasters (Benight, McFarlane, & Norris, 2006). Network structures influence risk perceptions, warnings, and household evacuation behaviors (Gladwin, Gladwin, & Peacock, 2001). It will be clear from the results discussed in this chapter that an accurate assessment of community disaster vulnerability requires data on the social support and organizational networks operating in a community (Zakour & Gillespie, 2010).

As noted above, a network is made up of actors and the relationships among those actors. There are three basic assumptions of network analysis. First, the structure of the system studied consists of stable patterns of repeated interactions connecting social actors to one another. Second, behavior is explained primarily by social relations, rather than by the attributes of individual actors. Third, actor perceptions, attitudes, and actions are shaped by the networks within which they are embedded. These assumptions are consistent with vulnerability theory, which as discussed in previous chapters assumes that vulnerability is caused by community structures formed through the patterns of social relations.

Types of Networks

Social networks have been studied at the ego network, secondary ego network, and the complete network levels. Ego networks consist of an individual actor (the "ego"), the other actors connected to that ego (the "alters"), and the relationships among all actors in that particular set or ego network. Relationships may represent a single content or more than one content. When relationships involve more than one type of content they are called "multiplex." Relationships may be directional ($A \rightarrow B$, $B \rightarrow A$) or reciprocal ($A \leftrightarrow B$). Sometimes reciprocity is assumed and sometimes it is empirically assessed. Measures that are frequently used in ego networks include the number of alters, the diversity of alters, and the density of connections.

A secondary ego network seeks to approximate a complete network. A secondary ego network begins with a central actor and then builds out toward a complete network by adding the ego networks of each alter. Secondary ego networks are similar to snowball sampling where one member of the population is identified and interviewed, and then that person is asked to identify others consistent with study objectives (Schutt, 2005). This technique can be extended beyond the secondary level to more closely approach the complete network. This technique can also be used to identify network boundaries because, given a domain focus, there is a point at which the environment of relevant cases (organizations) would be saturated.

Social support networks at the individual level of analysis are generally ego networks or secondary ego networks. An important aspect of social support networks is embeddedness in the support network. Social embeddedness is assessed as the number of network ties to others, participation in community and other social activities, and the different types of alters in an ego network. Alters in support networks can be friends, relatives, neighbors, people that the individual does not know personally (e.g., community leaders), and formal organizations (Kaniasty & Norris, 2009). Along with levels of received and perceived support, level of network embeddedness makes up the level of social support. Each aspect of social support influences individual and population disaster vulnerability and the likelihood of resilient recoveries.

Complete networks represent a population of actors and the relationships among these actors. From a practical perspective, there is only one complete network because everyone in the world is connected directly or indirectly to everyone else (Gurevich, 1961). But from a theoretical perspective, vulnerability researchers demarcate particular subpopulations and study these as relatively complete networks. These subpopulations are often defined by legal or administrative criteria, such as towns or cities, districts, counties, and states.

Complete networks are characterized by size (number of actors), density (proportion of possible links), distance (maximum number of links required to connect actors), and components (number of cliques, social circles, or structurally equivalent positions). Knoke and Yang (2008) discuss these measures and others. Murty and Gillespie (1995, p. 112) provide a list of measures to characterize both networks and individual actors in networks.

Network Boundaries

Because complete networks are considered to be populations the issue of network boundaries is particularly sensitive. As noted above, boundaries can be drawn on the basis of legal or administrative guidelines, or they can be drawn empirically by identifying concentrated patterns of relations as expressed by respondents. A network will vary in size and other characteristics depending on how its boundary is defined and measured. In addition, because complete networks are comprised of relations, it is critical to include all members of the network and their relationships to ensure an accurate and complete picture of the network is captured (Gillespie & Murty, 1994). It is easy to demonstrate the importance of this point by first graphing a complete network and then deleting a central actor. The deletion of even a single central actor changes the structure of the network, and almost always this change is dramatic. Figure 8.1 illustrates how much the loss of even one central actor changes the network.

The deletion of actors that are not central is generally less critical. Isolates are actors not connected to any other actor in a network. Network analysts often delete isolates since they seek to explain behavior on the basis of relations. Peripherals are actors with only one or a few connections or relationships (links) to other actors in a network. The most helpful services come from organizations participating in the

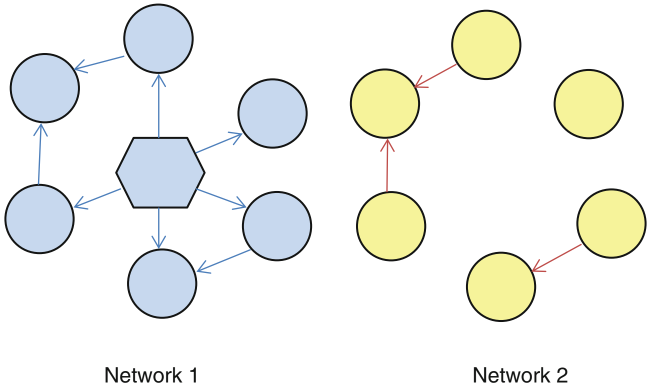

Fig. 8.1 Both networks are identical, except for absence of one organization (hexagon) and its links in network 2

larger, officially constituted disaster services network (Coston, Cooper, & Sundeen, 1993). Network analysis is particularly useful in identifying peripheral organizations and isolates (Gillespie & Murty, 1994). Zakour and Harrell (2003) found that the few organizations serving the most economically distressed areas were peripheral or isolates.

Findings in Support of Vulnerability

Different types of networks with findings relevant to disaster vulnerability have been studied. Support for vulnerability theory has come from studies of ego networks, secondary ego networks, and complete networks. These studies were cross-sectional and comparative, reporting on organizational differences in network capacity and coordination. The findings from these studies deal with community capabilities and liabilities, adaptation to the environment, and the distribution of vulnerability (Gillespie, Colignon, Banerjee, Murty, & Rogge, 1993; Gillespie & Murty, 1994; Zakour & Harrell, 2003). The findings of these studies have added support to three of the assumptions from vulnerability theory. We discuss this research as it relates to vulnerability theory.

Network Capacity

Gillespie and Murty (1994) identified poor linkage cracks in a network of disaster response and services organizations. The network consisted of 80 organizations in a mid-western metropolitan area with a willingness and capacity to respond to a widespread disaster of moderate intensity and scope. A realistic vignette was used to describe an earthquake disaster that caused a moderate number of deaths and injuries, and extensive property damage in the metropolitan area and surrounding states. The study design was cross-sectional.

The authors first determined the structure of the network and then related organizational experience and capacity for disaster response to groups found in the network (Gillespie & Murty, 1994). Nine groups (structurally equivalent positions) and six unique organizations were identified. The most central organizations included the American Red Cross (ARC) and the emergency management agencies of the two largest counties in the metropolitan area. One group was an isolate with no relations to the rest of the network; the only links the members of this group had were with other organizations within the group. Two peripheral groups were also identified with the organizations in each of these groups being linked only to a structurally unique organization. These unique organizations had only an indirect link to the most central group.

The peripheral and isolate groups had disaster experience and preparedness capacities which, due to their position in the network, were not accessible to the rest of the network. Compared to overall measures, the two peripheral groups and the isolate had above-average disaster experience in dealing with fire and explosions, toxic hazards, and blizzards and ice storms. One of these groups also had relatively high capacity to provide essential services such as food, shelter, and clothing. The isolate and peripheral groups also had a capacity to provide counseling for special populations. The capacities of isolate and peripheral organizations are essential in a disaster, but difficult to mobilize and deploy where they are most needed (Gillespie & Murty, 1994). This liability supports the fifth assumption of vulnerability theory concerning capabilities and liabilities (Chap. 2, pp. 20 and 21).

Information on network structure is most effectively used when representatives of all organizations meet to brainstorm and solve problems. Community planning councils can work to eliminate poor linkage cracks. A community planning council could work either with central groups or with peripheral groups and isolate organizations to find ways of effectively connecting all organizations together. Planning councils can also help isolated and peripheral organizations overcome barriers to resource sharing and coordination with the larger network (Gillespie & Murty, 1994). These steps facilitate more effective service delivery and distribution of resources before, during, and after disasters, which supports the first assumption of vulnerability theory regarding the capacity of a community to adapt to environmental circumstances (Chap. 2, p. 17).

Social capital is an important aspect of network capacity because it deals with the amount and quality of resources available to actors. Resources can be tangible or intangible (Gillespie et al., 1993). In network research a widely used measure for embedded resources is the number of different occupations or social positions of the actors in an ego network (Lin, 2001). The diversity of types of linked organizations (range-of-types) is a measure of embedded resources (Lin, Cook, & Burt, 2001). Relationships with many different types of actors are a form of social capital (Putnam, 2000).

Zakour (2008a) examined the effects of organizational type, diversity of linked types (range-of-types), and client-centered service delivery capacity of disaster-relevant organizations serving a southern metropolitan area. All of these organizations either provided or had the capacity to provide disaster services within a three-county area containing a major city. Diversity of linked organizational types (range-of-types) was measured by summing the total number of organizational types that each organization had a direct link with. There were 14 different types of organizations with capacity to provide disaster services. Capacity for client-centered service delivery was measured as the total capacity to provide (a) case management, (b) outreach, (c) case finding, (d) information and referral, (e) helping clients apply for or qualify for services, and (f) case advocacy.

Zakour (2008a) found that organizational type was correlated with each of the other independent variables, and each of the independent variables was positively and significantly related to the dependent variable of evacuation capacity. Organizational type was also related significantly to client-centered service capacity ($r = -0.20$, $p < 0.05$) and to range-of-type ($r = 0.52$, $p < 0.001$). However, range-of-type was negligibly and not significantly related to client-centered service delivery capacity ($r = 0.12$).

The relationships of organizational type, range-of-type, and service delivery capacity to evacuation capacity were elaborated in a block regression model. Organizations with a higher diversity of linked types had access to a greater number and variety of resources and were able to mobilize more effectively to achieve their goals. Access to embedded social resources had a positive effect on evacuation capacity (Zakour, 2008a). These results support the fifth assumption of vulnerability theory regarding the mix of capabilities and liabilities (Chap. 2, pp. 20 and 21).

Gillespie et al.'s (1993) study of a secondary ego network also examined effects related to the range of different types of organizations. This network was built out from the ego network of the St. Louis ARC. The ARC was directly connected to 24 organizations. Data from the ego networks of each of these 24 organizations yielded a secondary ego network of 154 organizations and their relations. Like a complete network, this secondary ego network included isolates and peripheral organizations (Fig. 8.2).

The total number of different organizational types cited as strategic by each member of the primary ego network of the ARC was measured to indicate the organization's willingness to work with organizations of different types. There were 12 different types of organizations that could be cited as strategic. Cohesion was measured as the number of shared links an organization had with another organization, divided by the total number of links for both organizations. Cluster analysis was used to identify homogeneous groups of organizations based on overlapping circles. Organizations with similar cohesion patterns to all other organizations in the network were grouped together into homogeneous groups (Gillespie et al., 1993). Hierarchical regressions were used to examine the unique contribution of structural network variables to preparedness.

Gillespie et al. (1993) found restricted numbers of organizational types in both the secondary and primary ego networks. Interestingly, the non-linked strategic category included organizations in almost all of the 18 types. The secondary ego network included 12 (67%) of the 18 types. The primary ego network included 8

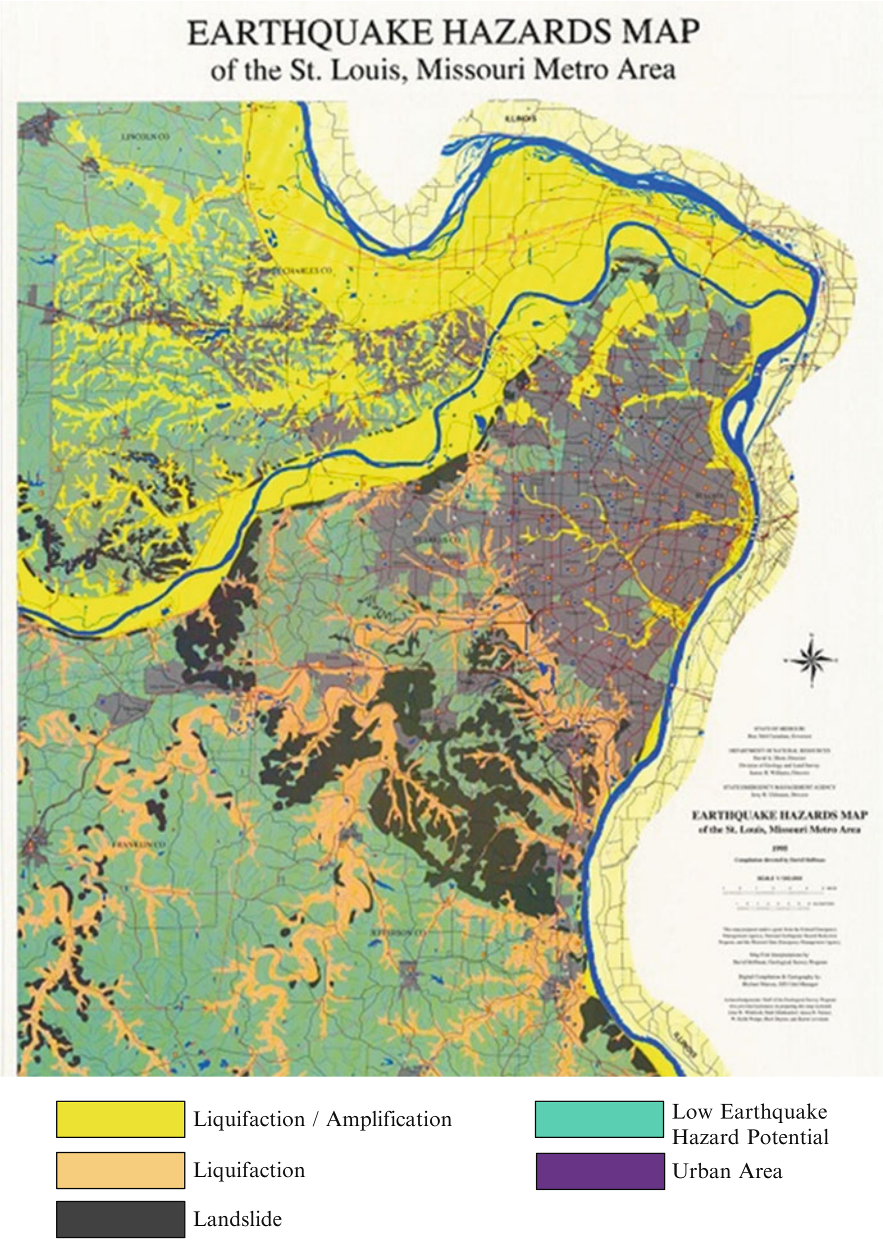

Fig. 8.2 Potential effects of an earthquake in the St. Louis, Missouri metropolitan area. *Source*: http://www.dnr.mo.gov/geology/images/StLouis_Discl.jpg

(44%) of the 18 types. The results revealed that the types of organizations were not evenly distributed, particularly in the primary ego network. Relative to the overall network, the primary ego network had relatively more social services, emergency management, and fire departments. This network did not include some important types of organizations such as municipal agencies, equipment suppliers, and organizations that handle hazardous materials. The absence of these types of organizations had a negative effect on the area's vulnerability. These results support the second assumption of vulnerability theory regarding the uneven distribution of vulnerability (Chap. 2, pp. 17 and 18).

In Gillespie et al.'s (1993) cohesion analysis, five clusters were found along with three unique organizations. The unique organizations were not part of any of the clusters. The unique organizations included the local chapter of the ARC, the American National Red Cross Midwest District Operations Office, and the primary urban fire department in the region. The most outstanding feature of this network is the low cohesion among clusters. None of the clusters had direct contact with any of the other clusters. For all five clusters fewer than half of the members of one cluster had a link with the members of any other cluster. In contrast, the ARC had direct links with each of the clusters; this meant that more than half of the members of each cluster had a link to the ARC. The primary way for clusters to link with each other is through the ARC. This puts too much emphasis on one organization (Gillespie et al., 1993), which limits the ability of the community to adapt. These findings support the first assumption of vulnerability theory concerning the ability to adapt to environmental circumstances (Chap. 2, p. 17).

Organizations connected with various types of other organizations were found to facilitate preparedness. The more different types the higher the preparedness. Both organizational type and training were found to be important predictors of preparedness. Four regression models were run, one for each of the structural variables measured: cohesion, total contacts, hierarchical autonomy, and proportional density. After controlling for organizational type and training, the coefficients for each of the structural variables remain statistically significant. Consistent with the findings of Zakour (2008a) and the fifth assumption of vulnerability theory (Chap. 2, pp. 20 and 21), these results confirmed that more contacts, higher cohesion, lower hierarchical constraints, and reduced proportionate density were positively associated with preparedness (Gillespie et al., 1993).

Gillespie et al. (1993) also demonstrated that structural network variables are superior to methods that average dyadic direct relationships of one organization with other network organizations. Average measures assume that the relationship of actor A with actors B and C will be very similar to that between actor A and actors D, E, and all other network actors. This assumption is weak and not supported by Gillespie et al.'s data. It is more accurate to use all links, direct and indirect, when calculating structural variables. Two-step links will be given less weight than direct (one-step) links, and three-step links will be given less weight than two-step links, and so forth. By weighting links structural variables maintain their full range of variability; averaged network variables suffer from restricted variability. Weighted structural variables are more refined and accurate, and thus better predictors of outcomes such as preparedness, evacuation, and service capacity.

