Disaster Risk Reduction
Methods, Approaches and Practices

Gopal Krishna Panda · Uday Chatterjee ·
Nairwita Bandyopadhyay ·
Martiwi Diah Setiawati ·
Debarpita Banerjee *Editors*

Indigenous Knowledge and Disaster Risk Reduction

Insight Towards Perception, Response, Adaptation and Sustainability

Springer

Disaster Risk Reduction

Methods, Approaches and Practices

Series Editor

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Disaster risk reduction is a process that leads to the safety of communities and nations. After the 2005 World Conference on Disaster Reduction, held in Kobe, Japan, the Hyogo Framework for Action (HFA) was adopted as a framework for risk reduction. The academic research and higher education in disaster risk reduction has made, and continues to make, a gradual shift from pure basic research to applied, implementation-oriented research. More emphasis is being given to multi-stakeholder collaboration and multi-disciplinary research. Emerging university networks in Asia, Europe, Africa, and the Americas have urged process-oriented research in the disaster risk reduction field. With this in mind, this new series will promote the output of action research on disaster risk reduction, which will be useful for a wide range of stakeholders including academicians, professionals, practitioners, and students and researchers in related fields. The series will focus on emerging needs in the risk reduction field, starting from climate change adaptation, urban ecosystem, coastal risk reduction, education for sustainable development, community-based practices, risk communication, and human security, among other areas. Through academic review, this series will encourage young researchers and practitioners to analyze field practices and link them to theory and policies with logic, data, and evidence. In this way, the series will emphasize evidence-based risk reduction methods, approaches, and practices.

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ISSN 2196-4106 ISSN 2196-4114 (electronic)
Disaster Risk Reduction
ISBN 978-3-031-26142-8 ISBN 978-3-031-26143-5 (eBook)
https://doi.org/10.1007/978-3-031-26143-5

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Dedicated to

Young Scholars in the Field of Indigenous Knowledge, Hazard and Disaster Management, Environmental Science, Geography, Social Science and Policy Makers

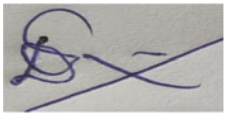
Foreword

Indigenous knowledge which promotes sustainability and responsible stewardship of natural and cultural resources is emerging as a significant input in development discussions in the field of social sciences and technology as well. Development practitioners and theorists now acknowledge the importance of indigenous knowledge as the key to sustainable development as the latest and the best strategy to fight against hunger, poverty, underdevelopment and resilience to disasters. It is increasingly realized that indigenous knowledge permits development to proceed in "harmony" with nature as an inalienable ally to development practice. However, considerable confusion does exist in defining what exactly constitutes indigenous knowledge as the term is interchangeably used to mean a host of knowledge systems such as traditional knowledge, local knowledge, folk knowledge or farmers or fishermen's knowledge, tacit knowledge etc.—all of which have different connotations when scrutinized at the conceptual level. No universal definition of indigenous knowledge is readily available which has resulted in much confusion with regard to the usage of the term. What is however common to all these terms used under the umbrella of indigenous knowledge is its focus on; the knowledge system that is rarely documented?

Moreover, indigenous knowledge was earlier contemptuously viewed not only as inefficient and inferior but also as an impediment to development. Thankfully there has been a perceptible change in this attitude of the development theorists in recent times who now accord a significant and often a privileged place to different forms of indigenous knowledge in the development discourse. Geographers and anthropologists however have taken a lead in emphasizing the importance of local and autochthonous knowledge even before the general acceptance of these systems by a wide range of disciplines with more and more evidences of failures of grand theories of development which are now accused of being elitist, highly technical and abstract. This represents a subaltern turn to development theory and practice. The importance of indigenous knowledge lies in its method of resource use which is largely participatory, cost-effective and hence far more sustainable. Such knowledge systems are viewed as essential ingredients of successful development.

It is in this context that the book on *Indigenous Knowledge and Disaster Risk Reduction: Insight Towards Perception, Response, Adaptation and Sustainability* acquires enormous significance. The book—a collection of some 25 very illuminating articles—is a timely contribution to the growing body of literature on disaster risk reduction from a contemporary perspective of indigenous knowledge and practice. Two of the editors of the book—Prof. Gopal Krishna Panda and Dr. Uday Chatterjee—are personally known to me as serious academicians who have made a significant contribution to the field of disaster studies. The other three editors too are well known for their impeccable academic commitments. The book in more than one way demonstrates the editorial skills of the five editors who have made strenuous efforts to sift and weave diverse aspects of disaster risk reduction which is so meticulously planned, coherent, readable and relevant. The book has very skilfully combined all the ingredients of research that conjure up a genuinely scholarly work. Each of the entries in this edited volume speaks different stories but brings out the most significant dimension of local and traditional wisdom in disaster management. The worth of the book lies in its ability to treat case studies from different peoples and cultures which are rarely documented but can be seen as other ways of regarding the world. From the experience of indigenous people on Merapi volcano eruption and Muslim indigenous ethnic minority in Sri Lanka to the Mao Nagas of the Naga Hills or the Rajbanshis of West Bengal and the Boti tribes of Indonesia, each represents diverse ways of perceiving and dealing with disasters in different geographies and interaction with the nature. The book also includes stories of Majuli Island—a rare river island that has fleeting and surreal waterscapes. Equally important contributions have come from the understanding of local knowledge in negotiating disasters in perpetually drought-prone areas and in mountainous areas which provide daily challenges for survival in the face of a harsh environment prone to hazards. Likewise, the book also contains a chapter on local and traditional knowledge in helping the people achieve water security. The challenge of climate change too receives adequate attention from the editors by emphasizing the importance of indigenous methods and techniques in mitigating the effects of this global crisis. The editors have taken special care to indicate the policy implications flowing from these seemingly diverse, highly localized and undocumented experiences and practices of the communities who have silently displayed their wisdom and resilience in dealing with numerous hazards in their own inimitable ways.

It is not an easy task to weave so many disparate threads in a single book. However, the editors have achieved what may seem unachievable. The organization of the book ensures that each aspect is given its due share, and the synthesis is done to provide the reader with a sense of satisfaction in contextualizing the indigenous knowledge.



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Preface

Recognition of the existence of a hazard is an important component of risk perception. Valid perception about disaster risks may not always exist with people. Hence, people fail to respond to hazards when they do not perceive. The way we perceive a hazard determines our course of action. Better awareness and capability to perceive a hazard has often shown that more efficient the community will be to give a sound response and resilience toward the same. The way indigenous communities respond and adapt to a hazard is thus largely dependent on their perception which comes mainly from their experience and understanding of the hazard in their own way. Mostly, it is dependent on how long the community is exposed to such hazards. The experience of any natural or manmade disaster often leads to better planning to respond in a disaster. The exposure to a hazard gives an insight into its repeatability, intensity and spatial extent of that hazard. Tapping the traditional knowledge to hazard monitoring, mitigation and most importantly in planning has long proven to be helpful in managing a disaster. In the absence of documentation of this knowledge, many vital informations are lost in course of time. In recent decades, natural hazards affected more than 200 million people. They killed more than 70,000 people annually in the Asia-pacific region, accounting for 90% and 65% of the world's total, respectively. Communities of the Asia-Pacific region are highly vulnerable to natural disasters due to their vulnerable geographic location. Besides physical vulnerability, other factors like poverty, illiteracy, lack of access to resources compounds their social and economic vulnerability. Furthermore, coastal areas or island countries face an increasing range of stresses and shocks due to climate change, sea-level rise, increased frequency of tropical cyclones, etc. Attempts to reduce the adverse effects of the natural hazards and adverse impact of climate change require disaster proof infrastructure such as construction of high seawalls or on high-tech alternatives; advanced early warning systems based on empirical data and modeling. Although these technical solutions save lives when hazards hit, they must be enhanced by actions to address the risks associated with the threat and the underlying components of vulnerability (i.e., the interconnected human, social, and cultural factors that influence risk). Local knowledge is a critical factor that can increase a community's resilience, and it has assisted communities in managing crises whether they are natural disasters, economic problems or political conflicts.

There has been growing evidences that local knowledge and experience can improve disaster preparedness. Although it has been noted that "indigenous knowledge has been slow to infiltrate the field of disaster management," there has been a significant increase in studies on the topic, particularly since the mid-2000s, when the knowledge that helped indigenous communities survive the 2004 Indian Ocean earthquake and tsunami was widely publicized. Indigenous knowledge was also applied for the adaptation of hydro-meteorological disasters. For Instance, farmers in Bhutan diversify their food sources by growing crops, raising livestock and managing communal forests. During crop failure, livestock and wild foods meet most of their households' nutritional needs. In Nepal, indigenous knowledge is regarded as a valuable asset in flood management planning. Indigenous flood forecasting methods were identified as effective community-based early warning systems that were long-lasting and economically viable, saving lives. The Hyogo Framework for Action (2005–2015) acknowledged "traditional and indigenous knowledge and cultural heritage" as a source of "knowledge, innovation, and education to build a culture of safety and resilience at all levels." When past and present techniques and knowledge are combined, the resilience of disaster-affected communities can be enhanced. Furthermore, it is now widely acknowledged that combining indigenous and scientific knowledge can result in successful disaster preparedness and climate change adaptation. When combined with cutting-edge technology and scientific analysis, local and indigenous knowledge can provide communities and decision-makers with a solid foundation to make decisions about environmental issues. Walshe, Nunn and Lauer describe how indigenous knowledge about tsunami risks and responses, combined with science-based and other knowledge, contributed an essential role for the villagers surviving the Vanuatu tsunami in 1999 and the Solomon Islands tsunami in 2007. The 2004 Indian Ocean tsunami is credited with igniting interest in integrating indigenous knowledge with science for disaster risk reduction, and numerous such efforts have since been launched worldwide. Vanuatu has developed participatory volcanic hazard awareness and education for disaster preparedness planning that combines traditional knowledge with volcanology. We propose in this book a process for integrating local and indigenous knowledge both for geological and hydro-meteorological hazards with science and technology because we believe it is necessary to promote the use of such knowledge to increase community resilience to the effects of hazards and to better adapt to climate change.

A prime example is the 2015 Sendai Framework for Disaster Risk Reduction, promoting indigenous environmental management knowledge and practices. Traditional knowledge of indigenous people includes information and insight that supplement conventional science and environmental observations, a comprehensive understanding of the environment, natural resources, culture and human interactions with them. Many of these knowledges have been lost in translation. In this book, we try to keep a record of each and every traditional knowledge study about the indigenous communities in managing the disasters. The use of indigenous knowledge systems in disaster understanding and management is the primary focus of the chapters. The study sought to comprehend how indigenous knowledge systems of local communities can be effectively used in disaster management of various types. This book is organized into four major sections. Part I will give an overview and help in conceptualizing the different concepts of hazard and disaster perception and how response and adaptation are connected with it. This part will also discuss the concept on the connection between hazard and sustainable development and how the understanding of risk reduction and resilience can happen with the help of indigenous knowledge, insights and strategies. Part II of the book introduces the different approaches to disaster and risk management. It establishes how vulnerability influences the risk associated with a hazard and the responses can be both positive and negative in disaster management. The approaches of the indigenous communities in managing a disaster, their resilience, capacity building and community-based preparedness will be the area of prime focus in this chapter. Part III of this book describes the concept of sustainability through indigenous knowledge and practice; the sole highlight of this chapter will be the indigenous knowledge efficacies in disaster identification, risk reduction, climate risk management and climate action. The last part of the book explores how to meet the gaps between local knowledge can be a part of policy formulations in disaster risk reduction. It is high lighting how traditional knowledge can be useful in configuring region specific policy frameworks for the stakeholders of disaster management. Thus, this fourth part of the book is presenting an integration of indigenous knowledge and modern technologies in disaster risk reduction for achieving the goals of sustainability.

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Acknowledgments

This book is the outcome of the inspiration and tremendous effort made by the academicians, engineers scientists, planner, policymakers and community activists worldwide who are working very hard toward disaster risk reduction and community resilience and sustainable development. We express our heartfelt gratitude to our distinguished authors for their valuable contributions to this book. We also acknowledge the hard work of the reviewers for their insightful constructive criticism, suggestion and positive feedbacks. This has helped a lot to our authors to improve their research contributions simultaneously raising the quality of the book. As lifelong learners, we are grateful for the incredible support of our colleagues, students, parents, family members, teachers and collaborators in easing out our efforts we have been putting day in and day out while editing this book so that it may add value and contribute positively to the knowledge creation in the area of indigenous knowledge in disaster risk reduction. Last but not least, we would like to acknowledge the continuous assistance, constant inspiration and support of our publisher and its publishing editor, managers and support staff in bringing out this volume. Our special thanks go to the honorable founder of KIIT and KISS, Prof. Achyuta Samanta, and vice chancellor of Kalinga Institute of Social Science (KISS) Deemed University, Prof. Deepak Behera for their constant encouragement in this academic endeavor. We are very much thankful to the innumerable authors of books, journals, reports and mimeographs which were directly or indirectly helped us in formulating the concepts and moldings our thoughts and ideas for this book.

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Contents

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Part I
Conceptualising Disaster and Risk

Chapter 1
Indigenous Knowledge and Disaster Risk Reduction: Insight Toward Perception, Response, Adaptation and Sustainability

Gopal Krishna Panda, Uday Chatterjee, and Snigdharani Panda

Abstract Indigenous knowledge system is being recognized as a significant component of disaster mitigation and risk reduction strategy of the twenty-first century. The Sendai Framework for Disaster Management, while seeking to advance risk reduction strategies for bringing resilience in the community, tends to promote indigenous knowledge in disaster risk management configuring it within their policy and programs for achieving the goals of sustainable development. These indigenous knowledge systems are also being promoted by the UNESCO LINKS program which promotes inclusion of indigenous knowledge in global climate science and policy formulations. LINKS strives to strengthen indigenous people and local communities, foster transdisciplinary engagements with scientists and policy-makers and piloting novel methodologies to further understandings of climate change impacts, adaptation and mitigation. Indigenous knowledge was first acknowledged in the Fourth Assessment Report of the IPCC as a basis for developing community-level adaptation and natural resource management in response to the stresses generated due environmental deterioration. But subsequently indigenous knowledge was accepted by IPCC as an alternate approach toward disaster mitigation- and community-based disaster preparedness. This paper aims to assess the usefulness of this alternate knowledge system in disaster risk reduction based on selected desk reviews of previous literatures of best practices. Besides this, the paper attempts to bring an insightful

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_1

analysis of the inherent linkage between indigenous knowledge, community perception, human response and adaptation so that it can be a part of an innovative strategy in sustainable disaster risk reduction.