Coordination

Well-coordinated organizational networks reduce disaster vulnerability and increase the community's probability of a resilient recovery. Coordination is particularly important in dealing with disasters of regional scope, affecting more than one state or country. In their study of interstate partnerships in emergency management, Kapucu, Augustin, and Garagey (2009) studied the direction of relationships, organization centrality, clique formation, and coordination. This study included the interstate Emergency Management Assistance Compact (EMAC) activated in both Louisiana's and Mississippi's response to Hurricanes Katrina and Rita. The EMAC was created to facilitate effective public sector collaboration and is administered by the U.S. National Emergency Management Agency (NEMA). The EMAC allows states to assist each other with some understanding of the expectations and responsibilities involved. Each state can activate the EMAC in major disasters, and in a particular state the EMAC has representatives from the other states assisting in disaster response. The coordinating organization is called an EMAC A-Team, and the Louisiana and Mississippi networks each included an EMAC A-Team.

The data for this study came from media reports and documents from both governmental and nongovernmental agencies. All organizations active in response to Hurricanes Katrina and Rita in Louisiana were identified. The relationships among these organizations were displayed graphically, with dots representing each organization and arrows going from each dot to others representing relationships as shown above in Fig. 8.1. Graphs of this type are called "sociograms" or directed graphs (Moreno, 1934; Wasserman & Faust, 1994). Three centrality variables were measured for each organization: degree centrality (number of connections), closeness centrality (inverse of average number of steps to connect to other actors), and betweenness centrality (number of indirect links in which the actor is required as an intermediary). Cliques were identified as well.

For the Louisiana organizational network, the EMAC A-Team had the highest degree centrality (21) except for the Louisiana Emergency Strike Team (27). The overall average degree centrality in the network was 10.46 indicating that variability of degree centrality among all organizations in the network was low. This revealed a loosely coupled network in Louisiana. The Louisiana Emergency Strike Team and the EMAC also had the first and second highest closeness centrality, indicating that these two organizations can more easily reach other organizations in the network. None of the organizations in the Louisiana network had a betweenness value of more than 0. This means that no organizations were more influential than others as intermediaries in the network. In addition, no cliques were found in the Louisiana network (Kapucu et al., 2009).

The Mississippi organizational network was more highly coordinated than the Louisiana network. The Mississippi EMAC organization (EMAC A-Team) played a central role in the network. The overall average measure of degree centrality in this network is 18.81, which again showed organizations in this network did not vary that much in degree centrality. However, the EMAC in the Mississippi organizational network had the highest degree (37) centrality among all organizations in the network. This network had four organizations with a betweenness centrality of greater than 0. These organizations occupy strategic positions in the network. Four cliques were found, with Mississippi's EMAC A-Team being a member of one of these cliques. The authors interpreted the existence of these cliques as indicative of greater coordination within this network, especially with the EMAC A-Team taking a coordinating role (Kapucu et al., 2009).

Based on after-action reports and content analysis of other reports, coordination in the Louisiana network was assessed at a lower level than that of the Mississippi network, and the EMAC played a greater role in coordination in Mississippi as well. These same reports indicated that the EMACs were effective in deploying both resources and personnel after the hurricanes. However, it was also the case that the impact of the hurricanes was much greater and widespread in Louisiana (Fig. 8.3), and Mississippi was assisted by the State of Florida which had extensive experience with mobilizing and training for EMAC operations.

Organizational representatives overwhelmingly wanted the EMAC to continue in its coordinating role, although they emphasized the need for greater outreach and training from EMAC. Both Louisiana and Mississippi had loosely coupled organizational networks, but more critical resources were coordinated in Mississippi, and Mississippi's EMAC played an important role in resource coordination, particularly for deployment of personnel and other resources.

This study shows that the activation of the EMAC and participation of an EMAC A-Team in a state's response network can be very helpful for coordinating resources, including personnel. A comparison between the networks in Louisiana and Mississippi responding to Hurricanes Katrina and Rita revealed that the EMAC helped increase network centrality, especially when the other states assisting in the response had more experience with mobilization of EMACs. Greater outreach and training from EMACs would help increase coordination in state organizational disaster response networks (Kapucu et al., 2009). The results of this study support the fifth assumption of vulnerability theory regarding capabilities and liabilities (Chap. 2, pp. 20 and 21).

Summary

Networks are sets of actors and the relations between those actors. Actors may be people, groups, organizations, or any meaningful unit of analysis. Network analysts assume that the systems (groups, organizations, communities) studied are stable, that observed behavior is explained primarily by social relations, and that an actor's behavior (perceptions, attitudes, actions) is shaped by their position in the network. Defining network boundaries is extremely important because complete networks are considered to be populations, and the absence of even a single central actor can be problematic. That is, the pattern of relations will be significantly different without a central actor than they would be with the inclusion of that actor.

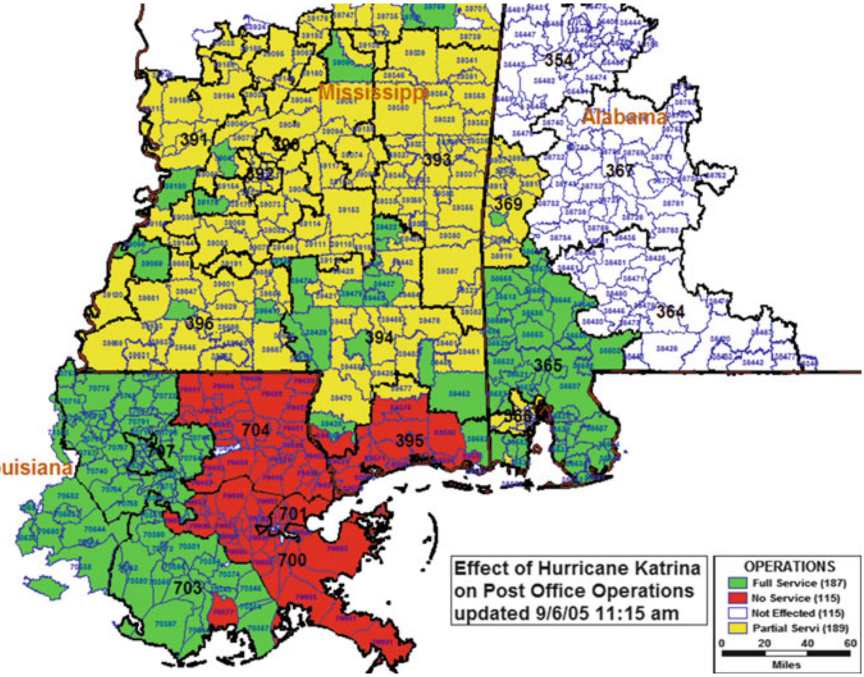

Fig. 8.3 Postal operations one week after Katrina made landfall in Louisiana and Mississippi, displayed as an indicator of the severity of damage from Hurricane Katrina. *Source*: http://saaal-apwu.org/images_po_huricane_katrina/hurricane_katrina.html

Although networks are critical to understanding vulnerability, network methods have only been recently applied in the study of vulnerability. Given that the causes of disaster are rooted in social relations, there is no doubt that network analysis will play an increasing larger role in testing the assumptions of vulnerability theory and expanding our ability to enhance community capabilities and reduce liabilities. As summarized in the following three paragraphs, the results of this work have supported the assumptions of vulnerability theory that deal with community capabilities and liabilities, adaptation to the environment, and the uneven distribution of vulnerability.

The first assumption of vulnerability theory regarding the capacity of a community to adapt to environmental circumstances is supported with Gillespie and Murty's (1994) finding that planning councils help isolated and peripheral organizations overcome barriers to resource sharing and coordinating with the larger network (Chap. 2, p. 17). Additional support for this assumption was given in Gillespie et al.'s (1993) finding that organizations in the network were primarily connected indirectly through one central organization, putting too much emphasis on one resource and therefore limiting the ability of the community to adapt.

Gillespie et al.'s (1993) finding that the network was missing some important types of organization and thus compromising the area's vulnerability supports the second assumption of vulnerability theory regarding its uneven distribution (Chap. 2, p. 18). In other words, certain resources deemed necessary in disaster response or recovery were available in some parts of the area but not others.

The fifth assumption of vulnerability theory regarding the mix of capabilities and liabilities was supported by Gillespie and Murty's (1994) finding that the capacities of isolate and peripheral organizations are essential in a disaster but difficult to mobilize and deploy where and when they are most needed (Chap. 8, pp. 120 and 121). Also supporting this assumption was Zakour's (2008a) finding that organizations with a higher diversity of linked types had access to a greater number and variety of resources and was able to mobilize more effectively to achieve their goals. Further support was added by Gillespie et al.'s (1993) findings that more contacts, higher cohesion, lower hierarchical constraints, and reduced proportionate density were positively associated with organizational disaster preparedness. Finally, more support for this assumption was revealed by Kapucu et al.'s (2009) finding that the presence of an EMAC in a state's response network helps in coordinating resources.

In this chapter we have drawn on network methods to describe empirical support for several of the assumptions underlying vulnerability theory. A radically different perspective on vulnerability theory is revealed in Chap. 9 through studies using system dynamics simulation modeling. Like network methods, system dynamics is relatively new approach in the study of vulnerability. The potential of system dynamics to refine and expand vulnerability theory is huge. As discussed in Chap. 9, simulation studies have special appeal to theorists and applied researchers.

Chapter 9
Vulnerability Explored and Explained Dynamically

In this chapter we describe system dynamics, reveal how it has been used to refine and extend theory, and discuss an application showing how a system dynamics simulation model contributed to the disaster policy and planning process. Simulation models offer representations of community systems and give emergency managers and other decision makers the opportunity to ask "what if" questions about their policies and the conditions that exist in their communities. System dynamics can be used to explore ideas, describe situations, and to test hypotheses and explain situations. Modeling system causes and describing how the system changes over time provide explanations and offer the potential of identifying leverage points or strategic places to intervene in the system (Senge, 2006, p. 64). System dynamics models have the potential to refine vulnerability theory and contribute in direct, practical ways to the mitigation, preparedness, response, and recovery efforts carried out by emergency managers and human service professionals.

We begin this chapter with an overview of system dynamics, covering the basic concepts of stock and flow variables, information connectors, behavior-over-time, feedback structures, and time delays. These concepts together with the principles of systems characterize system dynamics modeling (Forrester, 1968). Next we describe how resource dependence theory was refined and extended by considering it within a system dynamics framework. Finally, we discuss an application of system dynamics to disaster evacuation. We close with a summary of system dynamics, expressing the value that we believe it could add to vulnerability theory as well as the support for vulnerability theory provided by findings from system dynamics research.

Overview of System Dynamics

System dynamic models examine behavior over time. Human behavior is governed by feedback, so these models are based on feedback structures. Feedback structures that evolve over time include delays that are inherent in any system. Delays are the time it takes for information about behavior to circle back and affect subsequent

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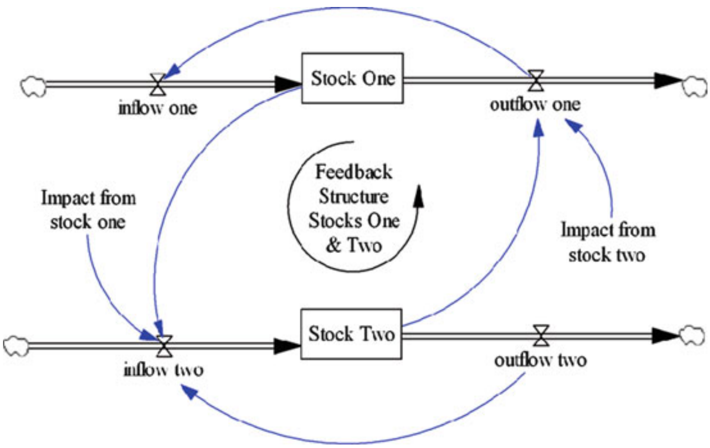

Fig. 9.1 Elements of a system dynamics model illustrated

behavior. Delays are modeled in system dynamics through time-based simulation of stock and flow structures. Stocks are variables that represent things at any point in time. For example, these can be physical things like the number of citizens or disaster workers in the community or the number of families that have reached safety in a flood disaster. Stocks can also be nonphysical things such as concern or danger recognition regarding a hazard. Stocks are barometers of how things are going within a system. Flows are variables that represent actions or activities over time. Stocks are like nouns and flows are like verbs (Richmond, 2004).

Every stock is governed by one or more flows, and the flows are influenced by one or more stocks. This influence is communicated through connectors, which are links that carry information about the level of a stock to a flow. Feedback structures are modeled by linking stocks and flows with connectors. In addition, to facilitate simulation runs, constants or variables called "auxiliaries" or "converters" are included in system dynamic models. These constants or variables enable unit consistency and facilitate the specification of model parameters. Figure 9.1 illustrates the basic elements of a simple system dynamics model, and the following paragraphs discuss briefly each of these concepts.

The model in Fig. 9.1 has two stocks represented by square boxes. Each stock has an inflow and outflow represented by butterfly valves. At the end of each flow there is a cloud symbol. These clouds indicate infinite sources and sinks for the activities of these flows. There are connectors running from the outflows of these stocks to their respective inflows. These two connectors indicate (unrealistically) that whatever goes out of these stocks is immediately replaced. There are also two connectors linking stocks 1 and 2, creating a feedback structure. Stock 1 is connected to the inflow of stock 2 and stock 2 is connected to the outflow of stock 1. There are also two auxiliary variables (impact from stock 1 and impact from stock 2) that specify the magnitude of the effect from stock 1 to the outflow of stock 2, and from stock 2 to the inflow of stock 1.

If there is any impact at all from stock 1 to stock 2, the feedback loop is positive because that impact adds to the amount of the output from stock 2 which as noted above feeds back immediately to its input. If there is no impact (zero) from stock 1 to stock 2, the model remains in equilibrium, and there is no other parameter that can change this trajectory. This is because the impact of stock 2 on stock 1 is simply carried forward to the input of stock 1. In other words, the input to stock 1 is only governed by the output of stock 1. The amount of input to stock 1 is equal to the amount of output from stock 1, so stock 1 remains in equilibrium irrespective of the strength of the impact from stock 2.

Stock and flow diagrams help us understand complex dynamics. They allow researchers to visualize systems in a concrete way. There are a number of software programs for creating stock and flow diagrams and doing system dynamics simulation research. Three widely used programs are Vensim (Ventana Systems—http://www.vensim.com/index.html), ithink or STELLA (isse systems—http://www.iseesystems.com/), and Insight Maker (Insight Maker—http://insightmaker.com/). Insight Maker is free web-based program and there are online tutorials to people get started. Vensim PLE is a free version offered by Ventana Systems and the User Manual is also free.

By plotting behavior over time hazard researchers and policymakers are able to track day-by-day, month-by-month, or year-by-year the levels of key variables. These behavior-over-time (BOT) graphs or reference modes reveal trends that are helpful in the planning process and critical to documenting the success of interventions. Several frequently observed trend patterns include (a) linear increasing or decreasing as reported in previous chapters with much of the research on vulnerability, (b) exponential increasing or decreasing as seen often in the early stage of system change, (c) step increase or decrease as occasionally seen with a radical change in funding (new grant = step increase; loss of grant = step decrease), and (d) cyclical as is typical of most systems. Plotting two or more variables on the same graph reveals relationships and thus facilitates theory construction and testing. Most people, researchers and planners alike, find BOT graphs intuitively appealing, easy to understand, and highly informative.

Feedback is a term from general systems theory, referring to information about a particular behavior returning to affect that behavior at a later point in time. Feedback loops are the most fundamental structural feature of systems (Richardson, 1991). Every decision occurs within a feedback loop. These feedback structures can be graphically summarized as causal loop diagrams (CLDs). CLDs highlight the feedback structure governing the behavior of a system. The visual representation provided through these diagrams helps communicate key aspects of complex systems. CLDs can be helpful at both the beginning and end of a project. They offer a potentially fruitful way to begin thinking about the relationships governing a system, and from these initial sketches researchers can more quickly specify the feedback structure with a stock and flow diagram. CLDs are also a good way to communicate the feedback structures documented through simulations with stock and flow models. Most policy planners and decision makers are not familiar with the stock and flow language of system dynamics, but CLDs are analogous to path models.

There are two types of feedback loops: reinforcing and balancing. Reinforcing feedback loops or positive loops are what drive system growth or decline. The presence of reinforcing loops is commonly referred to as virtuous or vicious cycles, bandwagon effects, or snowball effects. Balancing feedback loops or negative loops involve a system goal. The process represented in balancing loops is closing the gap between the system goal and the current condition. If the current condition rises above the goal, the system responds with a decrease to pull the condition back in line with the goal. If the current condition falls below the goal, the system responds with an increase to push the condition back up in line with the goal. Because of delays in the feedback structure, systems very often rise above and fall below their goals, which results in an oscillating pattern over time.

In community systems the behavior of every variable is driven by some combination of reinforcing and balancing feedback loops. Webs of reinforcing and balancing feedback loops can create counterintuitive behaviors challenging hazard policymakers and emergency service personnel. Models of the structure underlying performance patterns provide policymakers with the ability to discover interrelationships, rather than getting distracted by particular links and linear cause and effect chains (Gillespie, Robards, & Cho, 2004). These models also provide opportunities for vulnerability researchers, policy makers, and emergency managers to focus on recurring patterns, to work on the system, and to be designers of systems rather than merely operators.

As noted above, time delays are a key feature of dynamic systems. Delays may result from lags in the time it takes for one variable to affect another. These lags can be very short such as peoples' reaction to the vibration or shaking of an earthquake or they can be very long such as people changing their behavior in response to a national policy. Delays also occur as a result of variables being embedded in a web of relations, so that the feedback effect transpires through a chain of variables. Reducing delays is an important leverage point for improving performance (Meadows, 2008). It is worth noting that it can take a very long time for hazardous conditions to emerge in the environment. Global warming is an example (Intergovernmental Panel on Climate Change, 2012).

The simulation models of system dynamics are based on initialized stock and flow diagrams. This means that the parameter of each variable in the model is specified for the beginning point of the simulation and equations are written to represent relationships in the model. The model can be set to run in minutes, hours, days, weeks, or any time interval appropriate to the problem under study. The time horizon or period of time to be covered by the model can be set for 60 min, 40 h, 52 weeks, or any time frame needed to fully represent the system behavior. System models are tools for reducing complexity. These models can provide insight into the dynamics that drive conditions such as the vulnerability of a community, and they help identify potential leverage points for intervention. Adding simulation models to the hazards research tool kit has the potential to provide a quantum step forward in understanding and facilitating the vulnerability and resilience of communities (Gillespie et al., 2004).

Adding Dynamics to Refine Resource Dependence Theory

The use of system dynamics to refine existing theories is exemplified by an application of assumptions from system dynamics to resource dependence theory (Pfeffer & Salancik, 2003), creating what Cho and Gillespie (2006) call dynamic resource theory. Resource dependence theory was developed to understand exchanges between organizations. Resources are a driving force in the relationships among organizations, and resource dependence is theorized to shape the nature of relationships among organizations, with both positive and negative effects.

It turns out that the system dynamics focus on feedback loops complements certain weaknesses of resource dependence theory. Dynamic resource theory was created by integrating assumptions of systems dynamics with assumptions of resource dependence theory. Resource dependence theory does not deal with the dynamics of feedback loops. However, these loops are essential for understanding the continuously evolving relationships between organizations. Without reference to the feedback structure, it is impossible to fully capture how the relationship works over time, and thus to solve problems emerging from the relationship. Traditional resource dependence theory postulates statically that if one kind of organization has less power than another, the less powerful organization will experience a decline in the quality of their services. Dynamic resource theory postulates that the level of service quality at any point in time depends on the relative dominance of one or more feedback loops (Cho & Gillespie, 2006).

Resource dependence theory also ignores the goals that actors pursue in the exchange process. Without consideration of goals the relationship tends to be highly abstract or vague. Dynamic resource theory includes the goals sought by each party in the exchange process. These goals are incorporated into system dynamics models as part of the balancing feedback structure through which systems goals are specified.

Two additional features of dynamic resource theory are its accommodation of alliances and understanding of the decision-making environment. Resource dependence theory does not consider alliances among organizations. These alliances can modify the effects of organizations and their provision of resources to other organizations. Dynamic resource theory accommodates sets of actors in explaining the exchange process. Finally, resource dependence theory has not considered the effect of institutional environments on decision-making. Dynamic resource theory can take into account the effects of environmental constraints such as institutional variations or political environments (Cho & Gillespie, 2006).

Vulnerability theory suffers from the same static bias as traditional resource dependence theory. We believe that integrating dynamic assumptions with vulnerability theory will enhance generalizability of the theory. In addition, a focus on feedback loops will strengthen the explanatory power of vulnerability theory. Vulnerability theory has not explicitly incorporated the dynamics of feedback loops. However, as with the exchange of resources, these loops are essential for understanding the continuously evolving relationships between environmental capabilities and liabilities. Lacking an understanding of the feedback structure makes it impossible to know how the variables comprising the capabilities and liabilities got to their current levels, and impossible to know what direction they are heading. Dynamic vulnerability theory can be created in the same way that dynamic resource theory was created, by integrating assumptions of systems dynamics with the assumptions of vulnerability theory. We turn next to a discussion of a study that used system dynamics to facilitate evacuation planning.

System Dynamics Model of Flood Evacuation

One of the few uses of system dynamics modeling in community disaster vulnerability research is a study of the 1997 Red River Basin flood in Manitoba, Canada (Fig. 9.2). Simonovic and Ahmad (2005) used system dynamics to model the household evacuation process during this flood. Knowledge from the evacuation literature was used to conceptualize the model. Data were collected through interviews of households located in the Red River Basin and affected by the flood. The study sample included over 200 evacuees from 52 families. Additional interview and secondary data were obtained from the Manitoba Emergency Management Organization (MEMO) and Manitoba Conservation, both agencies of the Manitoba Government. Fieldwork was carried out to verify the data collected from interviews and MEMO's records of the flood operations. The operations data from MEMO and Manitoba Conservation referred to different points in time during the flood evacuation.

The International Joint Commission organized public hearings at five locations immediately after the flood in autumn 1997, and again before submission of the final report in spring 2000. The purpose of the International Joint Commission, made up of water and stream experts from the USA and Canada, is to resolve problems arising in lakes and rivers shared by the two nations. The total number of participants in these hearings exceeded 2,000 people. Fieldwork in these hearings allowed for verification of the data collected through the survey (Simonovic & Ahmad, 2005).

Concern is defined as the first phase of the process, when a family becomes aware of the risk and has some information about the disaster and its possible impact. In the evacuation model concern further develops into danger recognition, whose values are determined by flood warnings and social factors. Danger recognition is the second phase of the evacuation decision-making process. In this second stage of decision-making, a family becomes aware of the imminent threat and is on alert, closely watching external factors. External factors include information provided by the media, information from authorities, and the inundation levels and rainfall experienced by inhabitants (Simonovic & Ahmad, 2005).

Variables that form one feedback loop governing the decision-making process are concern, danger recognition, acceptance, and evacuation. Psychological factors govern all phases of the evacuation decision-making process. Social factors consist

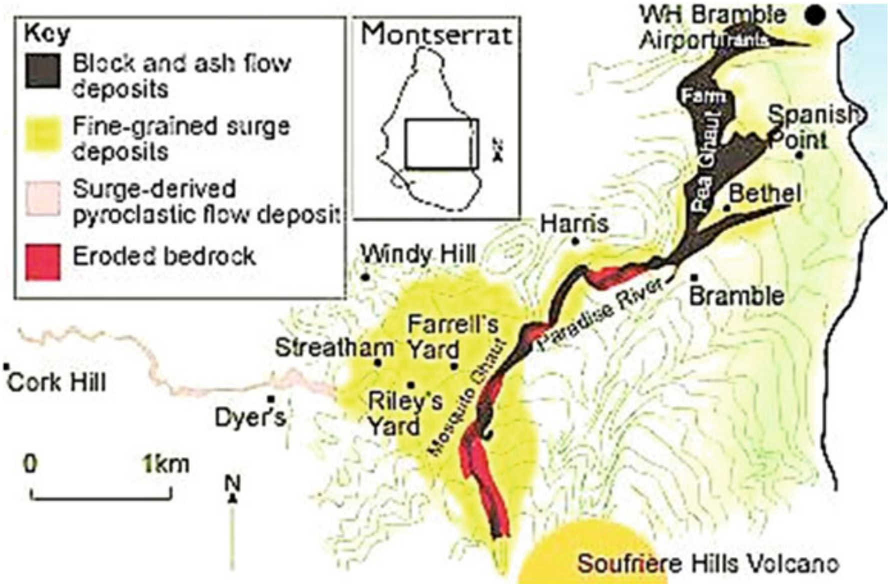

Fig. 9.2 Red River Valley Flood of 1997 in Manitoba, Canada

of variables such as age, years at present address, and number of children in the household. Along with flood warnings, social factors and rain/inundation conditions positively affect the danger recognition variable. Once the danger recognition rate reaches a certain threshold, evacuation orders, knowledge of upstream flooding, and the behaviors of others (a social factor) lead to threat acceptance. The evacuation decision results from the interaction between acceptance and the order to evacuate, evacuation claims experience, and community coherence, which is the level of social support within a community (Simonovic & Ahmad, 2005).

After a family evacuates it is counted as one of those in the process of evacuation. The timeliness of the family's evacuation (measured as the number of hours to reach a safe refuge) will be positively affected by their knowledge of refuge places. For those households without such knowledge, delays in their evacuation are likely. However households eventually gain knowledge of refuge places from other evacuees (Simonovic & Ahmad, 2005).

Simonovic and Ahmad's model of flood evacuation is represented in Fig. 9.3 with a causal loop diagram. The time horizon was set from the beginning of flooding in the Red River Basin until the time when all households had evacuated to a safe refuge. The model consists of three stocks: population under threat, population in the process of evacuation, and population that reached safety. The population under threat stock was the 52 households in the flood area.

In this diagram there are three balancing loops. The loop on the upper left side of the flood evacuation model shows the movement of families from being under threat to evacuating. The negative feedback loop on the lower left side links the psycho-

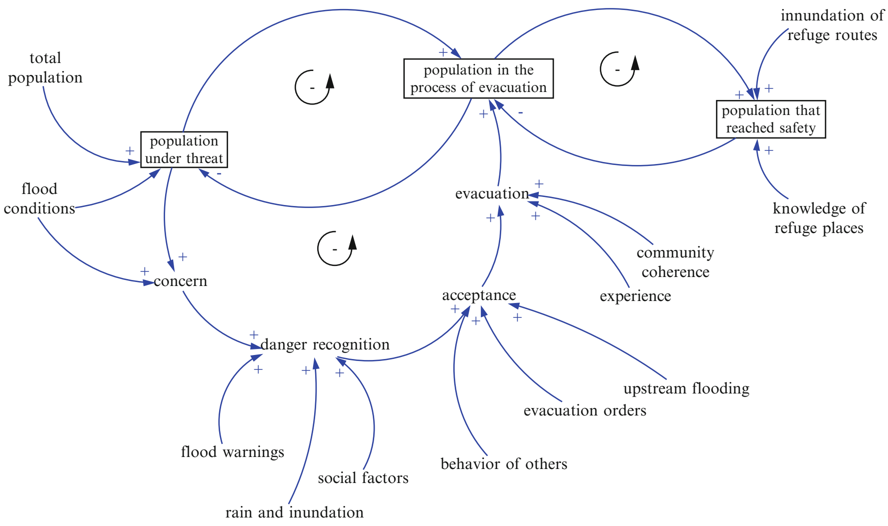

Fig. 9.3 Causal loop diagram of evacuation

logical variables that govern the movement of families from being under threat to being in the process of evacuating. These two stock variables are inversely related to each other; the more households in the process of evacuation, the fewer households which remain under threat.

The loop on the upper right side of the model diagram is a negative feedback loop. This loop shows the movement of people from being in the process of evacuating to having reached safety. This loop is associated with the goal of efficient and effective evacuation. Efficient evacuation refers to the time it takes households to arrive at a safe refuge after they actually begin evacuation. Effectiveness of the evacuation is the percentage of households reaching a safe refuge in a timely fashion, so as to avoid injury, drowning, or being stranded in unsafe conditions.

Delays were written into the model equations and are not represented in the diagram (Simonovic & Ahmad, 2005, p. 37). For example, the families who reached a place of safety are based on knowledge of the refuge location and inundation of refuge routes. Inundated routes create delays and can even prevent people from reaching safety. Information and material delays were also involved in making the decision to evacuate and in reaching a refuge place. An example of information delay is the difference between the point in time when a flood warning is issued, and the time a household takes to make the decision to evacuate. An example of a material delay is the time spent by people in the process of evacuation before arriving at their place of safe refuge.

Nonlinear relationships were programmed with graphic functions (Simonovic & Ahmad, 2005, p. 12). Most of these relationships had initial exponential increases that leveled off over time, resembling S-shaped curves. Some variables were given regression-like weights based on the data collected from MEMO and Manitoba

Conservation. For example, to produce the evacuation decision value, acceptance is weighted by 0.7, experience is weighted by 0.2, and support is weighted by 0.1. In this study, experience is previous experience with evacuation and disaster claims. Support refers to community coherence (social factors), which is the degree to which community members help each other. After being weighted, these three variables are then summed to produce the evacuation decision value. A decision by the household to evacuate is made if the value for the evacuation decision variable is greater than 0.65 (Simonovic & Ahmad, 2005). All variables in the equations are standardized (restricted to values between 0 and 1).

The purpose of the evacuation model was to assess the impact of various disaster policies. There were two groups of policy variables. The first group consisted of variables describing activities preceding the flood situation: the warning method and mode of disseminating the order to evacuate. The flood warning methods included mail, radio, television, the Internet, and a visit to the home. Two variables described the possible modes of disseminating the order to evacuate: visit to the home and order through mail. These variables were measured as dichotomous variables, to indicate whether or not a given method was used. Variables were additionally measured as continuous variables with values ranging from 0 to 1 to indicate the importance of each method used. The values for continuous measurements ranged from 0 (not important) to 1 (highly important).

A second group of policy variables was selected to describe local triggers of human behavior in the case of a flood disaster: warning consistency, timing of orders, coherence of the community, and upstream community flooding. Warning consistency described the variation over time in flood warning information. Timing of orders was the time when evacuation orders were disseminated. The coherence of community was the connections existing between individuals in the community. Upstream community flooding was the availability of information about upstream conditions. All of this information came from the MEMO and the Water Resource branch of Manitoba Conservation.

Sensitivity analysis was used to test outcomes in response to the two policy variable groups. Two outcome variables—evacuation efficiency and evacuation effectiveness—were used for these sensitivity tests. Evacuation efficiency was the number of hours it took for all households to reach a safe refuge. Evacuation effectiveness was the total number of families able to reach safe refuge. Outcome variables that are highly sensitive to policy decisions can improve by 100–400%.

The results of these sensitivity analyses are that timing of orders is the most important variable affecting outcomes during the 1997 Red River Basin flood. The second most important variable is warning consistency, and third is coherence of community. More coherent communities, with many ties among people and households, are much more efficient in dealing with the flood and evacuation. Awareness of upstream community flooding seems to be a motivating force for making a decision to evacuate. Finally, using different kinds of warnings will make the evacuation process more efficient (Simonovic & Ahmad, 2005). These findings support the tenth assumption of vulnerability theory concerning the importance of shared meaning to the progression of disaster vulnerability (Chap. 2, pp. 24 and 25).

Table 9.1 Comparison of three scenarios for flood evacuation efficiency

Variables	Residents'	MEMO	Best
Order dissemination	Visit	Visit	Visit and mail[a]
Community coherence[b]	0.6	0.6	0.6
Warning dissemination			
Mail effects	0.7	0.7	0.7
TV effects	0.9	0.9	0.9
Radio effects	0.5	0.5	0.5
Visit effect	–	–	0.9[a]
Internet effect	–	–	0.9[a]
Upstream flooding[b]	0.5	0.5	0.9[a]
Warning consistency[b]	0.5	0.9[a]	0.9
Timing of order[b]	0.4	0.9[a]	0.9
Acceptance level	0.6	0.6	0.8[a]
Hour evacuation begins	28	24[a]	5[a]
Evacuation time (h)	84	70[a]	47[a]

Note:

[a]Difference between residents' and MEMO scenarios, as well as between MEMO and Best scenarios

[b]Results from sensitivity analyses of most important variables affecting evacuation time

The Simonovic and Ahmad model simulates the effects from different flood evacuation policies. An advantage of systems dynamics for modeling human behavior before, during, and after disasters is that we gain an understanding of how a particular feedback structure generates the observed behavior. This understanding leads to insights regarding potential solutions for problems. Table 9.1 shows the results of three simulation runs testing for evacuation efficiency.

In the worst-performing scenario, named the Residents' scenario, the perspectives of the residents of the flood area were surveyed to assign weights indicating the moderate importance of warning consistency (0.5) and timing of the order variables (0.4). All other weights, and the selection of policy variables, were determined by the operations of the MEMO during the Red River Basin flood. Flooding of upstream community and coherence of the community were also deemed of moderate importance, as indicated by their weights (see Table 9.1). Also, warning was through mail, radio, and television; and evacuation orders were disseminated through a visit to the household. The weights for these means of dissemination were determined by consultation with residents.

The MEMO scenario, with outcomes in between those of the other two scenarios, understandably relied more heavily than the Residents' scenario on the perspective of the MEMO. Like the Residents' scenario, the selection of policy variables was based on the operations of the MEMO during the 1997 flood. The MEMO scenario was different from the Residents' scenario in that warning consistency and timing of orders are more heavily weighted (0.9) and considered more important influences on the evacuation process. Otherwise, the same media for disseminating warnings and evacuation orders were used in the MEMO scenario as in the Residents' scenario. The same weights used in the Residents' scenario for the mail, television, and radio effects were used in the MEMO scenario.

In the best-performing scenario warning took place through the same means as for the other scenarios, except that the Internet and a visit to the home were added. The order to evacuate was through a visit to the home and also through the mail. The weights for mail, television, and radio effects were the same as for the Residents' and MEMO scenarios. Flooding of upstream community, warning consistency, and timing of orders each had a much larger weight (0.9) reflecting the higher importance of these variables for evacuation in the Best scenario.