Keywords Hazards and disasters · Indigenous knowledge · Community perception · Human response · Risk reduction

1.1 Indigenous Knowledge System and Disaster Management

Since the beginning of twenty-first century, there has been a gradual shift in the recognition of the relationship between science and indigenous knowledge systems and its application in many global environmental programs. The Sendai Framework for Disaster Risk Reduction, while seeking to advance local, regional, national and global efforts to prevent the emerging risks, reduce the existing risks and bring resilience in the community, tends to promote (UNISDR 2015) indigenous knowledge in disaster risk management configuring it within their policy and programs. The World Meteorological Organisation published a report that there has been a five times increase in the number of disasters during the last 50 years between 1970 and 2019 (WMO 2021). International Federation of Red Cross and Red Crescent Societies reported a 35% increase in the number of disasters since 1990s besides increase in their magnitude and intensity (IFRC 2020). Global Outlook in Disaster Science of Elsevier reported that there is an increase in the number of publications in the field of disaster studies (Elsevier 2017). Sendai Framework for Disaster Risk Reduction has also accepted the local and indigenous knowledge as an important component of disaster risks reduction and sustainable development (UNISDR 2015). In this study, we aim to bring out an insight about how indigenous knowledge has been complementing to the community-based disaster risk reduction, its scope for furtherance of this alternate knowledge system for achieving the sustainable development goals of the countries and regions where there are limited capacities in technological interventions or limited and inadequate financial resources for ensuring resilience to build back batter in post- and pre-disaster phases (UNISDR 2015). UNESCO has also been influential in encouraging the indigenous knowledge holders and their knowledge through its LINKS program in including contemporary science–policy–society fora on issues of disaster risk reduction and preparedness, assessment and adaptation to climate change for sustainable development besides other areas like biodiversity conservation and environment (Nakashima et al. 2012). These indigenous knowledge systems are being promoted by the UNESCO LINKS program which promotes inclusion of indigenous knowledge in global climate science and policy formulations. LINKS strives to strengthen indigenous people and local communities, foster transdisciplinary engagements with scientists and policy-makers and pilot novel methodologies to further understandings of climate change impacts, adaptation and mitigation (UNESCO 2020). Indigenous knowledge was first acknowledged in the Fourth Assessment Report of the IPCC as a basis for developing community-level adaptation and natural resource management in response to the stresses generated due environmental deterioration (IPCC 2007). Subsequently, this was accepted by the IPCC that (IPCC 2010) indigenous knowledge can be a guiding principle and an alternate approach toward community based disaster preparedness and disaster resilience. Later on, this traditional knowledge system was introduced in the 5th assessment report of the IPCC.

Indigenous and traditional knowledge is a kind of skill, understanding, philosophy developed and transmitted through their past generations and used by communities based on a long period of living and interaction with their surrounding environment. This is a kind of local knowledge system adopted by indigenous people in decision making in their day-to-day life. This knowledge is an integral part of their cultural practices interwoven with the language, religious faith and believes systems in relation to their resource utilization, social interaction, rituals and spirituality. It has been realized at the national and international level that these unique knowledge system often provide a basis for achieving the goals of sustainable development (UNESCO 2020). Over the past decades of twenty-first century, international community dealing with hazards and disasters have increasingly recognized the significance of these traditional knowledge systems, as well as its importance in spearheading disaster risk reduction involving local communities. Utilization of this knowledge has also been emphasized by the Paris Agreement adopted in 2015 by the 21st Conference of the Parties, UNFCCC, and was reflected in the 5th Assessment Report of the IPCC (IPCC 2014). Indigenous knowledge systems are distinctly different from the scientific knowledge systems, with different intellectual heritages, contexts and applications. But, however, it has provided important insights toward community perception, human response and adaptations aiming toward achieving sustainability in disaster risk reduction. Community-based indigenous knowledge offers valuable insights about their coping strategies and adapting to the adverse impacts of the hazards and disasters. While the impacts of the hazards and disasters are getting unprecedented, indigenous knowledge with the communities and their coping strategies provide a strong foundation for community-based disaster risk reduction and mitigation measures. It has been observed by the disaster managers that indigenous and local knowledge is embedded in their ways of life of the community members and informs a wide range of practices from their food items that are anchored in seasonal availability. Despite their differences of origin, practices and focus, these knowledge systems rely on some shared principles, including observation, hypothesis building, cross-referencing of various indicators and then systems of adaptation and modification. As the systems are based on observing different phenomena at different scales, with different approaches, they provide important opportunities for community perception, response and risk reduction (Hadlos et al. 2022). This paper gives a conceptual overview of the significance of traditional and indigenous knowledge system in dealing with the disaster risk reduction and promotion of sustainable development goals.

Use of indigenous knowledge has been relatively new in disaster management although it is popular in the fields of agriculture, forestry, traditional medicine, biodiversity, natural resource management. Adaptations in agrarian practices based on the indigenous knowledge and perceptions of climatic phenomena have guided the local communities since ancient and classical times. This highlights how the traditional knowledge system helps in understanding the science of climate which is often considered insignificant by the climate scientists. Significance of this indigenous knowledge in shaping the local livelihoods, their food security and over all wellbeing in the face of the recent climate changes is remaining unnoticed (Nakashima et al. 2012).

This paper also aims to assess the usefulness of this alternate knowledge system based on selected desk reviews of previous literatures depicting some of the best practices. This paper attempts to draw attention of the disaster managers that indigenous knowledge can be a part of our strategy in sustainable disaster risk reduction.

1.2 Indigenous Knowledge, Disaster Risk Reduction and Community Participation

Natural hazards and disasters are the extreme geophysical events of nature triggered by the natural forces and processes which exceed the normal capacity of human system to reflect, absorb or buffer. These are natural phenomena which occur in proximity and pose a threat to people, structure and their economic assets caused by biological, geological, hydrological and meteorological conditions or processes in the natural environment. Many of the natural hazards often turn to be disasters due to their severe impacts and serious disruption in the functioning of a society, causing widespread human, material or environmental losses exceeding the ability of the affected society to cope using its own resources. A disaster is the product of a hazard such as earthquake, flood or cyclone coinciding with a vulnerable situation, which might include communities, cities or villages. Without vulnerability or hazard, there is no disaster (IFRC 2014). But very often a natural disaster is used to describe an event, naturally made, sudden or progressive, intensive or pervasive which impacts with such severity that the affected community has to respond by exceptional measures. Community participation has been a major thrust area in managing a disaster event and reducing its risk (Dey 2012). It is because community is the first victim of a disaster and community also becomes the first responder. Community perception and response to a disaster event is always guided by their indigenous knowledge that they have acquired and inherited from their age-old traditions and customary believes. This traditional and indigenous knowledge of a participating community has become an emerging strategy and a critical human factor in realizing the ultimate objective of disaster risk reduction. When greater emphasis has been placed in preparing for community participation in disaster management, the traditional knowledge often plays a very important role in roping the community members with the contemporary strategies of disaster mitigation (Kumar 2012) and risk reduction.

Indigenous or traditional knowledge is a kind of knowledge practiced by the communities in response to various issues or threats while making a living or adopting to a particular livelihood in an environment. It is being increasingly acknowledged that this knowledge can make important contributions to both the understanding and the management of hazards and disasters in developing countries (Shaw et al. 2009). It has also been experienced that there are extant indigenous practices and traditions which have revealed appropriate responses from communities confronted by disaster in a way which may be more effective than non-indigenous, science-based warning systems (Baumwoll and Krishnamurthy 2009). Effective disaster risk reduction for communities in developing countries has been recognized by international, national and developmental agencies over the past decade as a key to sustainable development of these communities and nations. Indigenous and marginalized population are more exposed to hazards and disasters due to their primary economy-based livelihoods and vulnerable location of their habitats. Their less number, physical isolation and poor accessibility to community resources often contribute to their vulnerability and risk. Despite their high exposure-sensitivity, indigenous people and local communities are actively responding to changing climatic conditions and have demonstrated resourcefulness and resilience in the face of climate change and disasters. Traditional nature-based livelihood and social cohesion among them contribute to their collective response through their indigenous response in the event of a hazard or a disaster (Dubey and Munsaka 2018).

Disasters are as old as human history but the dramatic increase in their magnitude and frequency and the damage caused by them in the recent years have become a cause of national and international concern. Over the past decade, the number of natural and manmade disasters has climbed inexorably. Many countries have been traditionally vulnerable to natural disasters on account of their unique geological situations, climatic conditions and vulnerable locations. Floods, droughts, cyclones, volcanic eruptions, earthquakes, tsunami and landslides have been the recurrent phenomena for many countries. United Nations Global Assessment Report on Disaster Risk Reduction reported that if current trends continue, the frequency of disaster events per year is likely to increase from nearly 400 in 2015 to 560 per year by 2030 across the globe. This amounts to a projected increase of about 40% during 2015 to 2030. The current trend of droughts also indicates a likely increase of more than 30% between 2001 and 2030 with an increase from 16 drought events per year during 2001–2010 to 21 per year by 2030. Similarly, the number of extreme heat wave events per year is likely to triple between 2001 and 2030 (UNDRR 2021). This has been further substantiated by the Sixth Assessment Report of IPCC which has revealed that with the current rate of climate change world is likely to face more intense heat waves, floods and droughts and an increase in extreme daily precipitation events by 2030. The current trend of the world is likely to exceed the target of the Paris Agreement of 1.5 °C global mean maximum temperature by 2030 bringing more severe hazard events with an accelerating pace (IPCC 2021a, b). As a consequence of global warming and climate change, natural hazards and disasters are posing greater challenges before humanity with an unprecedented increase in their frequency, intensity and geographical spread over the last few decades. In view of these growing challenges, it is essential for understanding the knowledge management strategies which can be useful in assessing vulnerability and reducing risk of hazards and disasters for better adaption and coping with the extreme events. Disasters had not only put people in great distress, causing enormous loss of life and property in their immediate effect, but also account for widespread social and economic dislocations affecting long-term economic growth and social development in the affected region. Given their highly debilitating secondary impacts, the natural disasters pose bigger problems in developing and underdeveloped countries which struggle to cope with their immediate and long-term consequences. In an economically underdeveloped region, the natural disasters put an additional burden on the society. Governments find little option except to channel the limited financial resources and support systems to cope with the immediate consequences of disasters, which severely squeezes their ability to work for long-term developments. While the experience of living through the natural disasters is traumatic, damage it causes continues to have its impact felt for years long after the immediate effects have become invisible. Governments, aid agencies and civil society organizations rush in the immediate aftermath of a natural disaster providing help to the helpless victims. However, the benefits people receive from such initiatives appear short-lived as they continue to struggle to cope with the long-term consequences on their own. Humanitarian aid does not address the basic question of after care, which is available only so long as the primary impact is visible. Once the initial relief efforts subside, the real struggle starts for the victims, as economic hardships redouble and wounds inflicted by natural disasters prove difficult to heal. Humanitarian aid itself cannot address problems that natural disasters bring. What we need is sustained effort to ensure community-based disaster preparedness and response through appropriate knowledge management practices and policies enabling people to cope with natural disasters on their own. This cannot happen unless an understanding is developed, and awareness is raised on the nature of the hazards or disasters of the different localities where the people live. Imparting knowledge and building capacities of the youth in the schools, colleges, institutes and vulnerable localities on understanding the hazards and disasters more specifically of their localities implies a continuous upgradation of knowledge on natural hazards and disaster management at the level of the communities (ISDR 2008). This also calls for a serious thinking and action on a range of important issues of teaching and learning on natural hazards and disaster management. In view of the future predictions of climate change and global warming, awareness programs in these areas attain a special focus in building a knowledge society capable of better coping and adapting to the extreme geo-physical events of nature. It is needless to emphasize that when it is not possible to prevent the natural hazards, there should be an effective capacity building program of knowledge management to minimize their effects through an improved adjustment system of community awareness and human preparedness. Application of indigenous knowledge in the area of natural hazards and disaster management assumes its importance because the traditional knowledge that people have inherited from generations is the best medium to replicate the learning on a wider scale in the society in the event of a disaster.

1.3 Indigenous Knowledge in Disaster Management and Sustainable Development

Disaster management is being defined as the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery, in order to lessen the impact of disasters. Disaster management is linked with sustainable development, particularly in relation to vulnerable people such as those with disabilities, elderly people, children and other marginalized groups. The primary responsibility of management of the natural disasters normally vests with the provincial and national governments providing the financial and other technical resources for disaster response. National action plans, standard operating procedures, institutional arrangements and policy guidelines are followed to deal with the emergency situations for ensuring timely assistance in the wake of a disaster. Knowledge on the networking of institutions, advance warning systems, preparedness and mitigation measures, coping mechanisms and regulations for disaster management have been developed by the disaster managers following the guidelines from the Yokohama strategy and Sendai framework for disaster risk reduction (Yokohama strategy) Spreading education, building capacity in the society in understanding the disasters, their impacts, community-based disaster preparedness and resilience after a disaster are some of the key areas of concern in disaster risk reduction. Although a significant advancement has been made in technical understanding of the hazards and disasters, our knowledge about the behavioral and socio-economic facets of the natural disasters and the preparedness to face such disasters are being complemented through indigenous knowledge management with a focus toward Disaster Risk Reduction. The Sendai framework adopted a holistic and integrated approach to disaster management spearheading a paradigm shift from the erstwhile relief-centric response to a proactive prevention, mitigation and preparedness-driven approach and sustainable risk reduction strategy for conserving developmental gains and also to minimize losses of life, livelihoods and property through application of indigenous knowledge at the community level (Islam and Shafie 2017). There have been many instances where community preparedness and response have been guided by the prevailing local and indigenous knowledge in advance disaster warning, response, coping and adaptation and post-disaster rehabilitation. Some of the facets of this application have been well demonstrated by the primitive tribes of Andaman and Nicobar during 2004 tsunami, droughts of Africa and people from the small islands of the Pacific ocean, etc. Indigenous people generally follow their traditional knowledge-based solutions inherited from their ancestors in dealing with their environmental variability and uncertainty. Their indigenous knowledge with regard to their livelihood, diversified socio-cultural believe systems and attitude help in generating resilience to the environmental extremes (Mondal 2012). Policies which can support resilience and adaptability and instill local practices through their indigenous knowledge has been a challenging area for the disaster managers and governance systems. Collaboration between indigenous knowledge holders and mainstream scientific research has been a focus area for the planners and policy-makers for generating and accepting innovative solutions enabling traditional knowledge to evolve for achieving community resilience.