These three scenarios had large differences in outcomes. The acceptance level for the Residents' and MEMO scenarios is 0.6, while a level of 0.8 was reached for the Best scenario. Acceptance has a direct effect on the evacuation decision as shown in the causal loop diagram (Fig. 9.3). It took all families 84 h to reach a safe refuge in the Residents' scenario, while in the Best scenario all families were at their safe refuge in 47 h. The MEMO scenario produced an evacuation time of 70 h, and intermediate value among the scenarios. Differences in time to safe refuge were accounted for partly by delays in evacuation, particularly for the Residents' scenario. The families in the Residents' scenario began their evacuation on average in the 28th hour, while those in the Best scenario began evacuating in the 5th hour of the simulation, a difference of nearly an entire day.

Simonovic and Ahmad offer three recommendations for future use of their model. First, the model should be tested with emergency management experts to evaluate the value of the database used. Second, the feedback loops should be closed for exogenous variables. Currently, flooding of upstream community, coherence of community and other social factors, flood warnings, evacuation orders, inundation of refuge routes, and knowledge of refuge places are exogenous. Ideally, system dynamic models are completely endogenous (Forrester, 1968). Third, the model should be tested on different disasters to demonstrate the process of transforming the model for use in different regions and different types of disasters.

The Simonovic and Ahmad (2005) study shows how system dynamic models can advance theory and help inform emergency managers and other planners. System dynamics models facilitate concrete specification of theory and produce information that can contribute to higher quality decisions and higher levels of disaster preparedness. For example, the ability of the evacuation model to address policy alternatives makes it a powerful planning and analytic tool. Potentially, it can help reduce community vulnerability, preventing loss of life and minimizing material losses.

Other applications of system dynamics reinforce the potential we have seen in the Simonovic and Ahmad study. Deegan's (2006) model of flood damage shows how property vulnerable to damage is caused by capacity of the local environment to withstand floods, development pressure, property tax needs, perceived risk of development, willingness to mitigate, policy entrepreneurs, and other people pressures. The amount of damage suffered is primarily due to the balance of capabilities and liabilities determined by people pressures. Cooke and Rohleder (2006) build a system dynamics model of safety and incident learning to promote safety in environments prone to technological disasters or so-called "normal accidents." Rudolph and Repenning's (2002) model reveals how an over-accumulation of interruptions can shift an organization from being a resilient, self-regulating system to a fragile, self-escalating system that amplifies the interruptions. The temporal patterns of these results suggest the potential for an early warning system.

Summary

System dynamics assumes that variables are linked in circular processes that form feedback loops. This shift from one-way causality to circular causality and from independent variables to interrelated variables is profound. Instead of viewing mitigation and preparedness as outcomes, they are viewed as ongoing, interdependent, self-sustaining or self-depleting dynamic processes. For systems dynamics the emphasis shifts from local spatial and temporal perspectives of an independent variable affecting a dependent variable, to a web of ongoing interrelated dependencies. System dynamics modeling focuses less on particular variables and more on various patterns of relationships among variables (Gillespie et al., 2004).

Reducing disaster vulnerability and optimizing community safety requires understanding the natural and social systems involved in disasters, communicating clearly with decision-makers about those systems, and identifying effective interventions. The natural hazards and disaster fields are weak in these areas, while system dynamics offers the potential to accomplish all three of these requirements. By drawing the model researchers identify crucial feedback loops that either balance behavior or reinforce a push toward growth or decline. By tracking model parameters over time researchers and policymakers can experiment safely with making changes in complex systems without having to suffer real-life consequences. For example, studying different ways of delivering evacuation orders can be done without actually risking the lives or safety of evacuees in a flood (Simonovic & Ahmad, 2005).

We believe using system dynamics modeling to design safe communities provides the next step forward in understanding the complex situations faced by hazard and disaster researchers. As the field moves beyond static and linear analyses, our ability to understand complex situations will deepen. Using stock and flow models will help promote new insights into the patterns of interconnections that make complex problems so resistant to change. These insights are particularly useful for refining and extending vulnerability theory because of the variety of social, economic, and political processes affecting the disaster vulnerability of communities. Through the use of systems dynamics modeling hazard theorists and researchers will gain understanding and become more effective in confronting the complex problems we face in promoting safe systems (Gillespie et al., 2004).

Simonovic and Ahmad's (2005) findings that evacuation efficiency is improved by the timing of orders to evacuate, the consistency of warnings, and community coherence adds support to the tenth assumption of vulnerability theory regarding the importance of culture, ideology, and shared meaning in reducing vulnerability

(Chap. 2, pp. 24 and 25). Shared meaning is particularly important during evacuation and other response activities because often during that period of time there is confusion, misinformation, and conflicting reports. Cooke and Rohleder's (2006) incident learning model is valuable tool to help reduce confusion, minimize the amount of misinformation, and generate community consensus.

Simonovic and Ahmad's (2005) finding that various policy configurations resulted in different degrees of efficiency in the evacuation process supports the eleventh assumption of vulnerability theory concerning the complex ways that community capabilities, liabilities, and disaster susceptibility are related (Chap. 2, p. 25). While the results from the flood evacuation model were supportive and useful, the full potential of this model is yet to be realized. As Simonovic and Ahmad (pp. 49–50) note, the omitted feedback structure governing the exogenous variables needs to be developed. For example, it is likely that there is a causal link between flood warnings and evacuation orders, and certainly there is a link between flood conditions and flood warnings. Moreover, the specific variables subsumed within the "social factors" construct need to be explicitly incorporated in the model along with the feedback loops that govern their behavior. Vulnerability theorists can refine the evacuation model and use it to further specify and test the assumptions of vulnerability theory.

In this chapter we have drawn on system dynamics to describe support for two of the assumptions underlying vulnerability theory, and to encourage the use of system dynamics in testing, refining, and extending vulnerability theory. In Chap. 10 we summarize the empirical support for vulnerability theory and comment on the strengths and weaknesses of the various perspectives used in developing the theory. We present a master table of the variables used so far in exploring, describing, and testing vulnerability theory. In addition, we offer a high-level map or diagram of vulnerability theory and encourage social work researchers to focus on select segments of the theory. We stress the overlap of social work values and interests with themes in vulnerability theory. We end the chapter and the book with a set of specific recommendations on future research of vulnerability theory.

Chapter 10
Enhancing the Future of Vulnerability Theory

In this chapter, we map the future of vulnerability theory in social work. First, we summarize the disaster vulnerability concept with reference to the perspectives of both development and resilience. A comparison of the work done on development and resilience shows these perspectives to be complementary. Second, we build on this complementarity by integrating resilience into vulnerability theory, resulting in vulnerability^{+} theory. The empirical support for vulnerability^{+} theory is reviewed and also illustrated through a series of graphs. Finally, the future of vulnerability^{+} theory for disaster social work is considered, with a focus on root causes, resources, liabilities (risk factors) and capabilities (protective factors), and community development.

The Disaster Vulnerability Concept

Social work researchers seek to document the extent of disruption caused by disaster events and to understand exactly how community functioning is disrupted. From this understanding, social work researchers can identify or create ways of reducing the amount and extent of disruption, as well as the other negative consequences of disasters. The concept of vulnerability has been discussed as a bridging idea that links research findings about disaster across disciplines and hazards (McEntire, 2004a, 2004b). Vulnerability encompasses each stage of disaster, every kind of hazard, and it has theoretical and practical significance in a wide range of disciplines and professions (Gillespie, 2008a).

The research on vulnerability has drawn on traditional methods of disaster mitigation, preparedness, response, and recovery, but also other areas, such as environmental sustainability, terrorism, and social development. Coordinating these streams of research across types of hazards and stages of disaster holds significant promise for generating and testing hypotheses about ways of reducing disaster losses. The general framework guiding research on vulnerability facilitates both describing and

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explaining disasters and also reveals mechanisms of control. A focus on vulnerability helps identify ways to reduce the negative consequences of disaster.

McEntire (2004a, 2004b) conceptualizes disaster vulnerability as being comprised of susceptibility, risk, resilience, and resistance. Susceptibility is the likelihood of people and communities suffering harm from disaster. Norris, Stevens, Pfefferbaum, Wyche, and Pfefferbaum (2008) consider susceptibility as interchangeable with risk, but McEntire argues that risk applies only to the physical structures and assets of a community. Resilience is the ability of a system to resume functioning following disaster. Resistance is the ability of physical structures such as buildings, bridges, and roads to withstand a disaster hazard without significant damage.

The Development Perspective

Because natural hazards cannot be entirely prevented, decreasing the vulnerability of individuals and communities is the most direct means of minimizing losses and achieving effective and timely recovery after disasters (Gillespie, 2008b). Vulnerability is defined as the ratio of disaster risk to susceptibility (Oliver-Smith & Button, 2005). Vulnerability to disaster is caused by both the physical and social environments. The physical environment is the natural, built, and technological environments. The social environment is the values, norms, beliefs, and other cultural characteristics governing a system (Zakour, 2008b). Variables in the physical and social environments are classified as liabilities or capabilities (Gillespie, 2008b; Wisner, Blaikie, Cannon, & Davis, 2004). Liabilities cause increases in susceptibility to disaster while capabilities cause decreases in susceptibility.

Some liabilities are ubiquitous yet nearly invisible. These liabilities are root causes of vulnerability. They include among other things limited access to political power, low levels of social and natural environmental resources, lack of access or restricted access to resources, and ideologies which justify social, political, and economic inequality. Other more immediate and visible liabilities combine with root causes to constitute unsafe conditions. These liabilities include unprotected and aging physical infrastructures, lack of social institutions to provide resources for people, or poorly functioning institutions, low income, and endemic disease. These liabilities interact together leading to susceptibility to disasters, and ultimately resulting in loss, trauma, and stress reactions (Bolin, 2007; Wisner et al., 2004).

The Resiliency Perspective

Resilience is the ability of an individual or community to return to a normal or improved state of functioning or to recover more quickly than expected. Resilience is a post-disaster process reflecting community conditions and resource mobilization. Community resources vary in their quality including their robustness, redundancy, and the time needed to mobilize. The resources available to a community represent networked adaptive capacities, which include social capital, community competence, information and communication, and economic development. To the extent that resources are robust, redundant, or rapidly deployed, resilience is more likely. The combination of the particular characteristics of a disaster, community resources, and mobilization result in some amount of transient community dysfunction. Communities evolve on trajectories of resilience or dysfunction (Kaniasty & Norris, 2009; Norris et al., 2008).

Comparing Vulnerability and Resiliency

Models of vulnerability and resiliency differ in emphasis but work together in a complementary fashion. First, vulnerability and resiliency represent different kinds of concepts. Second, vulnerability and resiliency deal with different phases of the disaster cycle. Third, the research on vulnerability and resiliency use different terms to describe the same phenomena. Fourth, vulnerability and resiliency theorists have focused on different levels of analysis. Fifth, vulnerability and resiliency researchers have worked with separate but conceptually similar models. Sixth, vulnerability and resiliency researchers focus on different dimensions of disaster-relevant resources. Interestingly, these differences are complementary, representing different facets of community life.

Vulnerability and resiliency are fundamentally different kinds of concepts. Vulnerability is conceptualized as a state variable. State variables represent conditions that accumulate over time and always have some value. Every system at any point in time is vulnerable to some degree. State variables describe dimensions of a system. It is impossible for any system to be completely non-vulnerable. Vulnerability is a negative idea. Systems seek to reduce their levels of vulnerability or to maintain low levels of vulnerability. In contrast, resiliency is conceptualized as a process variable. Process variables represent actions or steps taken in sequence. The resilience of a system can be known only by observing the process. It is possible for a system to completely lack resiliency. Resiliency is a positive idea. Systems seek to increase their resiliency, which means the probability of recovering quickly and effectively from disaster.

Vulnerability and resiliency represent different points of time in the stages of disaster. Vulnerability is descriptive of conditions before disasters happen. These conditions are continually changing. Safe conditions can deteriorate and unsafe conditions can be removed or mitigated. Mitigation projects as well as preparedness education and training are designed to reduce levels of vulnerability. Resiliency refers to the response and recovery processes after disasters happen. Resiliency applies most directly to the recovery process because it entails a return to pre-disaster conditions or something better. Implementation of the recovery process can be resilient to varying degrees.

The work on both vulnerability and resiliency emphasize environmental characteristics as determinants of susceptibility and resilience, but they use different words to describe the same characteristics. Vulnerability theorists draw on environmental "liabilities" and "capabilities" to describe and explain susceptibility and resilience, while resiliency theorists specify "risk factors" (liabilities) and "protective factors" (capabilities). We have a preference for using liabilities and capabilities as these terms more easily accommodate the wide spectrum of disciplines that study hazards and disasters.

Vulnerability theorists put more emphasis on the societal level analyses and on economic variables, while resiliency theorists emphasize individual and population outcomes such as wellness. Resiliency researchers discuss several components of individual wellness: (a) a lack of psychopathology and disease; (b) adequate role functioning at home, school, or work; (c) a lack of generalized distress; and (d) high quality of life (North, Hong, Suris, & Spintznagel, 2008). Many individuals may suffer from disruption of health behaviors, role functioning, generalized distress and a low quality of life, and yet not display psychopathology (Norris et al., 2008). Models of resiliency, with a focus on wellness outcomes, directly complement vulnerability theory. Although vulnerability theorists primarily emphasize the macro-level and household economies, they have explicitly recognized the importance of the individual wellness concept. "It is important to complement the economistic and quantitative aspects of our Access model with an understanding of the ways in which the disaster event was experienced by different people, and how it altered their sense of well-being and their strategies to reconstitute that well-being in a new, post-disaster world" (Wisner et al., 2004, p. 110).

The effects of liabilities or capabilities also vary by level of analysis. For example, place attachment may hinder resilience at the individual level but promote resilience and recovery at the community level (Norris et al., 2008). Individuals deeply rooted in a particular place can experience very adverse consequences from long-term relocation after a disaster. On the other hand, recovery is facilitated in communities of people with a high level of attachment to place. This effect of place attachment at the community level will benefit all individuals, regardless of their individual level of place attachment.

While the resiliency concept has been applied most often in research on life-span development of individuals and families, it is closely related to and complements vulnerability theory. Community psychologists have come closest to integrating vulnerability and resiliency theories using a "stress and coping" model (Norris, Galea, Friedman, & Watson, 2006; Norris et al., 2008). Community coping is conceptualized as adaptation to an environment changed by disaster (Norris et al., 2008). In vulnerability theory, environmental adaptation is central to reducing vulnerability, and this is conceptualized using a "pressure and release" model (Wisner et al., 2004). The progression to safety, which is the release part of the pressure and release model, is very similar to resiliency. The central idea underlying these models is essentially the same.

Compared to vulnerability theorists, resiliency theorists necessarily specify dimensions of the processes and resources used during recovery from disaster. When resources are robust, redundant, and rapidly accessible, they are conceptualized as adaptive capacities; community resilience is the linkage of quality resources to adaptive outcomes. Community resilience is based on networked adaptive capacities, so that unlike individual resilience, adaptive capacities in a community are not only robust, redundant, and rapidly accessible but also connected to each other. Resilience is a transformational process where communities learn to cope with disaster and apply lessons learned to future disasters. In contrast, the resource capabilities specified by vulnerability theorists are more macro and structural in character with an emphasis on how changes in these structures over time impact vulnerability.

Vulnerability theory subsumes the concepts, assumptions, and findings from resiliency theory (Norris et al., 2008). Vulnerability and resiliency theories complement each other. Vulnerability theory concentrates on pre-disaster conditions. Resiliency theory is focused on access and use of post-disaster resources. Both theories provide a framework for understanding human behavior in the social environment, and together they provide more comprehensive coverage. Given this complementary relationship we believe that the greatest potential of these theories will be achieved by integrating the resilience process into vulnerability theory. Next we discuss the merits of this integration, ultimately designating it as "vulnerability^{+} theory."

Integrating Resilience into Vulnerability Theory

Resilience is defined as adaptation and coping despite collective adversity in a system (individual, family, organization, community, country). This definition is consistent with the definition used by vulnerability theorists (Zakour, 2008b, 2010). In vulnerability theory, natural and technological hazards represent potential sources of adversity facing people, and the ability to make resilient use of resources emerges as an environmental capability helpful to any system hit by disaster. Both disaster vulnerability and social work resiliency theorists recognize that every community in the world is vulnerable in varying degrees to disaster, and every community has the potential in varying degrees to respond and recover resiliently (Queiro-Tajalli & Campbell, 2002).

As noted above, disaster resilience can be observed only after a disaster occurs (Norris & Elrod, 2006), but the likelihood of resilient recovery is increased by decreasing vulnerability. Like vulnerability, the prospect of resilient recovery is not evenly distributed among systems. Many social systems are highly stratified, especially in terms of socioeconomic status, social capital, and social resources. The resources facilitating resilient recoveries from disaster are stratified in most regions around the world (Oliver-Smith, 2004). People in less-developed countries, as well as ethnic and racial minorities in developed countries tend to suffer slow and ineffective recoveries from disaster (Bankoff, Frerks, & Hilhorst, 2004). Disparities in environmental capabilities indicate distributive injustice. The ideal is to seek an optimal distribution of resources among all people (Norris et al., 2008). The negative consequences of disaster will be reduced through equal access to an optimal distribution of resources.