1.4 The Shifting Paradigm of Disaster Management

1.4.1 Changing Vision of Disaster Management at the International Level

The beginning of the twenty-first century witnessed a profound and far-reaching transformation in disaster management sector at the international level. These transformations have been driven by a variety of factors which include (among others) an increase in the range and frequency of disasters, increasing pressures on emergency aid budgets, rapid technological development, rising community participation and expectations and the increasing recognition that disasters and development are intrinsically linked. These shifts in perceptions, approaches and methods gradually took root in many countries, although the international humanitarian and development assistance sector itself remained internalizing these changes. There was a paradigmatic shift in the main elements of a conceptual framework with certain new features of disaster risk management strategy (Myrna et al. 2022).

The Yokohama message emanating from the international decade for natural disaster reduction in May 1994 underlined the need for an emphatic shift in the strategy for disaster mitigation. It put stress on the disaster prevention, mitigation, preparedness and relief, i.e., the four elements which contribute to and gain, from the implementation of the sustainable development policies. The new strategy placed emphasis on the closely inter-related elements of environmental protection and sustainable development. Therefore, it was placed in the forefront that nations should incorporate these above-mentioned themes in their development plans and should ensure efficient follow up measures at the community, sub-regional, regional, national and international levels. Yokohama strategy also emphasized that disaster prevention, mitigation and preparedness are better than disaster response in achieving the goals and objectives of vulnerability reduction. It was believed that disaster response alone is not enough as it yields only temporary results at a very high cost. Prevention and mitigation may contribute toward a lasting improvement in disaster risk reduction and are essential to integrated disaster risk management programs (NIDM 2015). Gradually countries adopted mitigation and prevention as the essential components of their development strategy with a realization that development cannot be sustainable without mitigation being built into developmental process.

Thus, mitigation was being institutionalized into developmental planning involving participation of community members utilizing their indigenous knowledge to achieve the goals of sustainable development.

1.4.2 Shift in Disaster Management from Response to Risk Reduction

Disasters are natural or human-triggered in origin. When describing disasters, the general tendency is to focus on events, consequences and severity and less on the preceding aspects, notably awareness, preparation, anticipation and pre-disaster conditions and activities. Hazards are potential or existing conditions that may cause harm to people and/or damage to property and/or the environment. They can be characterized in terms of magnitude, timing, duration, location and probability of occurrence. Risk, on the other hand, is the probability that injury to life and/or damage to property and/or the environment will occur. In its simplest form, vulnerability is defined as the degree of susceptibility of a community or environment to a hazard. All natural crisis events do not become disasters, nor do they impact on everyone living in the exposed area equally. The explanation for this differential impact is in their differential vulnerability (UNDRR 2022). In this way, vulnerability is as much a causal factor of disasters as is the hazard. Vulnerability can take many forms, physical and material, social or organizational, attitudinal or motivational. Non-structural vulnerabilities are often assessed through the income and food security, water security or sustainable livelihoods. It is needless to mention that the combination of hazards and vulnerabilities present in any risk scenario is socially generated over time. Stakeholders are individuals and organizations that influence patterns of disaster risk. Stakeholder actions and interactions transform the environment, the economy and society. When stakeholders fail to consider the impact of their actions on hazards and vulnerabilities, these actions may increase disaster risks. Stakeholders often become aware of their own contribution to disaster risk after the experience of an actual disaster. Hazard exposure, risk and vulnerability and stakeholder interaction are key elements for the disaster risk management framework. Risk management can be described as ‘a framework for the systematic application of management policies, procedures and practices to the tasks of identifying, analyzing, evaluating, treating and monitoring risks. It is also viewed as a systematic process that produces a range of measures that contribute to the well-being of the community. Risk management is recognized as an integral part of good practice in disaster management. To be most effective, risk management should be integrated into the organization’s philosophy, practices and [programs] rather than be viewed or practiced as a separate program. When this is achieved, risk management becomes the focus of everyone within an organization. Disaster risk management is an approach that highlights the relationship between unsustainable development practices and disasters. This strategy focuses on the underlying conditions of risk—generated by unsustainable development—which lead to disaster impacts and occurrences (UNO 2022). The objective of disaster risk management is to increase capacity to manage and reduce risks, hence the occurrence and magnitude of disasters. Its implementation requires adequate 'enabling institutional mechanisms'. In the process of response to risk reduction in disaster management at the community level, indigenous knowledge in risk perception, risk, risk mitigation, pre-disaster preparedness and post-disaster rehabilitation and resettlement have been a successful endeavor for achieving environmental sustainability in the wake of a disaster.

1.4.3 Disaster Management Cycle and Indigenous Knowledge

The new approach in disaster management envisages through a disaster cycle (Fig. 1.1) which consists of a series of inter-related stages, including disaster prevention, preparedness, response, rehabilitation, reconstruction and development (Fig. 1.1: Disaster Management Cycle). The key disaster management functions in the pre-disaster period include hazard assessment, vulnerability and risk analysis/assessment, preparedness, mitigation, prediction and warning. During the disaster, the main functions are mobilization, assessment, needs and resource analysis. Rescue and evacuation, emergency assistance, rehabilitation and recovery are the main post-disaster functions. Although the classical cycle shows a linear and sequential relationship between the various phases, in practice, these phases may overlap and do not always follow a sequential pattern (UNDRR 2022). Effective disaster management places primary focus on the pre-disaster period. However, international experience shows that the post-disaster periods of rehabilitation and recovery offer the best windows for introducing sound indigenous mitigation practices in developing country contexts by capitalizing on the extraordinary resource allocations and a high level of political commitment which characterize most post-disaster situations.

1.4.4 From Relief to Development, from Natural Hazards to All Hazards, from Single Agency to All Agencies

The rising pressure of growing population and urbanization, increase use of marginal, low-lying and coastal lands and most recently the widespread impacts of extreme climate events and man-made hazards have forced a drastic re-thinking on the value of investment in prevention, mitigation and preparedness questioning the value of the traditional 'band-aid, biscuits and blankets' approach. The costs of disasters for social and economic development have been rising as developing nations accumulate more assets. Hence, the approaches and methods of disaster management have been steadily changing over the last decade (Walshe and Nunn 2012). In the process, the

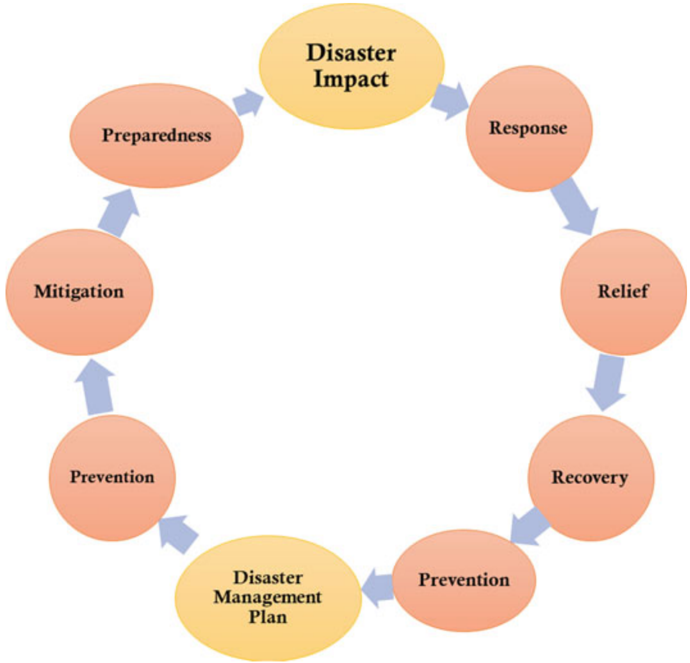

Fig. 1.1 Disaster management cycle

first and most important shift has been a move away from the traditional relief and emergency assistance to an emphasis on preparedness, prevention and mitigation aiming toward development in a multi-stake holder approach.

1.4.5 Development Oriented Emergency Aid

This approach sees victims as active and empowered people and communities with a host of indigenous knowledge-based capacities rather than helpless and dependent victims. It seeks their full participation in planning the emergency assistance using their age-old traditional knowledge. It integrates social/organization and motivational capacities prevailing with the communities in focusing on the long-term goal of reducing vulnerabilities and capacity development rather than meeting only the immediate needs. The use of food/cash for work measures in rehabilitating infrastructure and promoting preventive measures is an example of this approach.

1.4.6 Community Participation in Risk and Vulnerability Reduction Oriented Development

This approach stresses the importance of mainstreaming disaster risk analysis into development planning with an objective of turning disasters into a developmental experience. It is premised on the fundamental questions: How do socio-economic development programs help increase or decrease vulnerability in high-risk areas? Are vulnerability and risk reduction an integral part of the cooperation framework in disaster prone countries? Are the relationships between affected communities and their 'environment' sustainable? This approach is of highest relevance in disaster-prone and donor-dependent countries. Utilization of local knowledge about its environment and resources plays an effective role in implementation of these approaches. A strong community participation and their knowledge sharing area pre-requisite for its effective implementation. The disaster management activities focus on exploring available opportunities of turning disasters in to development initiatives by utilizing local people and their knowledge for its sustainability.

1.4.7 Indigenous Knowledge- and Community-Based Approach in DRR

International Strategy for Disaster Risk Reduction (ISDR), Sendai framework and related recent developments in the field of disaster management have put an emphasis on shifting the national agendas and approaches, natural hazards and technological solutions to a community and family-centered approach focusing on human and social vulnerabilities and promoting community-based solutions and coping mechanisms based on their indigenous knowledge. This approach stresses self-reliance and it favors indigenous knowledge and ways of learning to exogenous knowledge and external aid. It builds on local perceptions, capabilities, coping mechanisms and appropriate locally generated technologies (Weichselgartner and Pigeon 2015). The empowerment of individuals and communities to manage their own environments and the harnessing of local capabilities and resources for risk reduction are key premises of this approach.

1.4.8 DRR with a Focus on the Poorest and Most Vulnerable

Focus on the poorest and most vulnerable section of the community has been the new approach of DRR in the twenty-first century. It aims to integrates vulnerability reduction in disaster affected communities and countries as a primary concern of poverty reduction. It is based on the premises that a disaster reduction strategy in a poor community or country requires a poverty reduction approach focusing on reducing the socio-economic and physical vulnerability of the poorest segments of the society living in the highest risk areas. This premise raises a basic question on: How the conditions of poverty determine vulnerability of a community to hazards and disasters? It is expected that the poor have fewer capital resources, narrower bases for their livelihoods, fewer occupational tools and skills, limited access to social infrastructure, physical strength and health, access to food, water and shelter. Further, the poor are often socially and politically marginalized, having little or no status and influence. Their political life is characterized by limited leadership, marginal or non-existent control over resources and information resulting in their limited interest, authority and ability to change their conditions. The poor are often found in marginal lands and low-income settlements, occupying the highest risk and most vulnerable areas. They have few alternative choices, physically, socially, economically and politically as well. They are victims of their own poverty and paradoxically contribute to their own vulnerability through their survival strategies. Their poverty is in this way the major cause of their vulnerability and a serious obstacle to increased resilience to disaster shocks. Hence, the current approach is to address the issues of poverty as a major cause of their vulnerability and risk. The programs which can bring community resilience, reduce their disaster risk and simultaneously eradicate poverty require their participation, sharing their knowledge and skill to achieve the goals of sustainable development. Thus, indigenous local knowledge has been considered significant in uplifting such communities and bringing resilience in the event of hazards and disasters.

1.4.9 Disasters and Environment

The environment, as witnessed by micro-climatic changes due to global warming and the impact of natural hazards, is both a ‘victim’ of disasters and a causal factor of increased risk and vulnerability. Poor environmental management practices and rapid deforestation destruction of coastal mangroves are increasing the physical vulnerability of the countries and communities to the hazards of the environment degradation. For conserving the environment and promotion of sustainability, community participation and integration of their indigenous knowledge in decision making has been a successful effort in the habitats of the indigenous people residing in the remote areas. The present-day disaster management tends to focus on mitigations which may lead to sustainable development of the environment and the resources as well. Legislation and policy guidelines are established to support good mitigation practices, although international experience in developing countries shows that few countries have the means to enforce in the community. The organization builds on and is coherent with existing administrative and governance arrangements. The new approach emphasizes on an evaluative body, not static or stable one, adapting itself to a changing environment with some degree of flexibility. Active community participation, utilization of indigenous knowledge in assessing the vulnerability and risk, mapping community resources with adequate warning systems, training and awareness programs and institutional capacity development are important priorities for overall capacity building in disaster risk management. Community-based indigenous knowledge very often brings valuable insights into environmental hazards arising out of climate change based on their long-standing experience of living in the same environment. Indigenous societies have their own coping strategies to deal with the extreme events of the nature. In many instances, people have been adopting to the impacts of the climate change. Many of their success stories and best practices have generated faith that indigenous knowledge and coping strategies can support to the community-based adaptation measures.

1.5 Summary and Conclusion

Man has been living with the hazards and disasters since time immemorial. While living with the extremes of the environment in their day-to-day lives, they have accumulated sizeable information and developed certain knowledge and practices to adapt to the variability, fluctuations and extremes of the environment. This knowledge and experience have been their basis for their livelihood and sustenance. This knowledge provides an important insight in the process of perception, response, adaptation and sustenance. Their different facets of understanding and response such as social, economic, environmental and technical have been their basis for their resilience in the event of a disaster. This indigenous knowledge has been a strategic choice in community-based disaster preparedness. Although evolution and use of this knowledge is in infancy, substantial number of documents has been prepared by the scientific community demonstrating its strength and relevance in the context of community resilience. However, with the limitations of the traditional knowledge and its applicability in diverse situations and geographies, the synergy coming out of the amalgamation of both the indigenous and scientific systems seems to be promising in addressing the complexities of adaptation and resilience in the event of disasters.

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Chapter 2
Role of Traditional and Indigenous Knowledge in Disaster Management

Vinita Prasad and Bhawana Nigam

Abstract Human civilization is coping with disasters since time immemorial. In olden days, the disaster management was based on indigenous know-how and traditional prudence and was passed on from one generation to another. In the present era, the magnitude of disasters has magnified and requires proper planning and mitigation strategies. The present techno savvy disaster management and mitigation strategies are more or less universal and somehow fails to incorporate intricate details of probable disaster hit areas and many a times prove to be inadequate in dealing with the situation. Contrary to this, the traditional and primitive disaster management strategies are area-bound and consider every possible detail during the formulation of mitigation strategies. In this context, it will not be inappropriate to revive the traditional methods of disaster management. The blend of modern and traditional indigenous disaster management techniques and mitigation strategies can of great help in coping with disasters. Thus, the objective of this paper is to investigate the relevance of traditional indigenous know-how in the management of disasters such as drought, earthquake, lightening, tsunami, cyclones, etc., and to assess the effectiveness of the collective application of modern and traditional techniques to deal with disasters. The study reveals that the indigenous disaster management technologies are based on age-old observation and wisdom and are milieu specific. It implies that an universal disaster management technique cannot be applicable to everywhere and need be framed keeping in view the local physical and social morphology. The study is be based on in-depth literature review and secondary data.

Keywords Traditional know-how · Prudence · Indigenous techniques · Mitigation strategy

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_2

2.1 Introduction

The disasters are inevitable events, and indigenous communities are dealing with disasters since time immoral. At present, the complex human pursuits, population growth, urbanization and climate change have collectively amplified the frequencies and magnitude of disasters and calls for proper planning and mitigation strategies. Every year, more than 200 million people are affected by droughts, floods, cyclones, earthquakes, wild land fires and other hazards. The World Meteorological Organization reports a fivefold increase in the number of disasters in the past fifty years (WMO 2020).

The indigenous knowledge (IK) refers to a complete body of knowledge, expertise and practices, specific to certain areas, developed through history, experience, experiments and understanding of the environment by native peoples and maintained across generations. It is prudence and wisdom that develops within a particular culture and specific geographical area and has been orally transmitted from one generation to another through art, songs, stories and laws. These indigenous knowledges make people master in the art of perceiving the signs of sea, skies and wildlife and to sense upcoming hazard quite precisely in terms of location, time, duration, frequency and intensity of hazard (Jigyasu 2016).

Indigenous knowledges are traditional art and science, skills and practices, based on of observation and in-depth understanding of the local environ that has been developed outside the formal educational system (FAO 2017). The people keep passing them from one generation to another verbally as folk lore or in the form of rituals and enlightened people regarding their physical and social assets, strengths and limitations so that they can use their resources accordingly. These community-based indigenous knowledge is ingrained in their very life style and enabled indigenous people to successfully respond to ecological challenges. These human practices, evolved over centuries, are time-tested and proven to be sustainable and effective in both reducing disasters and managing unavoidable hazards (Policy Note 2008) and aim at risk avoidance, minimization and retention.

The planners and stakeholders need to understand that community-led, location-specific disaster preparedness is more effective, than the top-down modernist approaches to disaster mitigation, and hence, there is a strong need to recognize the potential of community knowledge and actions and of switching to a bottom-up approach that uses appropriate community practice as the base for policy formulation (Policy Note 2008).

The present technology-oriented disaster management and mitigation strategies calls for large investments of government and aid funds and creates ample opportunity for corrupt siphoning of funds away from those who need it most, often toward generating market opportunities for corporate actors what Klein (2007) names ‘disaster capitalism’. At the same time, the present disaster management and mitigation strategies somehow fails to incorporate intricate details of probable disaster hit areas and many a times prove to be inadequate in dealing with the situation, and hence, it is important to incorporate traditional technologies to make disaster management strategies all the more viable.

The indigenous knowledge is usually maintained by the local rural communities, through their extended interaction with their environment (Boven et al. 2002). The use of such knowledge is especially relevant to ignorant, illiterate and under privileged rural communities who are unable to access disaster-related information. The decisions related to disaster risk reduction, based on indigenous knowledge, can help rural folk to prepare and cope with catastrophic events. There is need to evolve specific framework, identifying how indigenous and western knowledge may be combined to mitigate the intrinsic effects of environmental processes and therefore reduce the vulnerability of rural indigenous communities to environmental hazards and disasters (Mercer et al. 2009).

The indigenous disaster management practices evolve around the interaction between humans and environment, whereas in most of the countries, the disaster-related policy is bureaucratic and is often associated with relief measures, overlooking the mitigation and risk reduction dimension of the disasters. The recent initiatives for development of national and local disaster management plans in many countries in the region have recognized this limitation, but have so far, been able to address it in very limited ways (Policy Note 2008).

The indigenous knowledge being location and culture specific is difficult to disseminate, and unfortunately, the valuable indigenous disaster mitigation and management techniques are not able to come in the forefront and left beyond the reach of research fraternity. In this context, it is worth mentioning that for the first time in June 1992, at the United Nations Conference on Environment and Development, in Rio de Janeiro, Brazil, the indigenous knowledge related the environment was internationally recognized. After that, in January 2005, at the World Conference on Disaster Reduction, Hyogo, Japan, under the umbrella of United Nations, the international community adopted a 10-year plan to make the world safer from disasters (Olowu 2010). The Hyogo Framework for Action recognized the importance and relevance of local and indigenous knowledge for disaster reduction and emphasis on the diffusion and application of such indigenous knowledge and cultural heritage.

The present disaster management and mitigation techniques and strategies often fail to identify minute and subdued details of the disaster-prone areas and prove to be inadequate in dealing with the situation, whereas the traditional and primitive disaster management strategies are location specific which take into account every possible detail in the course of formulation of mitigation strategies and are found to be quite effective in dealing with the situation. It is cost-effective and sustainable too and, in the paucity of adequate fund in the developing countries, makes such indigenous know-how a viable option to mitigate the impact of disasters.

The studies indicate that the developing countries are more vulnerable to disasters, and between a period of 1991 to 2005, about 90% of the deaths caused by disasters and 98% of people affected by disasters belong to developing countries (EMDAT). That is why majority of the literature on human response and adaptation to natural hazards and disasters has advanced further in the developing world than in developed countries (Dekens 2007a, b:3). The Asia–Pacific region is the epicenter of the world's worst hazards such as frequent earthquakes, volcanic eruptions, cyclones, flood and drought is particularly rich in such bodies of knowledge (Policy Note 2008).

It is the indigenous knowledge carried orally from one generation to other which made the Simeulueans (living off the coast of Sumatra, Indonesia) and the Moken (living in the Surin Islands off the coast of Thailand and Myanmar) survive the devastating tsunami (UNISDR 2008). Likewise, application and use of traditional knowledge in environmental conservation and natural disaster management is still prevalent and is being harnessed in Kenya (Kamara 2005). The global scientific community too has acknowledged and endorsed the relevance of indigenous knowledge at the World Conference on Science in Budapest, Hungary, in 1999 and recommended that scientific and traditional knowledge should be integrated, particularly in the field of environmental development (Mwaura 2008). However, the representatives of indigenous people's organizations attending the World Conference on Science are raising concerns that the draft of the final conference declaration takes insufficient account of the contribution of traditional knowledge systems to modern science (Masood 1999).

De Guchteneire et al. (2004) feared that indigenous knowledge has the risk of being extinct because of the lack of documentation and its mode of oral diffusion. The indigenous knowledge, therefore, needs to be recorded, protected and utilized in ways that will benefit both owners and communities. In this regard, the disaster reduction hyper-base initiative has elaborated the concept of transferable indigenous knowledge and indicated that though the time-tested indigenous knowledge is location specific, but have tremendous potential to be applied in other regions (drh.edm.bosai.go.jp/).

In this scenario, it is imperative to evolve strategies to mainstream the indigenous knowledge and revive the traditional methods of disaster management. The utilization of the traditional knowledge of the local communities and the advances scientific knowledge collectively can go a long run in dealing with the disasters.

2.2 Aims and Objective

The objective of the chapter is to explore relevance and applicability of the of the indigenous knowledge in forecasting, mitigation and management of the various disasters and to assess the effectiveness of the collective application of modern and traditional techniques to deal with disasters. The dissemination of traditional disaster management techniques can prove to be highly relevant to the planners and researchers.

2.3 Research Design

This chapter is an outcome of a qualitative research. It is descriptive in nature and is based on in-depth literature review. Relevant information and materials were collected from various sources incorporating books, journals, records, conference proceedings, reports, newspaper articles and web-based sources. Hence, this paper is entirely dependent on secondary published information and facts. Here, the indigenous techniques to deal with disasters in various parts of the world have been explored and discussed and need of radical paradigmatic shifts in disaster management has been observed.

2.3.1 Indigenous Technology and Flood Prediction, Mitigation and Management

Flooding is one of the major global challenges today. The nature of floods and the consequences of anthropogenic activities have made flooding an inherent environmental problem that is subject to control rather than eradication (Eni et al. 2011). The role of indigenous knowledge in offering an effective risk reduction strategy toward flood disaster disregarded for many decades is now gaining global recognition, and there is a growing call for empirical identification of the effectiveness of indigenous knowledge in flood risk reduction. The people living in flood-prone regions have inculcated numerous coping techniques for their survival, since ancient time.

The people inhabiting the catchment of the Subarnarekha River in Jharkhand, India, were able to perceive flood through farming calendars, cropping sequences, traditional proverbs, customs and environmental cues such as abrupt swell in mosquito and gnat populations, ants moving away from riverbanks and climbing up trees and buildings, the constant howling of wood cats and the flying of bats in large groups were indication of the impending flood to the local population (Schware 1984:61).

The tribal communities in the state of Tripura in India associate flood with the wilting of the petals of the flower Cassia Tora L., and the sudden growth of ferns and moss near ditches and rivers and wasps building nests on higher ground (Acharya 2011), as all these events are consequences of rise in underground water table.

It is often observed that the terms related to disaster are ingrained in the local lexicon (Santha et al. 2014) and reflect community's sensitivity regarding disasters. In Kerala, India, the fishermen uses the term 'kolu' (ibid.) which incorporates all sort of costal hazards.

The indigenous groups in the Chittagong Hill Tracts (CHT) of Bangladesh resonate with natural signs of flooding, which can be categorized as under, 'hydro-meteorological' and 'biological' indications (Irfanullah and Motaleb 2011). The very strong winds for 3–4 days are the hydro-meteorological indicator of flood and the unexpected arrival of wild boar and cock in the village from upstream areas as symbolic of a looming flash flood and falls under biological indicators (ibid.). The croaking of a yellow-bellied frog is a common indicator of heavy rain (ibid.) and considered as a reminder to initiate flood mitigation preparation. The communities often device local nomenclature to denote disasters. The floodplains of Jamuna

River in Bangladesh use local terms like barsha' and 'bonna" to designate sudden unpredicted flooding (Paul and Routray 2010).

Constant vigilance and monitoring of water level (ibid.), kept in turns and rafts made of local material available such as banana trunks, empty barrels (ibid.), are kept ready by individual families. The sandbags, cement bags and bricks (ibid.) are also kept to guard against the spread of floodwater. A 'khuta' (long piece of wood) or a 'laga' (long bamboo pole) is used to monitor level of river water in Bangladesh.

This apart the communities in the flood-prone parts of Bangladesh also undertakes various measures related to disaster risk resilience such as construction of high rising stilt houses, low-cost cluster housing, adoption of flood-proof sanitation methods and installation of elevated hand pumps for clean drinking water (ibid.) (Fig. 2.1).

The Deken's (2007a) study on floods and flash floods in eastern Terai of Nepal has identified three categories of indicators such as visual or change in composition of river water and floating of vegetables ruminants, snakes and animals carcasses; auditory or the gushing sound of water and olfactory or change in the smell of water. He has also acknowledged the role of proverbs, poems and songs in ensuring the intergenerational transmission of knowledge regarding flood from one generation to another (Deken's 2007b).

A few communities also developed floating gardens and nurseries, fisheries in floodwater. Community-based organizations (ibid.) help each other in time of crisis such as search and rescue activities and providing treatment to injured and sick. Similarly, along the Mekong River, for example, people use of ephemeral infrastructure (Gibson et al. 2018), and in Cambodia, a 1.5 km bamboo bridge has been built and

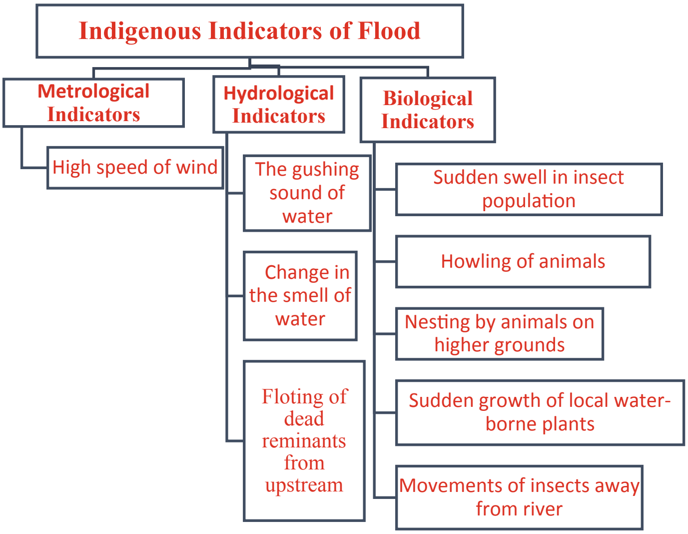

Fig. 2.1 Biological, hydrological and metrological indicators of flooding, identified by indigenous communities across the world

dismantled with the fall and rise of the Mekong waters for decades (Gibson-Graham et al. 2016) to survive the flood.