The disaster recovery process is transactional so that individual systems and their environments affect each other during and after adversity (Greene, 2002).

Resilience is helpful at life transitions or turning points, and disaster is often considered a turning point. The resilience concept applies to all systems recovering from disaster (Zakour, 2010). As pointed out above, both vulnerability and resiliency theorists seek to understand how liabilities (risk factors) and capabilities (protective factors) affect coping and well-being (Niederhoffer & Pennebaker, 2009). The liabilities magnify the negative effects of stress. The capabilities buffer people from the effects of stress and up to a point can even increase well-being under conditions of stress.

Environmental capabilities are hypothesized in both theories as positively associated with the probability of resilient recoveries from disaster. Some examples of capabilities from resiliency research include: (a) the availability of external social supports and resources including trusting relationships; (b) access to health, education, welfare, and security services; and (c) affiliation with religious organizations (Greene & Conrad, 2002). Additional capabilities are (d) access to warm relationships and guidance from family members and relatives, (e) connections with one or more types of pro-social organizations, and (f) access to high-quality education (Doll & Lyon, 1998).

Liabilities in both theories are environmental characteristics that magnify the effects of stress, adversity, or loss. In other words, liabilities increase the probability of disaster, amplify the harmful effects of disaster, and dampen the response and recovery processes. Liabilities also at times have effects on the amount of property damage and the number of people killed and injured (Norris & Elrod, 2006). Similar to vulnerability theory, the liabilities in resiliency theory are assumed to originate in the social and physical environments rather than in individuals (Zakour, 2010). Unsafe environments are the result of values, beliefs, customs, and policies governing community life.

For both resiliency and vulnerability theories, two important and related environmental liabilities are poverty and social isolation (Zakour, 2010). Social isolation from neighbors, kin, and formal organizations means that individuals and households are unable to mobilize social capital to recover after a disaster. Isolated individuals have difficulty obtaining information to help them make evacuation decisions or to obtain relief services from formal organizations. These individuals lack adequate social support and network ties, either to core networks of kin and neighbors or to geographically dispersed networks of aid organizations (Klinenberg, 2002). Households consisting only of older individuals are more likely to be socially isolated (Sanders, Bowie, & Bowie, 2003).

Poor neighborhoods have relatively few voluntary organizations and volunteers to provide social services (Putnam, 2000). These neighborhoods have a lower tax base and lower levels of financial and other donations to support voluntary organizations. People living in poverty often volunteer at lower rates or not at all due to transportation and other costs of volunteering (Zakour & Gillespie, 1998). These conditions lead to fewer human services organizations and fewer mitigation projects such as building stronger and higher levees (Zakour & Harrell, 2003).

Our discussion makes it clear that while the concepts of vulnerability and resiliency are very different from one another they neatly complement each other.

Vulnerability accumulates over time and sets up the conditions for disaster, while resilience emerges after disaster to determine how well and quickly the recovery takes place. Both vulnerability and resilience are unevenly distributed. Vulnerability theorists have focused on combinations of environmental liabilities (risk factors) and capabilities (protective factors) to understand changes in vulnerability. Resilience theorists have focused on combinations of risk factors (liabilities) and protective factors (capabilities) to predict the probability of resilient recoveries. In both approaches, the liabilities/risk factors and capabilities/protective factors originate in the social and physical environments. Finally, both vulnerability and resilience theorists have identified poverty and social isolation as key structural pressures causing unsafe conditions and constraining the development of system resiliency. We are convinced that integrating the process of resilience into vulnerability theory to create the vulnerability^{+} theory yields a more comprehensive, balanced, and potentially fruitful theory. Preceding chapters have shown substantial support for vulnerability^{+} theory. Below we provide a brief overview of that support.

Integration of Theories

Vulnerability theory and resiliency theory can be integrated by adding resilience as process to vulnerability theory's reduction of vulnerability and progression to safety. This integration creates what we call "vulnerability^{+} theory," which is a more complete theory of vulnerability. Vulnerability theory models the progression to safety as the mirror image of the progression to vulnerability. The emphasis is on changing unsafe conditions, reducing structural pressures, and addressing root causes of disaster. Resiliency theory models the progression to resiliency. Resiliency theory adds a host of additional variables known to increase resilient recoveries as well as enhance the progression to safety. Similar to vulnerability theory, some of the variables in resiliency theory are political-economic development variables at the societal and structural levels. But resiliency theory adds important noneconomic variables, including social capital, information, and communication variables.

In resiliency theory, addressing economic variables is a basis for networking social capital as well as information and communication variables. Social capital variables include capabilities that are not part of original vulnerability theory. For example, received and perceived social support, social embeddedness (informal ties), attachment to place, and sense of community. Other variables new to vulnerability theory are information and communication variables such as community narratives of successful recoveries, responsible media, communication skills and infrastructure, and trusted sources of information during disaster. The progression to safety in vulnerability theory includes changes in root causes, such as increasing access of vulnerable groups to power and other resources. Community empowerment in resiliency theory is a resource leading to greater access to resources for vulnerable groups.

While vulnerability theory has traditionally lacked a focus on wellness after disaster recovery, population wellness is a key outcome of resilient recoveries. Resilient recoveries result in high levels of wellness, with little or no variability in wellness among groups or demographically defined categories in the community. Disaster resilience theory has expanded the definition of wellness beyond that of disaster mental health researchers, which is on the absence of psychiatric disorders after a disaster. In resilience theory wellness also means low levels of generalized distress, high levels of individual and community functioning, and a uniformly high quality of life for members of a community or society.

Vulnerability^{+} theory adds new causal relationships and new variables to explore beyond those offered by traditional vulnerability or resiliency theory alone. The variables in vulnerability^{+} theory are not only societal and economic but also variables at different levels that include physical capital, social capital, the human capital underlying community competence, and both tangible and intangible adaptive resources (e.g., information and communication). Vulnerability^{+} theory holds the potential for achieving not only relatively complete recovery and safety but also resilient recoveries and community wellness. Vulnerability^{+} theory guides reductions in vulnerability while at the same time promoting resilient recoveries with high levels of functioning and adaptation to the new post-disaster environment.

Empirical Support

In this section we summarize the empirical support that exists for vulnerability^{+} theory. First, support for each of the assumptions of vulnerability theory is summarized in tabular form (see Table 10.1). Next, a model of community disaster vulnerability and resiliency is presented based of empirical support (see Fig. 10.1). This model is accompanied by a brief list of some of the more important variables in current vulnerability and resiliency research. The model proceeds from the most distal variables, which are root causes, to the proximal variables which describe the safety of living and working conditions. Resources relevant to community resiliency are the last set of variables in the causal chain, and they primarily mediate the severity of disaster exposure through recovery and wellness.

Table 10.1 lists the assumptions for vulnerability^{+} theory along with the empirical support for each assumption. The research studies cited and their connection to the assumptions have been discussed in previous chapters of this book. This table shows at a glance the substantial support for vulnerability^{+} theory. More research has been focused on the first six assumptions than on the last six assumptions. We anticipate more balanced coverage through the work on vulnerability^{+} theory.

In Table 10.1, the major variables of vulnerability^{+} theory are listed under the headings as they are presented in the model below. The types of variables are: (1) root causes, (2) structural pressures, (3) disasters, (4) resiliency, (5) safe or unsafe conditions, and (6) resources. Examples from each of these types have been operationalized by vulnerability^{+} researchers and represented in models covering aspects of vulnerability^{+} theory.

Table 10.1 Empirical support for vulnerability⁺ theory

1. Vulnerability of social systems is the reduced capacity of a community, society, or culture to adapt to environmental circumstances	Benight, Ironson, & Durham (1999), Gillespie, Colignon, Banerjee, Murty, & Rogge (1993), and Gillespie & Murty (1994)
2. Vulnerability is not evenly distributed among people or communities	Chakraborty, Tobin, & Montz (2005), Gillespie et al. (1993), Mitchell, Thomas, & Cutter (1999), Rogge (1996), Rüstemli & Karanci (1999), and Wisner et al. (2004)
3. Disaster vulnerability is multidimensional	Burnside et al. (2007), Collins (2008b), Gillespie et al. (1993), Renfrew (2009, 2012), Wisner et al. (2004), and Zakour & Harrell (2003)
4. The availability and equitable distribution of resources in a community decreases disaster vulnerability and facilitates resilience	Borden, Schmidtlein, Emrich, Piegorsch, & Cutter (2007), Burnside, Miller, & Rivera (2007), Chakraborty et al. (2005), and Cutter, Boruff, & Shirley (2003)
5. Vulnerability is largely the result of environmental capabilities and liabilities	Bonanno, Galea, Bucciarelli, & Vlahov (2009), Chakraborty et al. (2005), Gillespie et al. (1993), Gillespie & Murty (1994), Kapucu, Augustin, & Garayev (2009), and Zakour (2008a)
6. Social and demographic attributes of people are associated with but do not cause disaster vulnerability	Bolin (2007), Cutter et al. (2003), Burnside et al. (2007), Girard & Peacock's (1997), McGuire, Ford, & Okoro (2007), and Peacock & Girard (1997)
7. Unsafe conditions in which people live and work are the most proximate and immediate societal causes of disaster	Borden et al. (2007) and Wisner et al. (2004)
8. Root causes, the sociocultural characteristics of a community or society, historically and in the present, are the ultimate causes of disasters	Burnside et al. (2007) and Wisner et al. (2004)
9. Disasters occur because of a chain of causality: root causes interact with dynamic structural factors to produce unsafe conditions. Hazards then interact with unsafe conditions to trigger a disaster	Renfrew (2009, 2012) and Wisner et al. (2004)
10. Culture, ideology, and shared meaning are of central importance in the progression to disaster vulnerability	Norris et al. (2008), Rüstemli & Karanci (1999), Simonovich & Ahmad (2005), Tedeschi & Calhoun (2004), and Wellman & Frank (2001)
11. Environmental capabilities, liabilities, and disaster susceptibility are related in complex ways to produce the level of community vulnerability	Kaniasty & Norris (2009) and Simonovich & Ahmad (2005)
12. The environments of communities are growing in complexity and are increasingly global is scale	Girot (2012), Japanese Red Cross (2012), Mascarenhas & Wisner (2012), and Renfrew (2009, 2012)

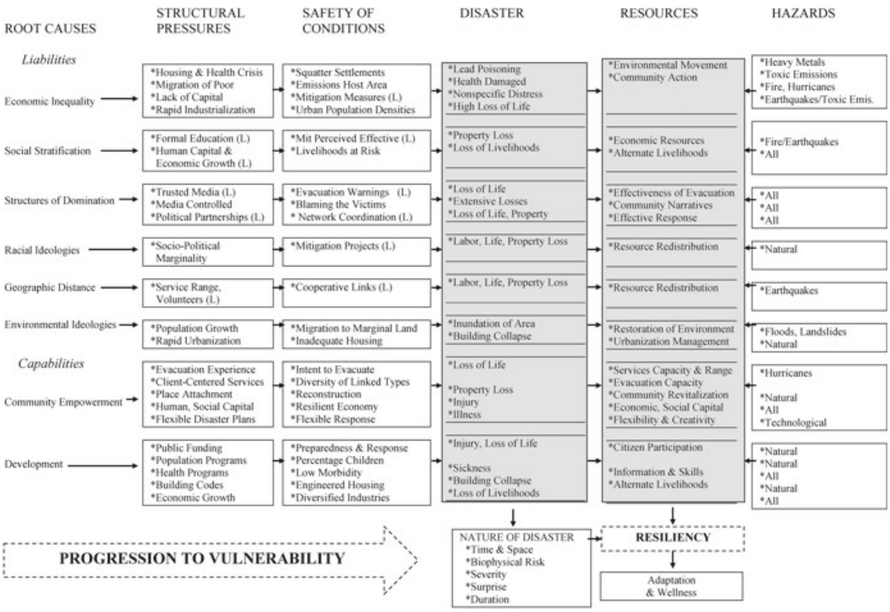

Fig. 10.1 Model of vulnerability⁺ theory

The model of vulnerability⁺ theory displays causal relationships among variables which are empirically supported by the research discussed in this book. Causality flows from left to right and from top to bottom. This diagram of vulnerability⁺ follows the causal order of the progression represented in Wisner et al.'s (2004) development work. Root social causes combined with structural pressures lead to conditions characterized by varying degrees of safety. Over time natural hazards interact with these conditions to trigger disasters.

Horizontal arrows indicate relationships among specific root causes, variables which are structural pressures, and safety of living or working conditions. Some root causes, structural pressures, and unsafe conditions are conceptualized as environmental liabilities. The two root causes at the bottom of the model (community empowerment and development), and the variables they affect, are environmental capabilities. All of the resource variables in the column on the right are capabilities as well. Causal chains of specific variables are shown across rows in the model. For example, at the top of the model under the labels from root causes to resources, the following causal chain is displayed (Fig. 10.2).

The model incorporates the work of Norris et al. (2008) on the resources that lead to resilient recoveries, a positive trajectory of functioning and adaptation after a disaster. Some of these resources are included among the root causes (e.g., community empowerment), structural pressures (e.g., political partnerships), or the safety of conditions (e.g., flexible and creative response) in the progression toward reduced vulnerability and likelihood of resilient recovery. Other resources are shown as intervening variables between disasters and the trajectory of recoveries.

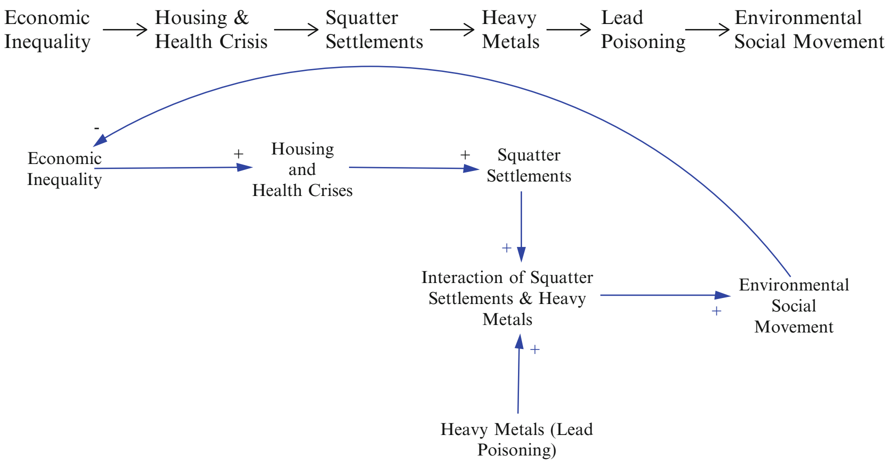

Fig. 10.2 Causal chain of vulnerability to lead poisoning

While the outcome of vulnerability is varying degrees of community dysfunction, the outcome of resilient recoveries is adaptation in varying degrees to new conditions and wellness among community members.

Causal chains initiated with a root cause liability progress to increased vulnerability. Root cause capabilities initiate a chain of causality toward reduced vulnerability and greater likelihood of resilient recovery. Under the hazards column, the various types of hazards correspond to the hazard conditions examined in research on a particular chain of causality. Some empirical support comes from research on a variety of natural disasters, and this is indicated by the "natural" category. Other support was derived from research which included both natural and technological disaster, and this is indicated by the "all" category. Under the disaster column is listed some of the predominant types of effects for the disasters studied.

Directly below the predominant effects of disasters is a set of characteristics which affect the conditions of vulnerability and the likelihood of resiliency. For example, the surprise element of disaster makes a resilient recovery less likely. Additionally, most of the impacts of disaster increase the likelihood of vulnerability. Finally, contained in the resources column are intervening variables relevant to the causal chain listed. Availability and access to these resources by all people in a community after disaster moves the community along a trajectory of resilient recovery, which has outcomes of adaptation and wellness.

Causal Chains

Root causes are deeply ingrained in a society or culture. They are distant in time and not readily apparent. For example, social stratification refers to differences in social status for categories of people in a community. Structures of domination manifest through formal and informal networks. Environmental ideologies may be liabilities or capabilities. An ideology of exploitation is a liability, frequently damaging natural environments to extract profit. This ideology encourages a relationship with nature that aggressively alters natural environments to extract short-term value and improve profit margins. An ideology of empowerment is a capability, encouraging people to have some control in producing new resources and accessing these resources to meet their demands. Core needs will differ among societies and cultures, but they often loosely follow Maslow's Hierarchy of Needs and prepotency principle.

Structural pressures combine with root causes to produce safe or unsafe conditions, depending on whether these root causes are capabilities or liabilities. Structural pressures are intermediate between distant and direct causes of disasters. Structural pressures combine with liabilities to produce unsafe conditions. Examples of structural pressures include lack of or too few people with appropriate skills, lack of or too little training, and various macro-pressures such as health crises, rapid urbanization, and industrialization. Structural pressures combine with capabilities to produce safe conditions. Examples include place attachment and dependence at the community level.

Among unsafe conditions are livelihoods at risk and lack of diversity within organizational networks. Livelihoods at risk include work in tourism or natural resource and mineral extraction. Many local rural economies are dependent on one of these industries. Not only are disasters highly likely to disrupt tourism and natural resource extraction, but also few alternate livelihoods are available after a disaster. The greater the number of different types of organizations in a community network, the more likely different types of resources will be available. A community which lacks a coordinated network of disaster services organizations with links to many different types of organizations will suffer from lower capacities and fewer types of resources available after a disaster.