The experiences of the members of Singas village, situated in Morobe Province, Papua New Guinea (PNG), along the banks of the Markham River is prone to yearly flooding and applies indigenous knowledge in five specific areas, namely building methods, social linkages, land use planning, food strategies and environmental strategies, and has proven to help contribute to the community's ability to mitigate the impact of regular flooding events (Mercer 2007). They use earthen pots to preserve food, use banana, use bamboo to cook and store water (ibid.). Traditional food in the area is also used in times of shortage; e.g., yam and taro are grown on the mountainside as disaster crops in case the villagers have to temporarily seek shelter in the hills (ibid.).

The heavy flooding in the Dagupan City of Pangasinan province in northwestern Philippines, in 2007, revived the use of kanungkong is a bamboo instrument producing sound and was traditionally used to call community members to assemble at the village hall for meetings is being used as early warning system and it is successfully allowed the entire community to prepare and respond to the disaster with sufficient time (Victoria 2007).

However, it needs to be kept in mind that floods are natural phenomena and revive the fertility of soil and have become disasters due to expansion of habituated areas in low-lying flood basin, which need to be checked. Many rural communities consider floods a sign of prosperity and fortune as they renew fertility of the alluvial soil.

2.3.2 Indigenous Technology and Cyclone Prediction, Mitigation and Management

A cyclone, typhoon or hurricanes all are formed due to wind circulation around an intense low-pressure area. The cyclones are meteorological hazards, causing heavy and prolonged rains, seawater inundation and coastal flooding. The cyclones are often devastating and lead to loss of life and property, salination of agricultural fields, erosion of beaches and embankments, contamination of drinking water and destruction of vegetation. The high-speed wind during cyclone uproots trees and electrical poles disrupting electrical supply, damages infrastructure and buildings and many a times proofs to be fatal.

The indigenous people largely observe the behavior and movements of animals to perceive the arrival of cyclone and use these biological indicators to predict the same. These biological indicators include the movement of ants, fishes, crabs, Heron flocks, collective barking of dogs, crowing of crows at night, etc. This apart the indigenous people also depend on meteorological signals like speed and direction of wind and the size of waves to predict the arrival of cyclone.

Once the native communities residing along coast perceive the arrival of cyclone, they start preparing themselves to face the cyclone. They try to protect their hutments by tying roof of the house with nearby big trees and by replacing poles of stilt houses. In the cyclone-prone area, the native people also take long-term initiatives, such as plantation of mangrove shelter bed along the coast. In Bangladesh, during cyclones people often stay at machans i.e., a elevated structure made of bamboo, some climb nearby strong trees to cope the severity of cyclone, this apart in the case of collapse of house the family members float on surge waters having plastic containers tied around the members of the family together beforehand (Khalil 2022). Likewise, in Vietnam, indigenous people plant trees along the coast which acts as wind and waves brakers protecting them from the devastating tropical storms (Magni 2017) (Fig. 2.2).

The maritime communities living in the typhoon-prone area in Philippines have devised distinctive building designs and ways of food preservation and storage to survive frequent typhoons (Uy et al. 2008). The Ivatans, in the Philippines, despite its natural limitations has successfully mastered the art of protecting them from the ravages of the seasonal typhoons through the use of indigenous knowledge. The Ivatans have inculcated the art of adaptation to the harsh and shifting weather conditions and is well reflected in their traditional houses built of stone, mud and cogon grass capable of withstand typhoons, and 'paluwas' their sturdier boats, the main mode of transportation between the islands (ibid.). They have unique agricultural practices and hedged their fields with trees which act as a windbreaker and allow root crops to grow. The Ivatan's have a well-knitted social gambit, based on mutual co-operation and self-help strengthening community ties (ibid.), and are a brilliant example of harmonious relationship of people with their environment (Datar 2002).

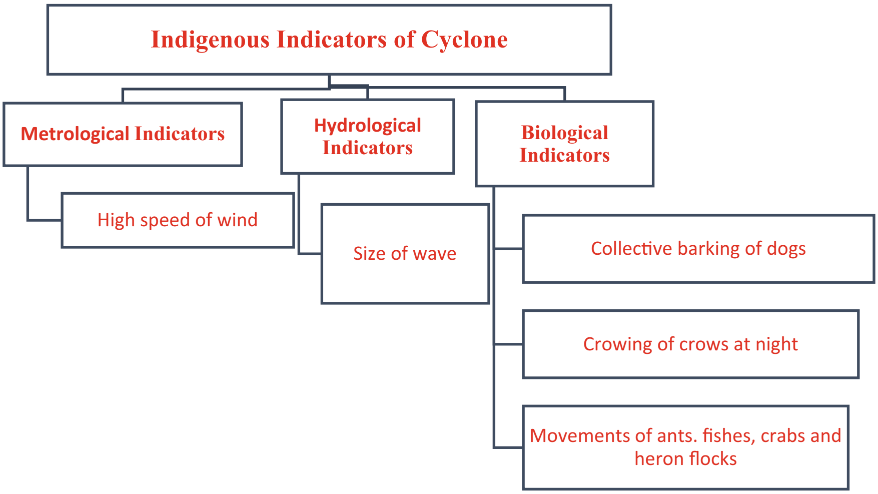

Fig. 2.2 Biological, hydrological and metrological indicators of cyclone, identified by indigenous communities across the world

2.3.3 Indigenous Technology and Drought Prediction, Mitigation and Management

The indigenous know-how can be used to evolve novel solutions to the fight natural disasters. Indigenous peoples often grow native species of crops that are better adapted to local contexts and are often more resistant to drought, altitude, flooding or other extreme conditions (FAO 2017). There is a gap in understanding and recognizing the value of indigenous knowledge in reducing vulnerability of rural communities to impacts of hazards such as drought. Local people who are most vulnerable to these impacts are left out of the research in many studies. It has been proved by many recent studies that local or indigenous knowledge holds valid, meaningful and relevant answers for coping with current and future droughts. Studies capturing local indigenous knowledge of the impacts, experiences, coping and adaptation strategies (or risk management strategies) of past and current droughts in South Africa are lacking, although indigenous people such as the Khoisan have been living and coping with extreme environmental conditions such as drought for a long time.

The farmers perceive a wide ranging of drought indicators, such as the wind direction, and changes in temperature behavior of certain animals and plants meant that drought was approaching. The farmers had devised various methods of conserving moisture such as using bottles to moisten the soil slowly, mulching and shade netting, methods of conserving water through rainwater harvesting from mountain slopes, construction of stock dams for water storage and use of windmill pumped boreholes, building silt traps/sluits to prevent dam siltation and the construction of contours across slopes to conserve soil which were other long-term strategies.

The Maasai pastoral community in Tanzania practices the 'Ronjo system' an indigenous method of dividing the village into pasture zones to conserve pasturelands and prevent drought-borne disasters, practice mixed cropping, the use of animal manure to conserving moisture and fertility of the soil.

The traditional system of irrigation Karze is an impressive hydraulic engineering project and a traditional way of water harvesting and irrigation water system which is able to use underground water more efficiently. This type of irrigation in used in Turpan and Hami prefectures in Xinjiang area in north-western arid part of China for over 2000 years (Sun et al. 2009) (Fig. 2.3).

These water systems have also been used in countries in North Africa and West Asia, as well as other Asian countries, including Afghanistan, Iran and Pakistan (Adeel 2009). It is constructed with minimal tools, on the principles of gravity neither requires energy nor equipment to lift the water, it is perineal and fed by underground water source and provides good quality water (Weihua et al. 2007). However, karez systems have faced great challenges over the past several decades and gradually getting extinct; however, the UN and concerned government are working on its revitalization (www.mei.edu).

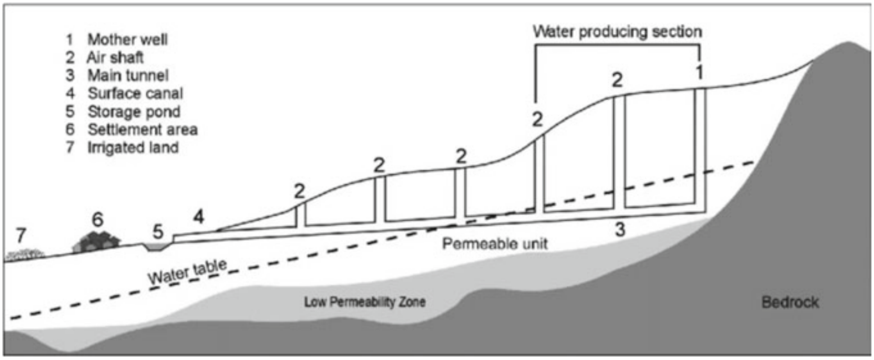

Fig. 2.3 Karze irrigation system of China. *Source* Todd (1980)

2.3.4 Indigenous Technology and Earthquake Prediction, Mitigation and Management

Indigenous earthquake-resistant housing technologies have been developed in different parts of the world to enable the people to safely withstand earthquakes. These technologies also address other crucial factors such as availability of local construction materials, functionality of the building designs and safety of the occupants from weather extremes. Unfortunately, these technologies are becoming increasingly unpopular due to large-scale induction of modern construction materials and technologies (Sinha et al. 2004) (Fig. 2.4).

It is seen that the essential elements of all the technologies can be categorized into four classes:

Fig. 2.4 Taq house at Jammu and Kashmir. *Source* herald.dawn.com

(1) Ductile construction materials, (2) Robust architectural forms, (3) Resilient structural configurations and (4) Reduction of seismic forces. Most earthquake-resistant construction technologies include multiple elements to provide the required resistance (ibid.); Kashmir in India lying in the seismic zones IV and V is highly vulnerable to earthquake, and the people of this area has developed indigenous construction practices for earthquake safe housing. The traditional construction systems known as Taq and Dhajji-dewari are based on quake-resistant techniques (Islam and Shah 2018) of construction. The Taq system is about 3000 years old. It incorporates load-bearing masonry walls with horizontal timbers embedded in them. The Dhajji-Dewari is about 200 years old technique of earthquake proof construction and appear as patchwork done using different types of patterns, and it is also referred to as brick nogged timber frame construction. In the year 2005, Kashmir experienced an earthquake of a 7.6 magnitude, making millions of buildings to tremble down but the Dhajji-Dewari building survives the earthquake and remained in tacked (www.thehimalayanarchitect.com) (Fig. 2.5).

Unfortunately, this architecture is rapidly being displaced by non-indigenous reinforced concrete buildings which are highly sensitive to earthquake jolt. However, the United Nations Educational, Scientific and Cultural Organization collaboration with India have advocated for the preservation of vernacular buildings in 2006. The 2005 Kashmir earthquake clearly demonstrated the superiority of traditional houses built of wood and other local material over the concrete buildings; hence, it is imperative to preserve and revive this traditional architecture.

Indigenous Technology and Tsunami Prediction, Mitigation and Management:

The indigenous knowledge is an effective tsunami mitigation tool when the right combination of education and physiography come together. Locations with broad coastal plains would have a hard time evacuating the coast, especially if population densities are high as is the case with Banda Aceh, Indonesia, during the 2004 Indian Ocean tsunami. Nonetheless, a barrier reef, wide lagoon and stand of mangroves were not enough to protect the residents of New Manra since they had no knowledge of tsunamis in this region.

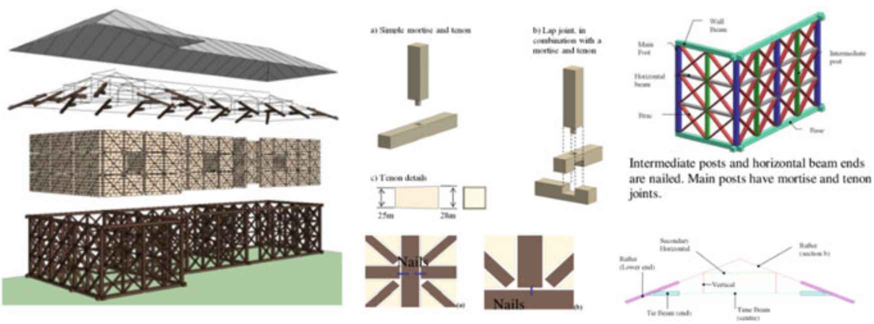

Fig. 2.5 Dhajji-Dewari house structure (Jammu and Kashmir). *Source* Hicyilmaz et al. 'Seismic Performance of Dhajji Dewari'

In indigenous villages on hard-hit Ghizo Island, they apply indigenous knowledge to mitigate the effects of the tsunami and they corelate emptying of lagoons post-earthquake as warning of tsunami and get alert and take shelter at higher places. Besides, the steep coral reef and shallow and wide lagoon at the Island coast, ebbs out the tsunami's energy reducing the intensity of tsunami and helping people to (McAdoo et al. 2007).

2.3.5 Indigenous Technology and Volcanic Eruption Prediction, Mitigation and Management

The communities living close to live volcanic mountains are found to be capable of perceiving signs of volcanic eruptions and can predict the same. The Barangay Matanag, Legazpi City, Albay, in Philippines located close to Mayon volcanoes is the example of indigenous prudence inculcated over generations. The villagers use indigenous knowledge to identify warning signs indicating volcanic eruptions and move to safer place and reduce the risk. The warning signs include drying up of rivers and creeks, the frequency and intensity of fiery sparks and the low rumbling sounds coming out of the Mayon from volcano which, local farmers can easily perceive, the sight of winds carrying ashes and the bionic senses of make animals race recklessly away from Mayon sensing the heat coming out of the volcanoes. (Cerdena 2007) and is perceived as alarm to evacuate and go to safer places.

2.3.6 Discussion and Conclusion

These indigenous coping mechanisms required to be recognized and adopted, to enable people in disaster-prone areas, to prepare themselves to mitigate the impact of disaster and make them learn to recover from environmental hazards (Mercer et al. 2007). In fact populations directly affected by environmental hazards should be the ones to decide and develop policies to deal with the same (Wisner et al. 2004).

The story-telling tradition of transforming traditional prudence of disaster risk reduction from one generation to another has been lost. Likewise, the communities traditional legends and songs meant to diffuse indigenous mitigation strategy too have lost. The present modern techniques of communication encompass broader area marginalizing the local information system. There is a need to have holistic approach toward protecting communities from disasters. The traditional houses were used to be constructed utilizing local available material and were built keeping in mind the physiography, climate and potential hazard and thus, were less vulnerable to disaster risk. Unfortunately, the construction of concrete houses had greatly eroded the art and science of construction of traditional houses, designed as per local milieu using local materials. Therefore, in order to preserve and propagate this precious knowledge, the local communities need to make aware of such information and techniques. It will empower local communities to deal with disasters at their own.

It is important to understand the significance of indigenous knowledge and their diffusion among concerned stakeholders. Moreover, the community's involvement is a key to utilization of indigenous knowledge, whereas modern disaster management technology erodes community's capability to deal with disasters and make them dependent on external forces. The systemic documentation of traditional knowledge and blend of modern technology and traditional prudence will make disaster-related traditional knowledge more viable.

The local communities are the most vulnerable to disasters, but do not have any saying in the formulation of disaster risk reduction strategies. The disaster management strategies are usually framed by planners and scientists sitting in entirely different physio-climatic area having negligible idea regarding local intricacies and requirement, and consequently such policies are of little use making people reeling under impact of disasters. Therefore, it is very important to involve local people and communities in the policy formation and execution to mitigate the impact of disasters.

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Chapter 3
Conception and Perception of Indigenous People on Merapi Volcano Eruption: Knowledge, Philosophy, and Indigenous Education on Disaster Risk Reduction in Indonesia

Hastangka and Suprapto

Abstract This study will discuss the conception and perception of the indigenous people living around Merapi Volcano. Merapi Volcano in Yogyakarta, Indonesia, is one of the most active volcanoes with a high potential for eruptions that likely affect people living around it. It is mentioned that it has erupted more than 80 times. The eruptions that took place in 2006 and 2010 were very devastating as they took the lives of many people. This study will dig into the philosophy, knowledge, and the way the indigenous people educate themselves on the disaster risk reduction (DRR) of any potential threat from the Merapi Volcano. This study describes the local wisdom about Merapi and the people's philosophy in understanding Merapi as a potential threat that can affect their lives. The issue seen in this study is the perception of the Indigenous people on understanding natural disasters in general and any natural condition that potentially cause both material and immaterial loss. The method used in this study is the phenomenological approach. This study will explore any insights that are related to the conception and perception of the local community (indigenous people) in addressing the disaster risk reduction issues of potential threats caused by the Merapi Volcano eruption. The results expected from this study are the documentation and the preservation of indigenous knowledge.

Keywords Disaster · Education · Indigenous knowledge · Merapi · Yogyakarta

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_3

3.1 Introduction

Disaster is a phenomenon that can occur around human life. Disasters can occur in various forms such as natural disasters, social disasters, and humanitarian disasters. Conceptions and perceptions of disaster in various perspectives are quite diverse. Disaster in the perspective of philosophy is seen as an objective and subjective reality of human life. Disasters have a transcendental dimension, so disasters are considered as existence and shared consciousness in human life. In every disaster event such as floods, landslides, volcanic eruptions, hurricanes, tsunamis, famines, droughts, and wars sometimes humans are unable to accept the reality of disasters (Nugroho 2018a, b). Natural disasters such as landslides and floods in a philosophical perspective are understood as the impact of arbitrary human behavior on nature, the development of science and technology has brought the conception and perception of nature to be different. Humans overexploit nature. Nature in the perspective of perennial philosophy is a sacred and sacred being. Nature is not an inanimate object and can be exploited freely. Nature and humans have a close relationship (Abdillah 2021). The condition of the earth as a place to live for humans or living creatures created by God has changed from year to year. This change in earth conditions occurs due to two factors, namely natural factors and human intervention factors. Natural factors are processes and events that occur because the earth interacts with substances or elements and the energy that makes up the earth, so that the earth undergoes natural changes such as earthquakes, volcanic eruptions, celestial bodies falling from space, and tsunamis. This phenomenon is seen as a natural disaster (Baifeto 2021).

Disaster in the perspective of religion or spirituality is seen as an effort to awaken people from the mistakes they have made, become better, and remind them of the greatness of God, and to always fear God. Disasters in a religious perspective are seen as warnings and calamities given by God to humans because of human attitudes and behavior that are not as expected (Husna 2019). Disasters do not know the geographical location, status of people, cultural, social, and economic background of a person, but it is necessary to know that the human response to a natural phenomenon will of course affect a culture that prevails in the place where the individual or group carries out their life. The community regarding disasters will of course be very diverse because this is closely related to their personal relationship as humans with nature which then leads to the response of each individual or group in overcoming the disaster (Utami 2019). This can be interpreted that an individual or group that inhabits a certain area has a different view or perspective regarding the response and meaning to a disaster, this is because the individual or group produces various experiences, values, and social attitudes which then grow and be learned as a culture in the region and is considered as a guide and applied from generation to generation.

People on the island of Java of course have different views and responses from the people on the island of Sumatra in interpreting a natural disaster phenomenon, in this case each community group of course has their own culture, beliefs, and differences in interpreting something that is judged from a cultural point of view. One of the disasters that often hit Indonesia and is a disaster whose management is very important is volcanic eruptions, there are 127 active volcanoes located in Indonesia (Wardyaningrum 2014). Indonesian local people of course have different views and cultural responses regarding volcanic eruptions and efforts to overcome the eruption of volcanoes, there are three volcanic eruptions that have occurred in Indonesia, namely the eruption of Mount Kelud in East Java, the eruption of Mount Kelud Agung, and the eruption of Mount Merapi which occurred in the Yogyakarta area. Local communities in the area around the volcano have different views in interpreting the disaster of a volcanic eruption and have their own cultural efforts in responding to the disaster. The traditional community in the village of Sugih Waras which is close to Mount Kelud has a the belief that the phenomenon of the eruption of Mount Kelud is a form of anger at Mount Kelud because *sesaji* presented by the caretaker in the implementation of the Larung offerings in 2007 were not in accordance with the established customary rules (Sulistyowati 2018). This is different from the views of the people in Karangasem Regency in interpreting the eruption of Mount Agung in Bali, the community interprets the eruption of Mount Agung as a form of blessing given by the Gods and considers the eruption of Mount Agung as a form of reminder to mankind to be closer to God (Ni Made Sintya Noviana Utama 2018).

The meaning of a catastrophic volcanic eruption that is believed by the Balinese and the people of Sugih Waras village is also different from the meaning of a catastrophic volcanic eruption which is believed by the people of Sempal Makmur village to the eruption of Mount Merapi. The people of Sempal Makmur village believe that the eruption of Mount Merapi is a sign of marriage between Kyai Sapu Jagad and Nyi Roro Kidul, the people of Sempal Makmur village believe that the eruption of Mount Merapi is considered as a momentum for Kyai Sapu Jagad and Nyi Roro Kidul to looking for human victims and becoming soldiers in their kingdom (Suaka 2020). Through the explanation of the three catastrophic events of volcanic eruptions in Indonesia and the meanings believed by every local community, it shows that humans are aware that there is a reciprocal relationship between human behavior and nature, and traditional communities believe that a natural disaster phenomenon is a consequence of human behavior toward nature. Natural disaster phenomena which are interpreted by the community from a cultural point of view are of course closely related to management efforts in overcoming natural disaster phenomena from a cultural point of view as well, in this case the community uses their minds and values that are firmly held to act or behave toward an event what happened (Sulistyowati 2018).

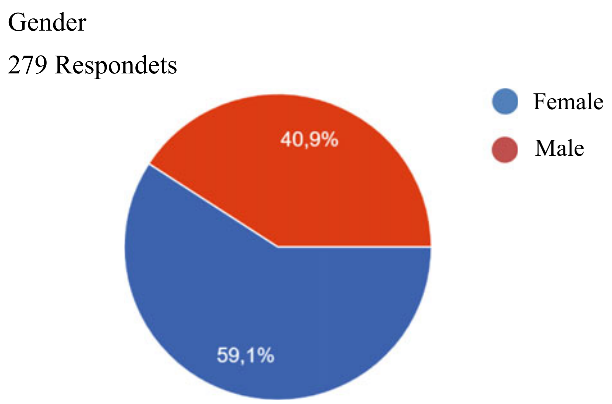
One of the community's responses in dealing with various natural disaster phenomena that occur is to always be guided by values, attitudes, and traditional views that are formed through the experience of a group toward an event that occurs in an area. Local wisdom becomes a guideline for traditional communities in overcoming various life problems that occur, without exception the problem of a natural disaster phenomenon. It is believed that local wisdom is realized through various life events of a community group, which have wisdom values and are believed to be able to guide a community group in continuing their life (Prasojo 2015). Local wisdom is a response as well as cultural guidelines for traditional communities in overcoming the threat of natural disasters, in this case local wisdom can be a form of disaster mitigation efforts from a cultural point of view. The discussion of disaster mitigation efforts with local wisdom that applies to community groups in an area is an interesting conversation, but it should be noted that the traditional view of a community group in an area in Indonesia regarding a natural disaster phenomenon and efforts to overcome the disaster are seen from the perspective of cultural point of view can be the rules and guidelines for humans in maintaining harmony with nature.

3.2 Materials and Methods

This paper uses a mixed methods approach by conducting a literature review and survey of 279 respondents. Secondary data was obtained through literature review from journals, books, and published scientific reports related to this research theme. Primary data was obtained through a survey of respondents conducted in October–November 2022. The location of this study was conducted in Yogyakarta. The analytical method used is content analysis and interpretation.

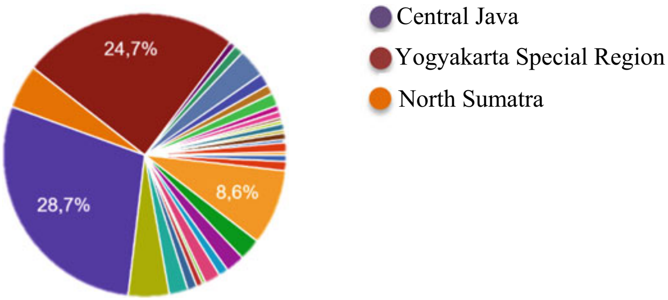
3.3 Results and Discussion

Based on the results of a survey conducted on November 8–10, 2022, there were 279 respondents who were respondents who had various cultural, age, and occupational backgrounds. Respondents who filled out this survey were Indonesian people from 31 provinces in Indonesia, with an age range of 17–55 years. The results of this survey are expected to be able to support the statements presented in this paper and are expected to be able to provide a study of new knowledge about natural disasters and their mitigation efforts from a cultural perspective.



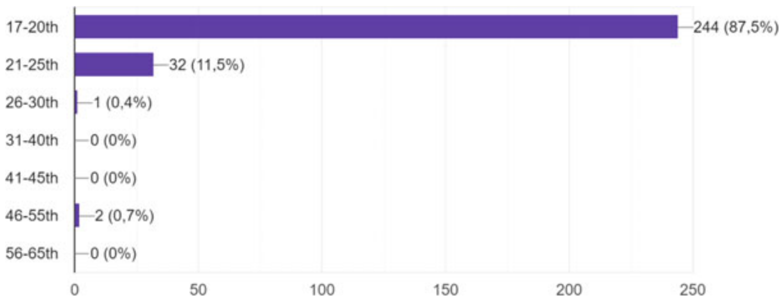
The amount of respondents consisted of 165 female (59.1%) with 114 male respondents (40.9%). Furthermore, the survey data will present the origin of the area that filled out this survey.

Origin of Area
279 Respondents



Based on the survey results presented in the data, it can be seen that quite a lot of respondents who answered came from the province of Central Java (28.7%), Yogyakarta Special Region (24.7%), and respondents from the North Sumatra region (8.6%), in addition to presenting the gender and background of the respondent's area of origin, this survey also presents the age range of respondents starting from 17 years old up to the maximum age limit of 55 years. Based on the survey results, it can be seen that the age range of respondents who filled out this survey was 17–20 years of 87.5%, 21–25 years of 11.5%, 26–30 years of 0.4%, and 46–55 years as much as 0.7%.

Age
279 Respondents

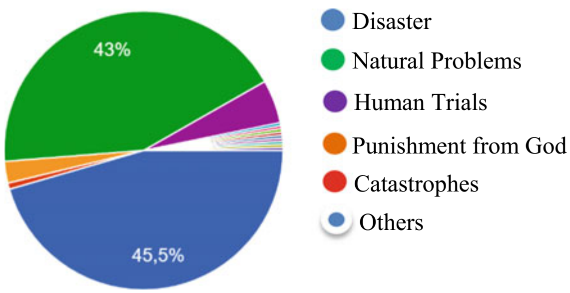


The types of work included in the contents of the survey were students, private sector, civil servants, housewives, and other jobs, but based on the survey results it was noted that of the 276 respondents who filled out the survey, 273 answers indicated that the respondents who filled out the survey had jobs as students and 3 respondents have a job as a private sector. This shows that the number of respondents who filled out this survey was a college student with a maximum age range of 17–20 years. The next diagram will explain the results of the respondents' answers in answering the contents of the questions from the survey conducted. The following are the questions presented in this survey.

1. "What do you mean by natural disasters?"

In this question the respondents were given choices namely "*Disaster*", "*natural problem*", "*human trial*", "*punishment from God*", and the answer "*other*". In other options, respondents were given the opportunity to answer the meaning of the disaster based on personal opinion, the results of the survey showed that 125 respondents chose to interpret disaster as "*disaster*" (45.5%), 119 respondents chose to interpret disaster as "*natural problems*" (43%), 14 respondents chose to interpret disasters as "*human trials*" (5%), 7 respondents chose to interpret natural disasters as "*a punishment from God*" (2.5%), 2 respondents chose to interpret disasters as "*catastrophes*" (0, 7%), and 9 respondents chose other answers by explaining each reason (3.3%).