Disasters are triggered when natural hazards interact with unsafe conditions. Each type of hazard has the potential to cause different types of damage. For example, although cyclones (hurricanes, typhoons) cause flooding similar to the flooding that occurs from concentrated heavy rain events, the storm surge is more likely to impact coastal areas, causing long-term salinization and mineralization of land near the coast. Natural versus technological disasters likewise have very different physical impacts. Technological disasters in particular can lack a low point, because the effects of chemicals and toxic emissions on children, infants, and the unborn can potentially unfold over decades or generations.

Disasters vary in their level of biophysical risk for a place, in the time of day they strike, and in the amount of space affected by a disaster. Disasters differ by severity, surprise, and duration. Severe, sudden, and long-lasting disasters may reduce the likelihood of a resilient recovery. For example, with hydroelectric dam failures the disaster is rarely anticipated, and so there is a high element of surprise. Such failures tend to be severe with millions of tons of water sweeping away everything in its path.

Four types of resources are important for community disaster resiliency. These resource types are economic, social capital, community competence, and information and communication (Norris et al., 2008). Available livelihoods are necessary for households to recover from disaster in a resilient manner, but some livelihoods, such as tourism and natural resource extraction (fishing, lumbering, hunting, and gathering), will be unavailable due to damage to the natural environment from a disaster. For example, as on the island of Montserrat, volcanic eruptions, pyroclastic flows, and lava flows destroyed places of employment and nonprofit aid organizations. This was also the case in Haiti in the 2010 earthquake, during which many governmental, nonprofit, and international aid organizations were severely damaged because of building collapses and loss of workers.

These resources, once accessed, act as intervening variables between severity of exposure to disasters and the probability of a resilient recovery with an outcome of adaptation to new conditions as well as wellness. Alternate livelihoods include new jobs in disaster recovery and reconstruction. Even if households are unable to pursue old livelihoods, they may be able to participate for wages in recovery and reconstruction after a disaster. This is particularly the case if organizations outside of the community hire community members to help in recovery. Community narratives, a type of information/communication resource, can be very useful if they focus on community successes in disaster response and recovery. Narratives emphasizing community efficacy often improve individual perceptions of efficacy, which is important for resilient mobilization, adaptation, and wellness.

The Future of Vulnerability⁺ Research

Vulnerability⁺ theory has tremendous potential as a guide in the work to reduce losses from disaster. The theory of vulnerability is now more balanced with emphases on both pre- (vulnerability) and post- (resiliency) disaster developments. Concepts of vulnerability⁺ theory have been defined operationally and broadly classified into types and positioned in time. Subsuming the process of resiliency into vulnerability theory is expected to bring more rigorous specification of the concept because in the past resiliency has been used mostly in vague ways as an inspiration.

Over the past dozen or so years vulnerability and resiliency researchers have become aware of the correspondence between these concepts and hinted at the integration achieved above (McEntire et al., 2002; Norris et al., 2008; Wisner et al., 2004). Support for vulnerability⁺ theory has come from different disciplines and professions, such as anthropology, social development, community psychology, physics, economics, sociology, public health, social work, and social geography. As the model of vulnerability⁺ shows (see Fig. 10.1), a number of relationships among the types of variables have been supported by recent vulnerability research. Causal and other relationships among more specific variables can now be identified and tested. Vulnerability⁺ theory is able to encompass the multidimensionality of disasters and exploit the potential leverage points for modifying systems to reduce vulnerability and increase resilient recoveries.

Root Causes

Root causes of vulnerability include economic inequality, social stratification, structures of political domination, and environmental degradation. These liabilities are reinforced by geographic distance, and also by racist ideologies and ideologies of environmental exploitation. Empowerment in communities and social development are capabilities. The effects of each of these root causes on specific other variables, categorized as structural pressures and the safety of living and working conditions, has been supported by recent research as reported in this book.

Additional research to refine or reconfirm the nature and effects of these root causes is needed. Replication of research which has identified these root causes is needed if vulnerability^{+} theory is to be ultimately successful in helping to reduce disaster losses. At present, root causes are usually defined as constructs at a middle level of abstraction. We need to know exactly how each of these root causes evolves and how to intervene in ways that reduce unsafe conditions without evoking countervailing forces. Systems are complex structures benefiting those in power and changes to the system are typically not appreciated. Finally, it is likely that additional root causes of disasters have yet to be identified. Some of these yet to be discovered root causes may be emergent, given the increasing incidence of novel types of technological disasters, biological disasters, and terrorism (e.g., cyber terrorism).

It is also likely that climate change and other macro forces may affect root causes and perhaps other variables which have so far not played a major role in natural or technological disasters. Given that most climate change has been identified at the global level, root causes of a community's disaster vulnerability may originate at a great distance from the community. An example of these kinds of root causes is the emission of large amounts of greenhouse gases, such as carbon dioxide. These gases are produced primarily by developed nations, yet communities in less-developed regions (e.g., sub-Saharan Africa, south Asia) disproportionately suffer from climate change and associated extreme weather conditions. These kinds of root causes reveal issues of social and distributive environmental injustice.

Structural Pressures

Structural pressures arise from change inspired by and guided through root causes. Social and cultural change occur continuously but the problems resulting from these changes tend to be noticed only periodically when a tipping point is reached or research has raised awareness of disaster vulnerability. Both the materialist approach to disaster mitigation (Hewitt, 1983) and the social systems approach (Mileti, 1999) are useful for tracking structural pressures. The day-to-day vulnerability governed by structural pressures is tied directly to community disaster vulnerability.

The better these relationships are understood, the better able vulnerability researchers will be in addressing a community's daily vulnerability to reduce unsafe conditions.

A vulnerability+ approach is needed to reduce the effects of structural pressures in producing unsafe conditions. Persistent economic failings and crowded social conditions are structural pressures that lead to heightened vulnerability. Economic weakness compromises the resources needed to remove unsafe conditions and carry out resilient recoveries after disaster. Vulnerability is reduced through the work of effective and coordinated disaster mitigation institutions and organizational networks (Gillespie et al., 1993). Communities which respond resiliently to disasters are also more likely to recover resiliently from disaster and to reach higher levels of development than before disaster occurred (Zakour, 2010).

Many of the resources needed for recovery are related to household livelihoods, community wealth (Wisner et al., 2004), and other economic variables such as the levels and diversity of economic resources and equity of resource distribution (Norris et al., 2008). Community vulnerability results from unsafe conditions and a lack of adaptation to the local physical environment (Oliver-Smith, 2004). A focus on vulnerability+ examines social variables such as ideologies about economic systems, human capital, local markets, debt repayment schedules, land, labor, and household livelihoods. Other variables used in vulnerability+ assessments include natural, social, human, and physical capital (Wisner et al., 2004).

Resources

Because vulnerability theorists and researchers have emphasized access to resources as a means of coping with disaster (Norris et al., 2008; Wisner et al., 2004), a number of resources and resource types have been identified. The classification of phenomena into either environmental liabilities or capabilities has helped build continuity across different fields of research. A number of resource variables have been identified by vulnerability researchers since 2000. These are shown mostly as community empowerment and development effects (see Fig. 10.1). Almost all of the variables in the resource column at the right side of the model are social resources. Though researchers think of these resources as being part of a network or system of resources that can enhance their effectiveness, future research is needed to discover which resources are most relevant for which kind of disaster, and which combinations of root causes and structural pressures cause the most damage, deaths, and injuries.

Most resource variables have been broadly conceptualized. Replication of the results of vulnerability research since 2000 is needed to confirm the usefulness of resources already identified and supported by empirical data. Additional resources important for reducing vulnerability and facilitating resiliency need to be identified. Because vulnerability models have been largely static, they do not specify which resources are important over time. The most important social resources need to be understood for each of the stages of disaster: mitigation (prevention), preparedness, response, and recovery (reconstruction).

It is not known which element of a given resource is the most effective in facilitating a community's resiliency trajectory. This knowledge is important given long-term financial limits of most governments and sovereign states. In situations with scarce resources, it would be most helpful to increase the resources most important for reducing disaster vulnerability and losses, which at the same time will facilitate resilient recoveries. This is particularly critical in developing nations, where individuals and the private sector have few available resources beyond those needed for survival. It is in these poor communities that disasters have the most negative effects and outcomes (Norris, Friedman, Watson, et al., 2002; Norris, Friedman, & Watson, 2002).

Liabilities and Capabilities

At the community level, a greater understanding of the relationship between environmental liabilities and capabilities is needed. An important example of the complexity of these relationships is the process of support mobilization and deterioration (Kaniasty & Norris, 2009). Social support mobilization is a critical capability while low social status and severity of disaster exposure are liabilities. Categories of people with low socioeconomic status (SES) are more likely to experience high severity of exposure to disaster. People with low SES are also less able to mobilize social capital, which includes the resources and social support needed for disaster recovery. However, the greater the relative need for social resources and support, the more social support a category of people is likely to receive. Though received support is conceptualized as a protective factor, and both low SES and severity of disaster exposure are liabilities, the effects of received support on the resilience outcomes of recoveries are not well understood.

There are limits to the protective effects of social support, so that there appears to be a threshold above which social support, especially emotional support, has little effect. Also, the relative effects of perceived versus received social support is not yet established (see Fig. 10.2). Even perceived severity of disaster exposure may play a more important role than objectively measured severity in explaining level of emotional distress in a disaster. There is some evidence that received support lessens emotional distress, but only because of the mediating effects of perceived support (Kaniasty & Norris, 2009). Also, part of the effect of severity of exposure on level of emotional distress is direct, while another part of the effect is through perceived support. The greater the severity of exposure, the more likely there is to be a perception that social support is inadequate for recovery, and the higher the levels of emotional distress. Perceived severity of exposure likely plays a similar role in level of distress.

Another area of knowledge that is lacking is how capabilities such as received and perceived support might lessen emotional distress. As with other capabilities, it is not clear if high levels of received and perceived support lessen the level of emotional distress in the absence of a disaster or other stressor. Received and perceived support may merely buffer the effects of disaster, or they may be beneficial in reducing nonspecific distress and increasing a sense of well-being under non-disaster conditions. Alternately, the positive effects of received and perceived support might interact with the severity of disaster exposure, and one or both of the social support variables have a greater effect as severity of disaster exposure increases. Similar questions arise when trying to understand the effects of different styles and means of coping. Only the perception that one is coping well is associated with reduced distress and dysfunction; curiously, the use of different types of objective coping is associated with more negative outcomes in a disaster (Kaniasty & Norris, 2009). This apparent anomaly needs to be explained.

Research Questions that Need to be Addressed

Of all the methods used in vulnerability research, system dynamics has the greatest potential to reveal the complex relationships among the sets of variables leading to differing levels of community disaster vulnerability. System dynamics models are able to deal with feedback loops that include delays in the progression to vulnerability or resilience. Social work researchers can use system dynamics methods to test scenarios and avoid a trial-and-error process during the danger of an actual disaster.

The single vulnerability study which has been conducted using system dynamics examined flood evacuation (Simonovic & Ahmad, 2005). Given the importance of evacuation for saving lives and the promise of system dynamics modeling, we recommend building on this work. Here we offer five questions for further research to gain greater understanding of disaster vulnerability and resilience.

The first research question has been partially addressed in system dynamics research. It concerns the importance of evacuation orders, warning consistency, and timing for household acceptance of the need to evacuate.

Q1: How important is evacuation warning consistency and timing of evacuation orders for household acceptance?

Though tests revealed that warning consistency and timing of evacuation orders influenced evacuation efficiency, varying the weights assigned to these two variables did not substantially change evacuation efficiency. Evacuation efficiency, the time from the evacuation order to arrival at a safe refuge, is important because those households which delay evacuation or take an excessive amount of time to reach a refuge are highly vulnerable. These households may be trapped in their homes or on the road in their automobiles as flooding and inundation becomes more severe.

The next two questions address the issue of generalizability of the results from Simonovic and Ahmad's (2005) system dynamics model.

Q2: Does the flood model developed using data from the Red River Basin flood of 1995 generalize to floods in other geographic settings?

The issue of generalization of the flood evacuation model to geographic areas beyond the Red River Basin in Manitoba, Canada, has not been addressed. It is possible that the geography of the Red River Basin, or the fact that the Red River is one of the few rivers crossing the U.S.-Canadian border flowing north, could cause the results of the study and system dynamics model to fail to generalize to other settings. Also, numerous towns in Manitoba along the Red River are protected by ring dykes, which is not the case for many other river towns.

A related question concerning generalization is:

Q3: Does the Red River Basin flood (1995) model generalize to other types of flooding?

There is currently no evidence that the Red River Basin model will generalize to different kinds of flooding, such as from hurricanes, coastal inundation, flash flooding, or tsunamis. As shown by Hurricane Katrina and the 1994 tsunami, massive destruction and high numbers of deaths result from these kinds of disasters. Though warning orders could have saved lives in the 1994 tsunami, a lack of communication links between governments in the Indian Ocean led to few evacuation orders being issued. A generalized system dynamics evacuation model could inform emergency managers about reducing vulnerability in many different kinds of disasters.

Finally, the issue of whether information on flooding of upstream communities and community coherence can be included as endogenous variables in a flood evacuation model has not been addressed. This leads us to suggest researchers address two final questions:

Q4: Does knowledge of upstream community flood conditions act as an endogenous variable in evacuation models?

Q5: Does community coherence (social support) act as an endogenous variable in evacuation models?

In Simonovic and Ahmad's (2005) model, both variables are exogenous. These variables are not explained by any variable. There is little doubt that these variables are endogenous and part of a feedback structure. These two variables were shown to be important for efficient household evacuation. Knowing what increases knowledge of upstream community flooding, as well as community coherence, could provide valuable information for better understanding vulnerability and resilience in disasters triggered by flood hazards.

ERRATUM

Community Disaster Vulnerability Theory, Research, and Practice

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The publisher regrets that in the online and print versions of this book the Acknowledgements text was omitted from the front matter. This text should read as follows:

This book integrates vulnerability and resiliency theories as a means of reducing losses from disasters. Vulnerability theory offers practical guidance toward reducing the rising human and financial costs stemming from disaster. National problems can quickly become international in scope. For example, the United States suffered its worst drought in over a quarter century in 2012, resulting in greatly reduced output of corn and soy beans. Because the U.S. is a major exporter of these crops, the drought in the U.S. is resulting in world-wide food shortages. It may take years to fully recover from this disaster. Reducing human vulnerability to extreme events is a world-wide mandate.

Elsewhere, on the international stage, flooding in Pakistan in 2010 and 2011 killed over 500 people and affected 5 million more. The 2010 flood in the People's Republic of China, affecting Fujian, Sichuan, and Guangxi provinces, affected 134 million people and cost 18 billion (US) dollars. The combination of earthquake, tsunami, and nuclear plant disasters in Japan in 2010 killed nearly 20 thousand people, and left large tracts of land either devastated or uninhabitable for decades. Like the drought in the United States, the effects from these disasters spread out around the world. It is critical that human safety become a primary goal of sustainable development.

We applaud the Katherine A. Kendall Institute for International Social Work Education, the Council on Social Work Education (CSWE), and the International Association of Schools of Social Work for sponsoring their 2007 conference on disasters. The Disaster Planning, Management and Relief conference was organized

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partly in recognition of the increasing costs from disasters occurring world-wide, including the 2004 tsunami and Hurricane Katrina in 2005. An important focus of this conference was the role of the social work profession in disaster preparedness, response, and recovery. Many of the ideas in this book were first presented at this conference. Subsequently, conference presenters contributed to a book edited by David Gillespie and Kofi Danso (2010), *Disaster Concepts and Issues*, published by CSWE Press. The first three chapters of the edited book, all of which explore aspects of disaster vulnerability, inspired our current book.

We thank Edward F. Lawlor, Dean of the Brown School of Social Work at Washington University in St. Louis, Missouri for the one semester sabbatical given to David Gillespie to work on this book. The additional time and opportunity to concentrate on the writing were essential to completing the book. Also essential was the support and encouragement given by David's wife Susan J. Gillespie. Susan was especially gracious in accepting the time in isolation needed to complete a project of this magnitude within a constrained timeframe.

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References

Arlikatti, S., Lindell, M. K., Prater, C. S., & Zhang, Y. (2006). Risk area accuracy and hurricane evacuation expectations of coastal residents. *Environment and Behavior, 38*(2), 226–247.

Banerjee, M. M., & Gillespie, D. F. (1994). Linking preparedness and organizational disaster response effectiveness. *Journal of Community Practice, 1*(3), 129–142.

Bankoff, G. (2004). The historical geography of disaster: "Vulnerability" and "local knowledge. In G. Bankoff, G. Frerks, & D. Hilhorst (Eds.), *Mapping vulnerability: Disasters, development & people* (pp. 25–36). London: Earthscan.

Bankoff, G., Frerks, G., & Hilhorst, D. (2004). *Mapping vulnerability: Disasters, development, & people*. London: Earthscan.

Barton, A. H. (1969). *Communities in disaster. A sociological analysis of collective stress situations*. Garden City: Doubleday.

Barton, A. H. (2005). Disaster and collective stress. In R. W. Perry & E. L. Quarantelli (Eds.), *What is a disaster? New answers to old questions* (pp. 125–152). Bloomington: Xlibris.

Benight, C. C., Ironson, G., & Durham, R. L. (1999). Psychometric properties of a hurricane coping self-efficacy measure. *Journal of Traumatic Stress, 12*(2), 379–387.