1. What do you mean by natural disasters
   279 Respondents

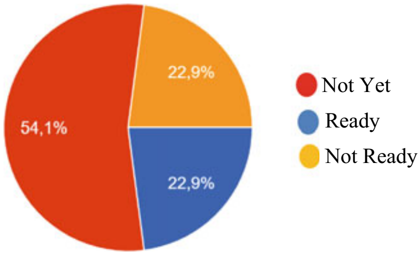


This question aims to find out the meaning of natural disasters according to the personal opinion or perspective of the respondents, and the majority of respondents who filled out this survey interpreted natural disasters as a disaster, and only a few respondents chose natural disasters as a form of punishment from God. The respondents who chose other answers expressed personal opinions or perspectives, one of which explained that natural disasters are part of the earth's cycle (1 respondent).

2. "Are you prepared for the Catastrophe?"

In this survey question, there are 3 answer choices that respondents can choose, namely "*Ready*", "*Not yet*", and "*Not Ready*". Based on the survey results, there were 149 respondents who chose "*not yet*" to face disasters (54.1%), 64 respondents chose "ready" in facing disasters (22.9%), and 63 respondents chose "*not ready*" in facing disasters (22.9%).

2. Are you prepared for the Catastrophe?
279 Respondents

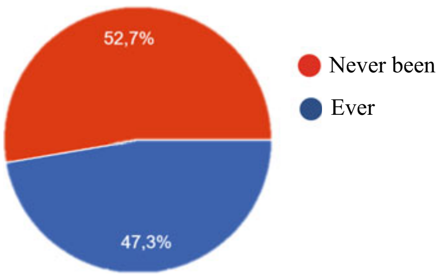


This question shows that most of the respondents who filled out this survey were not ready to face the phenomenon of natural disasters, and respondents who said they were ready to face natural disasters had the same results as respondents who said they were not ready to face natural disasters.

3. "Have you ever received training or carried out disaster mitigation actions?"

In this question, there are two options that respondents can choose, namely "*Ever*" and "*never been*", as many as 146 respondents answered "*never been*" received training or carried out disaster mitigation measures (52.7%) and as many as 130 other respondents answered "*ever*" received training or carried out disaster mitigation measures (47.3%).

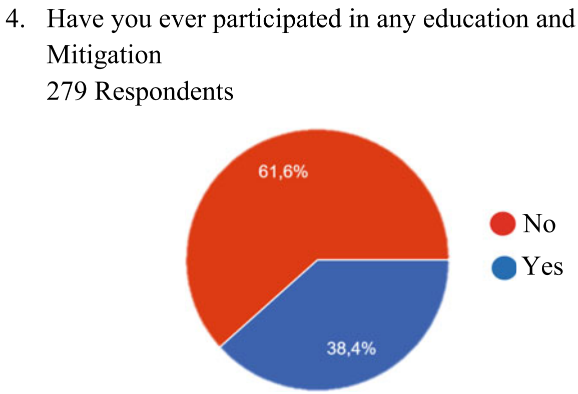
3. Have you ever received training or carried out disaster mitigation actions?
279 Respondents



This question shows the results that of the 279 respondents who answered this survey, as many as 52.7% of the respondents who filled in had never received training or carried out disaster mitigation measures. The results of this survey can also support the question "*Are you prepared for natural disasters*?" can be the one of the factors that caused most of the respondents in this survey to state that they were not ready to face disasters because most respondents had never received training or taken action in disaster mitigation.

4. “Have you ever participated in any education and training regarding disaster mitigation?”

In this question, there are two answer choices that can be chosen by respondents, namely “*No*” and “*Yes*”. Based on the survey results, it was noted that 172 respondents answered “*No*” that they had attended education or training on disaster mitigation (61.6%) and another 107 respondents stated that they had attended education and training on disaster mitigation (38.4%).

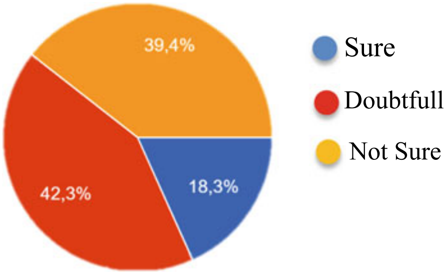


The results of this question show that 61.6% of the respondents who filled out this survey had no training or education regarding disaster mitigation. The results of this survey question can also be a result that supports the survey question regarding the readiness of respondents in dealing with disasters as well as supporting the survey results in the question section “*Have you ever received training or carried out disaster mitigation actions*?”

5. “Are you sure the local people are ready for a volcanic eruption?”

In this question, there are three choices that respondents can choose, namely “*sure*”, “*doubtfull*”, and “*not sure*”. Based on the survey results, there were 118 respondents who stated “*doubtfull*” that local communities were ready to face disasters (42.3%), 110 respondents chose “*not sure*” (39.4%), and 51 respondents chose “*yes*” for the answer. given in the survey (18.3%).

5. Are you sure the local people are ready for a volcanic eruption?
   279 Respondents



The results of this survey indicate that most of the respondents who filled out this survey indicated the doubts of the local community in dealing with natural disasters, especially volcanic eruptions and only a portion of the respondents indicated that local communities were prepared to face volcanic eruptions.

3.4 Nature and Human Relation

Nature and humans have always been an interesting study. The relationship between humans and nature is an important process in the formation of civilization and world order. The view of Tan Minggayani, a Confucian clergyman, states that "Human life is very dependent on the natural surroundings. The human environment in question, is like water, air, land, energy. Some of these energy sources are replaceable and some cannot be replaced; alias will be used up" (Minggayani 2021).

In its development, the ecological understanding of nature experienced a shift, the ecological conception of nature and humans at first only understood the interaction of humans and nature. Humans use nature only to fulfill their basic needs. The process of managing nature is still simple, but along with modernity, technological developments, and the increasing number of human populations, the way to treat nature is different. Human thinking to maintain, care for, and preserve nature in a sustainable manner in the modern era has not yet become a comprehensive thought (Prasetyo 2018).

Nature is understood in human life as a living space. The theme of nature and humans becomes interesting when it is associated with disasters. Ecological disasters that continue to occur around humans show symptoms of increasingly intensive natural changes, this is caused by the use of unfriendly natural resources (Wartoyo 2020). While in religious teachings, many provide advice and instructions on how to protect and care for nature. The story of the process of creating humans and nature in the narrative of religious teachings shows how humans should take care of nature as well as possible, humans have been given the knowledge to be able to protect nature and the surrounding environment (Mufrizon 2005).

Questions about nature and humans in traditional ecological thinking have been asked such as why humans exist in this world?, what is the meaning and purpose of humans living in this world?, where do humans come from?, understanding nature needs to also understand philosophy and humans. Nature as an ecological reality, while humans become part of the ecological reality. Learning about the world is an important process for studying the relationship between humans and nature (Rachman 2011). The relationship between humans and nature can be understood through the process of interaction that occurs. Disasters are a medium for how humans and nature interact with one another. Humans are basically not fully able to understand natural phenomena and the changes that occur.

3.5 Disaster, Human, and Its Philosophy

Nature has a certain character. The character of nature is looking for balance in the universe. The balance that nature does can be seen with the emergence of natural phenomena and phenomena such as earthquakes, Merapi eruptions, floods, storms, tsunamis, and droughts. Disasters are seen as natural events (Cahyana 2019). But this natural phenomenon is understood negatively in human life. Disasters are one of the factors that humans consider dangerous and have an impact on material and immaterial losses. Disasters make people unhappy. In the view of philosophy, disaster as a process of the balance of the earth toward a point of perfection. Meanwhile, from a religious perspective, disaster can be interpreted in several ways, namely (1) Trials for mankind, (2) Sanctions/punishments due to human carelessness, and (3) Wisdom after getting a test and getting closer to God's majesty (Rosyid 2020). Another view says that disaster is a human error or God's plan.

Based on the results of the survey conducted, it was shown that of the 279 respondents who filled out the survey, 45.5% interpreted natural disasters as a calamity. Based on the Big Indonesian Dictionary, a disaster can be interpreted as a sad event or event that befalls (https://kbbi.web.id/musibah), 119 respondents chose to interpret disaster as a "*natural problem*" (43%), 14 respondents chose to interpret disaster as a "*human trial*" (5%), 7 respondents chose to interpret natural disasters as "*a punishment from God*" (2.5%), 2 respondents chose to interpret disaster as "*catastrophe*" (0.7%), and 9 respondents chose the answer others by explaining each reason (3.3%). Perspectives or personal opinions described by respondents who chose other answers, namely part of the earth's cycle (1 respondent), an event that occurs naturally from nature (1 respondent), something to watch out for but not completely useless because natural disasters contain lessons that can make humans became a better person (1 respondent), the calamity that God gave to His human creation and is a form of rebuke/trial by humans on the earth of His creation (1 respondent) and other answers. Through the results of the survey it can be concluded that respondents are aware that humans and nature are one unit that are interrelated with one another, or it can be interpreted that a natural disaster is a consequence caused by human action or behavior.

The perspective that is believed by an individual or community group will of course influence the response or actions of the community group in overcoming the threat of disaster, there are three patterns of relations between humans and nature. *First*, humans have the highest position compared to nature, in this perspective humans only see nature as a means to fulfill their daily needs. *Second*, humans and nature have an equal position, this perspective shows that humans realize that nature also has control in their lives. *Third*, nature has a higher position than humans, this perspective shows that humans should obey and surrender to natural phenomena and shows that human life is very dependent on nature (Aryanta and Utami 2019). If we examine the three forms of relations with the survey results chosen by the respondents, the results show that the pattern of relations between nature and humans shows that humans and nature have an equal position, respondents realize that natural disasters are "*disasters*" that can cause grief to human life.

Disasters in Law Number 24 of 2007 concerning Disaster Management are defined as: "Events or series of events that threaten and disrupt people's lives and livelihoods caused, both by natural factors and/or non-natural factors as well as human factors, resulting in human casualties., environmental damage, property loss, and psychological impact" (Indonesia 2007). Human existence when facing disaster is in a weak position. Humans do not have the ability to prevent and resist disasters. For example, in Switzerland, melting of glaciers has become an important historical record in human life, that this indicates that the earth is experiencing significant global warming. Potential natural disasters such as the temperature of the earth getting hotter and the volume of sea water increasing are potential natural disasters for human life in the future. For this reason, the role of humans is important to carry out disaster management and disaster mitigation. The effectiveness of disaster management is important for humans to do (Handoyo 2019). Indonesia is one of the disaster-prone countries, because Indonesia located in the equatorial area with geographical conditions that have many active volcanoes. Humans are faced with understanding disasters as suffering or natural events.

3.6 Disaster Risk Reduction and Disaster Mitigation in Indonesia

The results of the Indonesian National Disaster Management Agency (BNPB) note that there have been 1926 natural disasters that occurred in Indonesia from the beginning to the middle of this year, natural disasters that occurred in Indonesia in 2022 include 747 flood events, 690 extreme weather events, 373 landslides, and 12 earthquakes (Dihni 2022) Disasters that occur in almost every part of Indonesia of course have an impact that often results in losses, both material and moral losses. One of the natural disasters that was very detrimental and caused "deep sorrow" for the Indonesian people was the tsunami and earthquake that occurred in the Palu area, Central Sulawesi, on September 28, 2018. Based on BNP data quoted by BBC News

Indonesia, noted that the tsunami and earthquake that hit the Palu area reached 1374 fatalities (Indonesia 2018).

Natural disaster events that occurred in the Palu area and natural disasters that occurred in almost all parts of Indonesia should be able to become important indicators for the Indonesian government to be more active in socializing disaster risk management efforts (disaster mitigation) in accordance with Law Number 24 of 2007 on disaster management. Disaster mitigation can be defined as a series of efforts carried out with the aim of reducing the risk or consequences caused by natural disasters through physical development, public awareness, and capacity building against disaster threats (Nurjani 2013). In this case, disaster mitigation can be interpreted as a series of activities carried out through various stages in order to reduce the impact caused by disasters and reduce the risk of natural disasters.

Currently, disaster mitigation efforts being carried out in Indonesia still show the inability of the Indonesian state to carry out professional, proportional, and holistic disaster mitigation efforts can be carried out and explored in order to create a community that is responsive to disasters (Nugroho 2018a). Bearing in mind also that the community is the main object when a disaster occurs; therefore, the community should have more in-depth knowledge in reducing disaster risk and knowledge of the actions that need to be taken, increasing understanding of community knowledge about disasters must be instilled in the whole community, especially in children. Children who still do not have sufficient understanding of the actions that must be taken when a disaster occurs (Desfandi 2014).

Education is an effective means of disseminating disaster knowledge to the public, because through education there is an effective and efficient effort for the community, especially children, to understand and understand disaster mitigation efforts (Atmojo 2020). Through this statement, it can be seen that Indonesia as a country that often experiences natural disasters requires a more professional effort that does not only emphasize assistance after a disaster (recovery phase), but disaster mitigation efforts that emphasize the prevention phase (disaster mitigation) are needed. Through awareness and improvement in dealing with natural disasters, the preparedness phase (disaster mitigation through organizing through appropriate and efficient steps) as well as the response phase (activities carried out when a disaster occurs). One of them is through utilization in the field of education, but unfortunately disaster mitigation efforts that have been integrated into the world of education have not been implemented optimally, because disaster education is only included in other subjects and is only emphasized on students' knowledge but there is still no factual implementation in the learning process (Desfandi 2014).