Benight, C. C., McFarlane, A. C., & Norris, F. H. (2006). Formulating questions about postdisaster mental health. In F. H. Norris, S. Galea, M. J. Friedman, & P. J. Watson (Eds.), *Methods for disaster mental health research* (pp. 62–77). New York: Guilford.

Bielefeld, W., Murdoch, J. C., & Waddell, P. (1997). The influence of demographics and distance on nonprofit location. *Nonprofit and Voluntary Sector Quarterly, 26*(2), 207–225.

Blaikie, P., & Brookfield, H. (1987). *Land degradation and society*. London: Methuen.

Blaikie, P., Cameron, J., & Seddon, D. (1980). *Nepal in crisis: Growth and stagnation at the periphery*. Oxford: Clarendon.

Blalock, H. M. (1964). *Causal inferences in nonexperimental research*. Chapel Hill: University of North Carolina Press.

Blalock, H. M. (1969). *Theory construction. From verbal to mathematical formulations*. Englewood Cliffs: Prentice Hall.

Bolin, R. C. (2007). Race, class, ethnicity, and disaster vulnerability. In H. Rodriguez, E. Quarantelli, & R. Dynes (Eds.), *Handbook of disaster research* (pp. 113–129). New York: Springer.

Bollen, K. A., & Bauldry, S. (2011). The three C's in measurement models: Causal indicators, composite indicators, and covariates. *Psychological Methods, 16*(3), 265–284.

Bonanno, G. A. (2004). Loss, trauma, and human resilience: Have we underestimated the human capacity to thrive after extremely aversive events? *American Psychologist, 59*(1), 20–28.

Bonanno, G. A., Galea, S., Bucciarelli, A., & Vlahov, D. (2007). What predicts psychological resilience after disaster? The role of demographics, resources, and life stress. *Journal of Consulting and Clinical Psychology, 75*(5), 671–682.

M.J. Zakour and D.F. Gillespie, *Community Disaster Vulnerability: Theory, Research, and Practice*, DOI 10.1007/978-1-4614-5737-4,

Bonanno, G. A., & Gupta, S. (2009). Resilience after disaster. In Y. Neria, S. Galea, & F. H. Norris (Eds.), *Mental health and disasters* (pp. 145–160). Cambridge: Cambridge University.

Borden, K. A., Schmidtlein, M. C., Emrich, C. T., Piegorsch, W. W., & Cutter, S. L. (2007). Vulnerability of U.S. cities to environmental hazards. *Journal of Homeland Security and Emergency Management, 4*(2), 1–21.

Bottero, W. (2007). Social inequality and interaction. *Sociology Compass, 1*(2), 814–831.

Bourque, L. B., Siegel, J. M., Kano, M., & Wood, M. M. (2006). Weathering the storm: The impact of hurricanes on physical and mental health. *The Annals of the American Academy of Political and Social Science, 604*, 129–151.

Burnside, R., Miller, D. S., & Rivera, J. D. (2007). The impact of information and risk perception on the hurricane evacuation decision-making of greater New Orleans residents. *Sociological Spectrum, 27*, 727–740.

Cardona, O. D. (2004). The need for rethinking the concepts of vulnerability and risk from a holistic perspective: A necessary review and criticism for effective risk management. In G. Bankoff, G. Frerks, & D. Hilhorst (Eds.), *Mapping vulnerability: Disasters, development & people* (pp. 37–51). London: Earthscan.

Centre for the Epidemiology of Disasters (2011). *EMDAT: The international disaster database*. Retreived from http://www.emdat.be/natural-disasters-trends.

Chakraborty, J., Tobin, G. A., & Montz, B. E. (2005). Population evacuation: Assessing spatial variability in geophysical risk and social vulnerability to natural hazards. *Natural Hazards Review, 6*(1), 23–33.

Cho, S., & Gillespie, D. F. (2006). A conceptual model exploring the dynamics of government-nonprofit service delivery. *Nonprofit and Voluntary Sector Quarterly, 55*(3), 493–509.

Collins, T. W. (2008a). What influences mitigation? Household decision making about wildfire risks in Arizona's White Mountains. *The Professional Geographer, 60*(4), 508–526.

Collins, T. W. (2008b). The political ecology of hazard vulnerability: Marginalization, facilitation and the production of differential risk to urban wildfires in Arizona's White Mountains. *Journal of Political Ecology, 15*, 21–43.

Cooke, D. L., & Rohleder, T. R. (2006). Learning from incidents: From normal accidents to high reliability. *System Dynamics Review, 22*(3), 213–239.

Coston, J. M., Cooper, T. L., & Sundeen, R. A. (1993). Response of community organizations to the civil unrest in Los Angeles. *Nonprofit and Voluntary Sector Quarterly, 22*(4), 357–373.

Cuny, F. C. (1983). *Disasters and development*. Oxford: Oxford University.

Cutter, S. L. (2006). *Hazards, vulnerability, and environmental justice*. Sterling: Earthscan.

Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability of environmental hazards. *Social Science Quarterly, 84*(1), 242–261.

Cutter, S. L., Mitchell, J. T., & Scott, M. S. (2000). Revealing the vulnerability of people and places: A case study of Georgetown County, South Carolina. *Annals of the Association of American Geographers, 90*(4), 713–737.

De Vaus, D. (2001). *Research design in social research*. London: Sage.

Deegan, M. A. (2006). *Defining the policy space for disaster management: A system dynamics approach to U.S. flood policy analysis*. Paper presented at the 24th International Conference of the System Dynamics Society, Nijmegen, The Netherlands.

Deming, W. E. (1994). The new economics (2nd ed.). Cambridge, MA: Massachusetts Institute of Technology Centre for Advanced Educational Services.

Doll, B., & Lyon, M. (1998). Risk and resilience: Implications for the delivery of educational and mental health services in schools. *School Psychology Review, 27*, 348–363.

Drabek, T. E. (1986). *Human system response to disaster*. New York: Springer.

Duncan, O. D. (1966). Path analysis: Sociological examples. *The American Journal of Sociology, 72*(1), 1–16.

Dyer, C. L. (1999). The phoenix effect in post-disaster recovery: An analysis of the Economic Development Administration's culture of response after Hurricane Andrew. In A. Oliver-Smith & S. M. Hoffman (Eds.), *The angry earth: Disaster in anthropological perspective* (pp. 278–300). New York: Routledge.

Enarson, E., Fothergill, A., & Peek, L. (2007). Gender and disaster: Foundations and directions. In H. Rodriguez, E. Quarantelli, & R. Dynes (Eds.), *Handbook of disaster research* (pp. 130–145). New York: Springer.

Erickson, K. (1994). *A new species of trouble*. New York: Norton.

Fordham, M. (1999). The intersection of gender and social class in disaster: Balancing resilience and vulnerability. *International Journal of Mass Emergencies and Disasters, 17*(1), 15–36.

Forrester, J. W. (1968). *Principles of systems*. Portland: Productivity Press.

Freedman, D. A. (1992). As others see us: A case study in path analysis. In J. P. Shaffer (Ed.), *The role of nonexperimental social science: Two debates* (pp. 3–30). Washington, DC: American Educational Research Association and American Statistical Association.

Gabe, T., Falk, G., McCarty, M., & Mason, V. W. (2005). *Hurricane Katrina: Social-demographic characteristics of impacted areas* (Publication No. RL33141). U.S. Washington, DC: Congressional Research Service.

Galea, S., & Maxwell, A. R. (2009). Methodological challenges in studying the mental health consequences of disasters. In Y. Neria, S. Galea, & F. H. Norris (Eds.), *Mental health and disasters* (pp. 579–593). Cambridge: Cambridge University.

Galea, S., & Norris, F. H. (2006). Public mental health surveillance and monitoring. In F. H. Norris, S. Galea, M. J. Friedman, & P. J. Watson (Eds.), *Methods for disaster mental health research* (pp. 177–193). New York: Guilford.

Gillespie, D. F. (2008a). *Disasters. Encyclopedia of social work* (20th ed.). New York: Oxford University Press. http://www.oxford-naswsocialwork.com/entry?entry=t203.e107.

Gillespie, D. F. (2008b). Theories of vulnerability: Key to reducing losses from disasters. In *Proceedings of the 21st international conference of social work. Social work and human welfare in a changeable community* (pp. 15–26). Cairo, Egypt: Helwan University.

Gillespie, D. F. (2010). Vulnerability: The central concept of disaster curriculum. In D. F. Gillespie & K. Danso (Eds.), *Disaster concepts and issues: A guide for social work education and practice* (pp. 3–14). Alexandria, VA: Council on Social Work Education.

Gillespie, D. F., Colignon, R. A., Banerjee, M. M., Murty, S. A., & Rogge, M. (1993). *Partnerships for community preparedness* (Program on Environment and Behavior Monograph No. 54). Boulder, CO: University of Colorado, Institute of Behavioral Science.

Gillespie, D. F., & Murty, S. A. (1994). Cracks in a post-disaster service delivery network. *American Journal of Community Psychology, 22*(5), 639–660.

Gillespie, D. F., & Perron, B. (2007). *Structural equation modeling. Encyclopedia of epidemiology* (Vol. 2). Beverly Hills: Sage.

Gillespie, D. F., Perry, R. W., & Mileti, D. S. (1974). Collective stress and community transformation. *Human Relations, 27*(8), 767–778.

Gillespie, D. F., Robards, K. J., & Cho, S. (2004, May). Designing safe systems: Using system dynamics to understand disasters. *Natural Hazards Review, 5*, 82–88.

Gillespie, D. F., & Streeter, C. L. (1994). Fitting regression models to research questions for analyzing change in non-experimental research. *Social Work Research, 18*(4), 344–354.

Girard, C., & Peacock, W. G. (1997). Ethnicity and segregation: Post-hurricane relocation. In W. G. Peacock, B. H. Morrow, & H. Gladwin (Eds.), *Hurricane Andrew: Ethnicity, gender and the sociology of disasters* (pp. 191–205). London: Routledge.

Girot, P. O. (2012). Plant disease, pests, and erosion of biodiversity. In B. Wisner, J. C. Gaillard, & I. Kelman (Eds.), *The Routledge handbook of hazards and disaster risk reduction* (pp. 447–457). New York: Routledge.

Gladwin, C. H., Gladwin, H., & Peacock, W. G. (2001). Modeling hurricane evacuation decisions with ethnographic methods. *International Journal of Mass Emergencies and Disasters, 19*(2), 117–143.

Greene, R. R. (Ed.). (2002). *Resiliency: An integrated approach to practice, policy, and research*. Washington, DC: NASW.

Greene, R. R. & Conrad, A. P. (2002). Basic concepts and terms. In R. R. Greene (Ed.), *Resiliency: An integrated approach to practice, policy, and research* (pp. 29–62). Washington, D.C.: NASW.

Greene, R. R., & Greene, D. G. (2009). Resilience in the face of disasters: Bridging micro- and macro-perspectives. *Journal of Human Behavior in the Social Environment, 19*, 1010–1024.

Green, R. R. & Livingston, N. C. (2002). A social construct. In R. R. Greene (Ed.), *Resiliency: An integrated approach to practice, policy, and research* (pp. 63–93). Washington, D.C.: NASW.

Gurevich, M. (1961). *The social structure of acquaintanceship networks*. Cambridge, MA: MIT Press.

Hawkins, A. O., Zinzow, H. M., Amstadter, A. B., Danielson, C. K., & Ruggiero, K. J. (2009). Factors associated with exposure and response to disasters among marginalized populations. In Y. Neria, S. Galea, & F. H. Norris (Eds.), *Mental health and disasters* (pp. 277–290). Cambridge: Cambridge University.

Henry, D. (2007). Anthropological contributions to the study of disasters. In D. McEntire (Ed.), *Disciplines, disasters, and emergency management: The convergence and divergence of concepts, issues and trends from the research literature* (pp. 111–123). Springfield: Charles C. Thomas.

Hewitt, K. (1983). *Interpretations of calamity*. Boston: Allen & Unwin.

Hoffman, S. M., & Oliver-Smith, A. (Eds.). (2002). *Catastrophe & culture. The anthropology of disaster*. Santa Fe: School of American Research.

Hurlbert, J. S., Beggs, J. J., & Haines, V. A. (2001). Social networks and social capital in extreme environments. In N. Lin, K. Cook, & R. S. Burt (Eds.), *Social capital: Theory and research* (pp. 209–231). New York: Aldine de Gruyter.

Hurlbert, J. S., Haines, V. A., & Beggs, J. J. (2000). Core networks and tie activation: What kinds of routine networks allocate resources in nonroutine situation? *American Sociological Review, 65*(4), 598–618.

Intergovernmental Panel on Climate Change. (2007, November). *Summary for policymakers of the synthesis report of the IPCC fourth assessment report.* Retrieved November 18, 2007, from http://www.ipcc.ch/IPCC Nov17 ar4_syr_spm.pdf.

Intergovernmental Panel on Climate Change, (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of Working Groups I and II of the Intergovernmental Panel on Climate Change* (pp. 582). Cambridge, UK: Cambridge University Press.

International Federation of Red Cross and Red Crescent Societies. (2008). *World disasters report 2008.* Retrieved March 14, 2009, from www.redcross.ie/layout/set/print/content/view/full/1831Red_Cross_Red_Crescent_figures_HIV_disasters.pdf.

Japanese Red Cross Society. (2012). *The long road to recovery one year on from the earthquake and tsunami*. Retrieved from http://www.jrc.or.jp/eq-japan2011/news-stories/l4/Vcms4_00002862.html.

Joreskog, K., & Sorbom, D. (1993). *LISREL 8: Structural equation modeling with the SIMPLIS command language*. Chicago: Scientific Software International, Inc.

Kaniasty, K., & Norris, F. H. (2009). Distinctions that matter: Received social support, perceived social support, and social embeddedness after disasters. In Y. Neria, S. Galea, & F. H. Norris (Eds.), *Mental health and disasters* (pp. 175–200). Cambridge: Cambridge University.

Kapucu, N., Augustin, M.-E., & Garayev, V. (2009). Interstate partnerships in emergency management: Emergency management assistance compact in response to catastrophic disasters. *Public Administration Review, 69*(2), 297–313.

Kendra, J. M., & Wachtendorf, T. (2007). Community innovation and disasters. In H. Rodriguez, E. Quarantelli, & R. Dynes (Eds.), *Handbook of disaster research* (pp. 316–334). New York: Springer.

Klinenberg, E. (2002). *Heat wave: a social autopsy of disaster in Chicago*. Chicago: University of Chicago.

Knoke, D., & Yang, S. (2008). *Social network analysis* (2nd ed.) (Quantitative Applications in the Social Sciences No. 154). Los Angeles: Sage.

Lee, E. K. O., Shen, C., & Tran, T. V. (2009). Coping with Hurricane Katrina: Psychological distress and resilience among African American evacuees. *Journal of Black Psychology, 35*(1), 5–23.

Lin, N. (2001). Building a network theory of social capital. In N. Lin, K. Cook, & R. S. Burt (Eds.), *Social capital: Theory and research* (pp. 3–29). New York: Aldine de Gruyter.

Lin, N., Cook, K., & Burt, R. S. (Eds.). (2001). *Social capital: Theory and research*. New York: Aldine de Gruyter.
Mackinnon, D. P., Fairchild, A. J., & Fritz, M. S. (2007). Mediation analysis. *Annual Review of Psychology, 58*, 593–614.
Mascarenhas, A., & Wisner, B. (2012). Politics: Power and disasters. In Wisner, J. C. Gaillard, & I. Kelman (Eds.), *The Routledge handbook of hazards and disaster risk reduction* (pp. 48–59). New York: Routledge.
McCullagh, P., & Nelder, J. (1989). *Generalized linear models* (2nd ed.). Boca Raton: Chapman and Hall/CRC.
McEntire, D. A. (2002). Coordinating multi-organizational responses to disaster: Lessons from the March 28, 2000, Fort Worth Tornado. *Disaster Prevention and Management, 11*(5), 369–379.
McEntire, D. A. (2004a). Development, disasters and vulnerability: A discussion of divergent theories and the need for their integration. *Disaster Prevention and Management, 13*(3), 193–198.
McEntire, D. A. (2004b). *The status of emergency management theory: Issues, barriers, and recommendations for improved scholarship*. Paper submitted at the FEMA Higher Education Conference, Emmitsburg, MD
McEntire, D. A. (2005). Why vulnerability matters: Exploring the merit of an inclusive disaster reduction concept. *Disaster Prevention and Management, 14*(2), 206–222.
McEntire, D. A. (Ed.). (2007a). *Disciplines, disasters, and emergency management: The convergence and divergence of concepts, issues and trends from the research literature*. Springfield: Charles C. Thomas.
McEntire, D. A. (2007b). The importance of multi- and interdisciplinary research on disasters and for emergency management. In D. McEntire (Ed.), *Disciplines, disasters, and emergency management: The convergence and divergence of concepts, issues and trends from the research literature* (pp. 3–14). Springfield, IL: Charles C. Thomas.
McEntire, D. A. (2008). A critique of emergency management policy: Recommendations to reduce disaster vulnerability. *International Journal of Public Policy, 3*(5/6), 302–311.
McEntire, D. A. (2009). Revolutionary and evolutionary change in emergency management. *Journal of Business Continuity & Emergency Planning, 4*(1), 69–85.
McEntire, D. A., Fuller, C., Johnston, C. W., & Weber, R. (2002). A comparison of disaster paradigms: The search for a holistic policy guide. *Public Administration Review, 62*(3), 267–281.
McEntire, D. A., & Mathis, S. (2007). Comparative politics and disasters: Assessing substantive and methodological contributions. In D. McEntire (Ed.), *Disciplines, disasters, and emergency management: The convergence and divergence of concepts, issues and trends from the research literature* (pp. 178–188). Springfield: Charles C. Thomas.
McFarlane, A. C., & Norris, F. H. (2006). Definitions and concepts in disaster research. In F. H. Norris, S. Galea, M. J. Friedman, & P. J. Watson (Eds.), *Methods for disaster mental health research* (pp. 3–19). New York: Guilford.
McGuire, L. C., Ford, E. S., & Okoro, C. A. (2007). Natural disasters and older US adults with disabilities: Implications for evacuation. *Disasters, 31*(1), 49–56.
Meadows, D. H. (2008). *Thinking in systems*. White River Junction: Chelsea Green Publishing.
Meichenbaum, D. (1997). *Treating post-traumatic stress disorder: A handbook and practice manual for therapy*. New York: Wiley.
Michels, R. (1962). *Political parties*. New York: The Free Press.
Mileti, D. S. (1999). *Disasters by design: A reassessment of natural hazards in the United States*. Washington, DC: John Henry.
Minahan, A., & Pincus, A. (1977). Conceptual framework for social work practice. *Journal for the National Association of Social Workers, 22*(5), 347–352.
Mitchell, J. T., Thomas, D. S. K., & Cutter, S. L. (1999). Dumping in Dixie revisited: The evolution of environmental injustices in South Carolina. *Social Sciences Quarterly, 80*(2), 229–243.
Moreno, J. L. (1934). *Who shall survive? A new approach to the problem of human interactions*. Washington, DC: Nervous and Mental Disease Publishing Company.
Murty, S. A., & Gillespie, D. F. (1995). Introducing network analysis into the social work curriculum. *Journal of Applied Social Sciences, 19*(2), 107–119.

Neria, Y., Galea, S., & Norris, F. H. (2009). Disaster mental health research: Current state, gapes in knowledge, and future directions. In Y. Neria, S. Galea, & F. H. Norris (Eds.), *Mental health and disasters* (pp. 594–610). Cambridge: Cambridge University.

Niederhoffer, K. G., & Pennebaker, J. W. (2009). Sharing one's story: On the benefits of writing or talking about emotional experience. In S. J. Lopez & C. R. Snyder (Eds.), *Oxford handbook of positive psychology* (2nd ed., pp. 621–632). New York: Oxford University Press.

Norris, F. H. (2006). Disaster research methods: Past progress and future directions. *Journal of Traumatic Stress, 19*(2), 173–184.

Norris, F. H., Baker, C. B., Murphy, A. D., & Kaniasty, K. (2005). Social support mobilization and deterioration after Mexico's 1999 flood: Effects of context, gender, and time. *American Journal of Community Psychology, 36*(1/2), 15–28.

Norris, F. H., & Elrod, C. L. (2006). Psychosocial consequences of disaster: A review of past research. In F. H. Norris, S. Galea, M. J. Friedman, & P. J. Watson (Eds.), *Methods for disaster mental health research* (pp. 20–42). New York: Guilford.

Norris, F. H., Friedman, M. J., & Watson, P. J. (2002). 60,000 disaster victims speak: Part II. Summary and implications of the disaster mental health research. *Psychiatry, 65*(3), 240–260.

Norris, F. H., Friedman, M. J., Watson, P. J., Byrne, C. M., Diaz, E., & Kaniasty, K. (2002). 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981–2001. *Psychiatry, 65*(3), 207–239.

Norris, F. H., Galea, S., Friedman, M. J., & Watson, P. J. (Eds.). (2006). *Methods for disaster mental health research*. New York: Guilford.

Norris, F. H., & Kaniasty, K. (1996). Received and perceived social support in times of stress: A test of the social support deterioration deterrence model. *Journal of Personality and Social Psychology, 71*(3), 498–511.

Norris, F. H., Murphy, A. D., Kaniasty, K., Perilla, J. L., & Ortis, D. C. (2001). Postdisaster social support in the United States and Mexico: Conceptual and contextual considerations. *Hispanic Journal of Behavioral Sciences, 23*(4), 469–497.

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology, 41*(1/2), 127–150.

Norris, F. H., Tracy, M., & Galea, S. (2009). Looking for resilience: Understanding the longitudinal trajectories of responses to stress. *Social Science & Medicine, 68*, 2190–2198.

Norris, F. H., & Wind, L. H. (2009). The experience of disaster: Trauma, loss, adversities, and community effects. In Y. Neria, S. Galea, & F. H. Norris (Eds.), *Mental health and disasters* (pp. 29–44). Cambridge: Cambridge University.

North, C. S., Hong, B. A., Suris, A., & Spitznagal, E. (2008). Distinguishing distress and psychopathology among survivors of the Oakland/Berkeley Firestorm. *Psychiatry, 71*(1), 35–45.

North, C. S., Spitznagal, E. L., & Smith E. M. (2001). A prospective study of coping after exposure to a mass murder episode. *Annals of Clinical Psychiatry, 13*(2), 81–87.

O'Keefe, P., Westgate, K., & Wisner, B. (1976, April 15). Taking the naturalness out of natural disasters. *Nature, 260*, 566–567.

Oliver-Smith, A. (1996). Anthropological research on hazards and disasters. *Annual Review of Anthropology, 25*, 303–325.

Oliver-Smith, A. (2002). Theorizing disasters: Nature, power, and culture. In S. M. Hoffman & A. Oliver-Smith (Eds.), *Catastrophe & culture: The anthropology of disaster* (pp. 23–47). Santa Fe: School of American Research.

Oliver-Smith, A. (2004). Theorizing vulnerability in a globalized world: A political ecological perspective. In G. Bankoff, G. Frerks, & D. Hilhorst (Eds.), *Mapping vulnerability: Disasters, development & people* (pp. 10–24). London: Earthscan.

Oliver-Smith, A., & Button, G. (2005). *Forced migration as an index of vulnerability in Hurricane Katrina.* Paper presented at the UNU-EHS Expert Working Group II, Measuring the Un-measurable, Bonn, Germany.

Peacock, W. G., & Girard, C. (1997). Ethnic and racial inequalities in hurricane damage and insurance settlements. In W. G. Peacock, B. H. Morrow, & H. Gladwin (Eds.), *Hurricane Andrew: Ethnicity, gender and the sociology of disasters* (pp. 171–190). London: Routledge.

Peacock, W. G., Morrow, B. H., & Gladwin, H. (1997). *Hurricane Andrew: Ethnicity, gender and the sociology of disasters*. London: Routledge.

Pedhazur, E. J. (1982). *Multiple regression in behavioral research. Explanation and prediction* (2nd ed.). New York: Holt, Rinehart and Winston.

Pedrotti, J. T., Edwards, L. M., & Lopez, S. J. (2009). Positive psychology within a cultural context. In S. J. Lopez & C. R. Snyder (Eds.), *Oxford handbook of positive psychology* (pp. 49–57). New York: Oxford University Press.

Pfeffer, J., & Salancik, G. R. (2003). *The external control of organizations: A resource dependence perspective*. Stanford: Stanford University Press.

Pulwarty, R. S., Broad, K., & Finan, T. (2004). El Niño events, forecasts and decision-making. In G. Bankoff, G. Frerks, & D. Hilhorst (Eds.), *Mapping vulnerability: Disasters, development & people* (pp. 83–98). London: Earthscan.

Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*. New York: Simon & Shuster.

Quarantelli, E. L. (2005). A social science research agenda for the disasters of the 21st century: Theoretical, methodological and empirical issues and their professional implementation. In R. W. Perry & E. L. Quarantelli (Eds.), *What is a disaster? New answers to old questions* (pp. 325–396). Bloomington: Xlibris.

Queiro-Tajalli, I., & Campbell, C. (2002). Resilience and violence at the macro level. In R. R. Greene (Ed.), *Resiliency: An integrated approach to practice, policy, and research* (pp. 217–240). Washington, DC: NASW Press.

Raphael, B., Cieslak, R., & Waldrep, E. (2009). Social and cognitive frameworks for understanding the mental health consequences of disasters. In Y. Neria, S. Galea, & F. H. Norris (Eds.), *Mental health and disasters* (pp. 161–174). Cambridge: Cambridge University.

Raphael, B., & Maguire, P. (2009). Disaster mental health research: Past, present, and future. In Y. Neria, S. Galea, & F. H. Norris (Eds.), *Mental health and disasters* (pp. 7–28). Cambridge: Cambridge University.

Renfrew, D. E. (2009). In the margins of contamination: Lead poisoning and the production of neoliberal nature in Uruguay. *Journal of Political Ecology, 16*, 87–103.

Renfrew, D. E. (2012). New hazards and old disease: Lead contamination and the Uruguayan battery industry. In C. Sellers & J. Melling (Eds.), *Dangerous trade: Histories of industrial hazard across a globalizing world* (pp. 99–111). Philadelphia: Temple University.

Richardson, G. P. (1991). *Feedback thought in social science and systems theory*. Philadelphia: University of Pennsylvania Press.

Richmond, B. (2004). *An introduction to systems thinking*. Lebanon: ISEE Systems.

Rogge, M. E. (1996). Social vulnerability to toxic risk. In C. L. Streeter & S. A. Murty (Eds.), *Research on social work and disasters* (pp. 109–129). New York: Haworth.

Rogge, M. E. (2003). The future is now: Social work, disaster management, and traumatic stress in the 21st century. *Journal of Social Service Research, 30*(2), 1–6.

Ronan, K. R., & Johnston, D. M. (2001). Correlates of hazard education programs for youth. *Risk Analysis, 21*(6), 1055–1063.

Ronan, K. R., & Johnston, D. M. (2005). *Promoting community resilience in disasters: The role for schools, youth, and families*. New York: Springer.

Rosenberg, M. (1968). *The logic of survey analysis*. New York: Basic Books, Inc.

Rosenfeld, L. B., Caye, J. C., Ayalon, O., & Lahad, M. (2005). *When their world falls apart: Helping families and children manage the effects of disasters*. Washington, DC: National Association of Social Workers.

Rudolph, J. W., & Repenning, N. P. (2002). Disaster dynamics: Understanding the role of quantity in organizational collapse. *Administrative Science Quarterly, 47*(1), 1–30.

Rüstemli, A., & Karanci, A. N. (1999). Correlates of earthquake cognitions and preparedness behavior in a victimized population. *The Journal of Social Psychology, 139*(1), 91–101.

Sanders, S., Bowie, S. L., & Bowie, Y. D. (2003). Lessons learned on forced relocation of older adults: The impact of Hurricane Andrew on health, mental health, and social support of public housing residents. *Journal of Gerontological Social Work, 40*(4), 23–35.

Schutt, R. K. (2005). Sampling. In R. M. Grinnell Jr. & Y. A. Unrau (Eds.), *Social work research and evaluation* (7th ed., pp. 150–169). New York: Oxford University Press.

Scott, J. (2000). *Social network analysis: A handbook* (2nd ed.). London: Sage.

Senge, P. M. (2006). *The fifth discipline*. New York: Currency Doubleday.

Simonovic, S. P., & Ahmad, S. (2005). Computer-based model for flood evacuation emergency planning. *Natural Hazards, 34*, 25–51.

Soliman, H. H. (1996). Community responses to chronic technological disaster: The case of the Pigeon River. In C. L. Streeter & S. A. Murty (Eds.), *Research on social work and disasters* (pp. 89–107). New York: Haworth.

Soliman, H. H., & Rogge, M. E. (2002). Ethical considerations in disaster services: A social work perspective. *Electronic Journal of Social Work, 1*(1), 1–23.

Streeter, C. L. (1991). Disasters and development: Disaster preparedness and mitigation as an essential component of development planning. *Social Development Issues, 13*(3), 100–110.

Streeter, C. L. (1992). Redundancy in organizational systems. *Social Service Review, 66*(1), 97–111.

Sundet, P. A., & Mermelstein, J. (2000). Sustainability of rural communities: Lessons from natural disaster. In M. J. Zakour (Ed.), *Disaster and traumatic stress research and intervention* (Vol. 21–22). New Orleans: Tulane University.

Tabachnik, B. G., & Fidell, L. S. (1996). *Using multivariate statistics* (3rd ed.). New York: Harper Collins College Publishers.

Tedeschi, R. G., & Calhoun, L. G. (2004). Posttaumatic growth: Conceptual foundations and empirical evidence. *Psychological Inquiry, 15*(1), 1–18.

Thomas, N. D., & Soliman, H. H. (2002). Preventable tragedies: Heat disaster and the elderly. *Journal of Gerontological Social Work, 38*(4), 53–66.

Tierney, K. J. (2007). Business and disasters: Vulnerability, impact, and recovery. In H. Rodriguez, E. Quarantelli, & R. Dynes (Eds.), *Handbook of disaster research* (pp. 275–296). New York: Springer.

Ullman, J. B. (1996). Structural equation modeling. In B. G. Tabachnik & L. S. Fidell (Eds.), *Using multivariate statistics* (3rd ed., pp. 709–811). New York: Harper Collins College Publishers.

United Nations International Strategy for Disaster Reduction (2009). *2008 Disasters in numbers*. Retrieved on March 14, 2009 from HYPERLINK http://www.unisdr.org/eng/media-room/facts-sheets/2008-disasters-in-numbers-ISDR-CRE.pdf.

Villagran De Leon, J. C. (2006). Vulnerability: A conceptual and methodological review. *Source, 4*.

Wallace, A. F. C. (1956a). Revitalization movements. *American Anthropologist, 58*(2), 264–281.

Wallace, A. F. C. (1956b). Mazeway disintegration: The individual's perception of socio-cultural disorganization. *Human Organization, 16*(2), 23–27.

Wallace, A. F. C. (1956c). Mazeway resynthesis: A biocultural theory of religious inspiration. In R. S. Grumet (Ed.), *Revitalizations & mazeways: Essays on culture change* (Vol. 1). Lincoln: University of Nebraska.

Warwick, D. P., & Lininger, C. A. (1975). *The sample survey: Theory and practice*. New York: McGraw-Hill.

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge: Cambridge University.

Wellman, B., & Frank, K. A. (2001). Network capital in a multilevel world: Getting support from personal communities. In N. Lin, K. Cook, & R. S. Burt (Eds.), *Social capital: Theory and research* (pp. 233–273). New York: Aldine de Gruyter.

Wijkman, A., & Timerlake, L. (1984). *Natural disaster: Act of god or acts of man?* London: International Institute for Environment and Development.

Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). *At risk. Natural hazards, people's vulnerability and disasters* (2nd ed.). New York: Routledge.

Wright, S. (1960). Path coefficients and path regressions: Alternative or complementary concepts? *Biometrics, 16*(1), 189–202.

Zakour, M. J. (1996). Geographic and social distance during emergencies: A path model of interorganizational links. *Social Work Research, 20*(1), 19–29.
Zakour, M. J. (2007). Social work and disasters. In D. A. McEntire (Ed.), *Disciplines, disasters and emergency management. The convergence and divergence of concepts, issues, and trends from the research literature* (pp. 124–141). Springfield: C.C. Thomas.
Zakour, M. J. (2008a). Social capital and increased organizational capacity for evacuation in natural disasters. *Social Development Issues, 30*(1), 13–28.
Zakour, M. J. (2008b). Vulnerability to climate change in the Nile delta: Social policy and community development interventions. In *Proceedings of the 21st international conference of social work. Social work and human welfare in a changeable community* (pp. 425–451). Cairo, Egypt: Helwan University.
Zakour, M. J. (2010). Vulnerability and risk assessment: Building community resilience. In D. F. Gillespie & K. Danso (Eds.), *Disaster concepts and issues: A guide for social work education and practice* (pp. 15–60). Alexandria: Council on Social Work Education.
Zakour, M. J. (2012a). Coping with loss and overcoming trauma. In J. Framingham & M. Teasly (Eds.), *Behavioral health response to disasters* (pp. 95–113). New York: CRC/Taylor & Francis Group.
Zakour, M. J. (2012b). Natural and man-made disasters. In L. M. Healy & R. J. Link (Eds.), *Handbook of international social work: Human rights, development, and the global profession* (pp. 226–231). Oxford: Oxford University Press.
Zakour, M. J., & Gillespie, D. F. (1998). Effects of organizational type and localism on volunteerism and resource sharing during disasters. *Nonprofit and Voluntary Sector Quarterly, 27*(1), 49–65.
Zakour, M. J., & Gillespie, D. F. (2010). Recent trends in disaster vulnerability and resiliency research: Theory, design, and methodology. In D. F. Gillespie & K. Danso (Eds.), *Disaster concepts and issues: A guide for social work education and practice* (pp. 35–60). Alexandria: CSWE Press.
Zakour, M. J., Gillespie, D. F., Sherraden, M. S., & Streeter, C. L. (1991). Volunteer organizations in disasters. *Journal of Volunteer Administration, 9*(2), 18–28.
Zakour, M. J., & Harrell, E. B. (2003). Access to disaster services: Social work interventions for vulnerable populations. *Journal of Social Service Research, 30*(2), 27–54.

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