Based on the results of the survey conducted, it was found that 273 respondents were students, but it was unfortunate that the survey results showed that as many as 54.1% of the respondents were not ready to face a disaster. This is also supported based on the question indicators in the survey content, namely "*Have you ever received training or carried out disaster mitigation actions*?", apart from that in the survey there was an indicator question "*Have you attended any education and training on disaster mitigation*?", and the survey results on this question indicator showed that as many as 61.6% of respondents had never attended training or education on disaster mitigation. Based on the results of this survey, it shows that the government's efforts to create disaster mitigation efforts that are integrated with the world of education have not shown maximum results, so that the disaster mitigation efforts carried out by the Indonesian government are still only focused on providing assistance after a natural disaster occurs. Based on Government Regulation Number 21 of 2008 concerning Implementation of Disaster Management Article 1 paragraph 6 it is explained that disaster mitigation is a series of efforts to reduce disaster risk carried out through physical development and increasing capacity to face disaster threats. Through these Government Regulations, it can be concluded that disaster mitigation efforts do not only emphasize physical development, but also capacity building through education.

Disaster mitigation efforts through education can be carried out with disaster mitigation training through simulations and various models or approaches to learning. Disaster mitigation efforts through simulations can be carried out by demonstrating them in real imitation so that they can provide an overview to students regarding the situation that will be faced when a disaster occurs, disaster mitigation efforts through this simulation activity also require assistance and the skills of educators as figures who interact directly with participants learn in the learning process. Disaster mitigation efforts in the learning process can also use various learning media such as posters, videos, and comics, because this learning media is able to increase student participation through verbal, visual approaches, and increase students' understanding and memory (Nugroho 2018a).

Disaster mitigation education is expected to be able to form and develop the knowledge of students who understand more deeply about the area where they live, especially regarding the history, needs and characteristics of their respective areas of residence; therefore, disaster mitigation education must also be able to accommodate local wisdom or knowledge, traditional about regional characteristics. *First*, the values of local wisdom are proven to be able to deal with natural disasters. *Second*, disaster mitigation combined with local wisdom can increase community participation and role in reducing disaster risk. *Third*, the values contained in local wisdom can provide very valuable information about the characteristics of the area. *Fourth*, the dissemination of non-formal local wisdom can provide development for other educational efforts regarding disaster risk reduction efforts (Desfandi 2014). Disaster mitigation education combined with local wisdom can be a new formula for the Indonesian government in developing disaster mitigation efforts and can be one of the most targeted steps in reducing disaster risk according to the characteristics of the community. Disaster mitigation education combined with indigenous knowledge can also increase students' knowledge about their origins. Disaster mitigation education combined with indigenous knowledge can be referred to as indigenous education, which can also be interpreted as the path and process whereby individuals gain knowledge and meaning from their indigenous heritage (James Jacob and Porter 2015).

It should also be noted that disaster mitigation education efforts must also pay attention to the principles of curriculum implementation and development, namely relevance, effectiveness and efficiency, and the principle of flexibility. The principle of relevance means that curriculum development must be relevant to the development of science and technology and in accordance with the needs and characteristics of students and society. The principle of efficiency and effectiveness can be interpreted that curriculum development efforts must pay attention to the use of funds, time, energy, and the principle of effectiveness. The principle of flexibility means that the development and implementation of the curriculum must be designed dynamically so that it allows for changes that cannot be predicted by the curriculum (Desfandi 2014).

In simple terms, it can be concluded that disaster mitigation efforts organized by the Indonesian government are still emphasizing physical development after a disaster occurs, of course this is not in accordance with the draft definition of disaster mitigation based on predetermined regulations that disaster mitigation efforts are actions to prevent threats and minimizing the impact of disasters that can be done by developing knowledge, in another sense disaster education is also included as a disaster mitigation effort. Disaster mitigation education in Indonesia is still not optimally implemented, disaster mitigation education should be one of the facilities that can be emphasized and improved considering that Indonesia is a country that often experiences natural disaster phenomena, besides that disaster mitigation education efforts can be effective and efficient efforts in realizing a society that is responsive in the event of a natural disaster phenomenon. Efforts to implement disaster mitigation education must also pay attention to the principles of curriculum development and implementation, because the curriculum is a system that regulates the implementation of the learning process so that if there is development the implementation of the curriculum can still be in accordance with the required needs and characteristics of students, especially the community.

One form of efforts to develop disaster mitigation through Science and Technology (IPTEK), namely TOAST (Tsunami Observation and Simulation Terminal) application is software for tsunami modeling and verification simulations that provides a quick hazard assessment, and a tsunami potential modeling simulation using the TOAST application can produce important information such as tsunami wave arrival time, tsunami water level (run up), and tsunami status (alert, alert, and alert this application is useful for detecting earthquakes and tsunamis (Kurniawan et al. 2021). The TOAST application is a form of disaster mitigation efforts related to the development of science knowledge and education. Efforts to develop disaster mitigation through the development of education and curriculum should be able to become a program that is more emphasized by the government in dealing with natural disasters that occur.

3.7 Conception and Perception of Indigenous People on Disaster

Indonesia is recorded to have 17,508 islands, 300 ethnic groups or ethnic groups, and 1340 ethnic groups in the country (Indonesia.go.id 2017). The diversity of ethnic cultures in Indonesia, of course, makes the Indonesian nation a country that has a diversity of local wisdom between one ethnic group and another. Local wisdom can be interpreted as traditional views and knowledge that become a reference in behavior and has been practiced from generation to generation to meet the needs and challenges in society and functions for the preservation of natural resources, human resources, preservation of customs, and culture and functions for the benefit of life. Humans (Raden Cecep Permana 2011). Based on this definition, it can be interpreted that local wisdom is a traditional guideline that is able to become a reference for the community to act and behave from generation to generation and can be used as a reference to answer all needs in human life, especially in responding to problems of natural disasters.

The study or discussion of local wisdom and disaster mitigation in traditional Indonesian society can be seen from the belief that humans and nature are interdependent and interdependent with each other, in this case it can be interpreted that human actions or behavior have an influence on the sustainability of nature (Ruli As'ari 2016). If humans can do good to nature, then nature will also do the same to humans, but if nature is angry, natural disasters will appear such as landslides, floods, tsunamis, earthquakes, and other natural disasters. This traditional view shows that natural disasters that occur are a form of "punishment" of nature to humans. Local wisdom in the view of traditional Indonesian society is one of the guidelines for natural disaster mitigation efforts. One form of local wisdom as a disaster mitigation effort is carried out by the people of Mukebuku and Lakamola Villages, Rote District, Rote Ndao Regency. People in Rote Ndao district do not have a theoretical understanding of tectonic earthquakes, people only believe that the earth is balanced by dragons; therefore, if dragons are not given offerings, the dragons will rebel and be angry with humans and shake the earth. When an earthquake occurs, people will shout "ami nai ia o" (we exist), because the dragon feels that there are no humans on earth to feed him. The people of Mukebuku and Lakamola villages believe that the earthquake that occurred encouraged them to work together in joy and sorrow, the people of Mukebuku and Lakamola villages have a philosophical value of harmony, harmony with God, others, and nature. In the communities of Mukebuku and Lakamola villages, there is no latest earthquake disaster mitigation knowledge, the people only shout "ami nai ia o" as a form of warning that there is an earthquake to other people, so they can find safe places and open fields to protect parents and children (Thene 2016).

Local people around Mount Merapi also have an understanding of a natural disaster phenomenon from a traditional perspective. Local people who live around Mount Merapi have the belief that Mount Merapi is a place of residence for spirits and creatures that have supernatural powers or are known in the local language as *lelembut*, and as known as a dwelling place for every spirit who in his life always does so much good. Local people in Sempal Makmur village, which is located in the southwest of Mount Merapi, also have a traditional view of the disaster of the eruption of Mount Merapi, the people in Sempal Makmur village has believe that the disaster of the eruption of Mount Merapi is a sign of marriage between the male god, namely Kyai Sapu Jagad and the woman Nyi Roro Kidul and has a belief that the eruption of Mount Merapi is considered a moment for Kyai Sapu Jagad and Nyi Roro Kidul to look for human victims and become soldiers in their kingdom. The traditional perspective of disaster is also believed by the Turgo people who live around the slopes of Mount Merapi, the Turgo people believe that if one night there is a running lantern, this is a sign that the lantern bearer is Ratu Kidul's army heading to Mount Merapi, also is a sign that Mount Merapi will erupt. The traditional views that are believed by local people living around Mount Merapi are increasingly unshakable because the community has sacred rituals or local wisdom that has been carried out for generations from generation to generation, such as the l*abuhan* ceremony and the salvation and *semedi* ceremony.

The villages of Tlogolele and Tlogomulyo are two areas that are included in the Disaster-Prone Area (KRB) in the event of the eruption of Mount Merapi, this is because the location of the two areas is very close to the peak of Mount Merapi so that the potential for danger is very large and this is also increasingly supported by the population or the people in the two villages are included in the densely populated category, so that the people in the villages of Tlogolele and Tlogomulyo are advised by the government to relocate to a safe area that has been prepared by the government, but most of the people from these villages refuse the relocation carried out by the government. This is because the community finds it difficult to adapt in the area prepared by the government, besides that the people in Tlogomulyo and Tlogolele believe in the assumes if the eruption of Mount Merapi is not a harmless event or in the local language referred as *lelaku.* The Tlogolele community also carries out the *Sega Cagak* and *Sega Gunung* as a form of worship to Mount Merapi if there is an increase in Mount Merapi activity and stay away from the taboos that have been set, such as the prohibition of loud voices and ringing the gong, the prohibition of directly seeing the eruption of Merapi and the prohibition of conducting exploration nature in excess. The people of Tlogolele believe that this local wisdom can save them from the eruption of Mount Merapi (Prasojo 2015).

Another source stated that local people around Mount Merapi often refer to Mount Merapi as "*Mbah Merapi*", this term for local people who live around Mount Merapi can be interpreted in two contradictory views, namely local people have the view that Mount Merapi is a "*threats*" as well as "*blessing bearers*" in the lives of people around Mount Merapi. The meaning of "*threat*" can be interpreted if the eruption of Mount Merapi demands and causes death, while the notion of "*blessing bearer*" can be interpreted that the eruption of Mount Merapi is able to bring blessings to the people living around Mount Merapi in the form of soil fertility, sand material resulting from the eruption, tourist attractions, and other activities that are able to bring blessings to the local community who live around Mount Merapi, besides that the community also interprets the eruption of Mount Merapi with the meaning of "*wasting feces*" or throwing feces like humans do (Pramono 2016).

Local wisdom believed by people in the Rote Ndao Regency area and local wisdom believed by traditional communities around Mount Merapi show that local wisdom such as beliefs, traditional ceremonies, and taboos that are believed to be a manifestation of traditional communities in Indonesia are hereditary. From generation to generation learn to make friends and live side by side with nature, so as to create a local wisdom which is considered as an effort or solution in overcoming various problems, especially in problems related to natural disaster phenomena. This local wisdom continues to be firmly held by the community through a mechanism that is formed and born from an experience, understanding, and meaning of every event, phenomenon, hope, and problem that occurs around it. The mechanism is then socialized through generations whose implementation is in accordance with the level of quality to understanding in their lives (Pramono 2016). Local wisdom believed by traditional communities around Mount Merapi shows that there are various worship ceremonies and traditional taboos that are believed to protect the traditional communities around Mount Merapi safe and secure from the dangers of the eruption of Mount Merapi. These local wisdoms show that traditional people believe that Mount Merapi has control over the sustainability of their lives and is a reminder for traditional people to always be careful in processing and managing nature to meet their life needs, or in short it can be concluded that local wisdom is a human effort in establishing a harmonious relationship with nature (Prasojo 2015) This proves that local wisdom possessed by each region in Indonesia can be used as an instrument that can be used to maintain human relations with nature, besides that local wisdom believed by traditional communities in Indonesia can be a disaster mitigation effort in accordance with tradition.

3.8 Indigenous Knowledge and Philosophy on Disaster Management

The study of natural disaster mitigation efforts with the local wisdom of the Indonesian people shows that humans have an influence on nature and the abilities and knowledge possessed by humans greatly affect the sustainability of nature. In this case, it shows that local wisdom that grows in traditional Indonesian society is part of human ideas; therefore, local wisdom in a foreign language can often be defined as local policy (local wisdom), local knowledge (local knowledge), or local intelligence (local genius) as a work of reason, deep feelings, character, form of temperament, and suggestions for human glory (Ruli As'ari 2016). This can be interpreted that traditional Indonesian people have local or local knowledge or intelligence in the form of temperament or reason that is used for the welfare of the local community.

Each region in Indonesia has different local wisdom; therefore, the views or knowledge of traditional Indonesian people in understanding a disaster and its mitigation will definitely be different from each other, for example, in the people of Rote Ndao Regency who consider that natural disasters that occur are a form of anger. dragons against humans (Thene 2016). The view of disaster that is owned by the traditional community of Rote Ndao Regency will also definitely be different from the view of disaster held by the Baduy community in Kanekes village. One form of local wisdom of the Baduy community in Kanekes village as a manifestation of disaster mitigation is in the tradition of preserving forests and water. The Baduy community for generations has continued to maintain and protect a forest area of 5635 ha near the headwaters of the Ciujung River, Lebak Regency. The local wisdom of the Baduy community in forest and water is closely related to flood and landslide disaster mitigation, this is evident from the function and location of the forest and water.

Forests in the local wisdom of the *Baduy* community are divided into three namely forbidden forests, *dungusan* forests, and cultivated forests. The forbidden forest is a protected forest that cannot be entered by just anyone, even traditional leaders, the *dungusan* forest is a forest that is preserved close to the upstream of the river and is believed to be the ancestral place of the *Baduy* tribe, while the cultivated forest is a huma cultivated by the *Baduy* tribe in general.

The *Baduy* community in their tradition calls the field as Huma, in the tradition the Baduy community recognizes five types of Huma, namely (1) *Huma Serang* is a customary field that is jointly owned by Baduy Tangtu, (2) *Huma Puun* is a field owned by a traditional leader while serving as known as *puun* and the location of this huma is located behind the *puun* house, (3) *Huma Tangtu* is a field owned by the *Tangtu Baduy* people and is only used for the needs of the *Tangtu* Baduy community, (4) *Huma tuladan* is a field used for traditional ceremonies of the *Baduy* community, and (5) *Huma panamping* is a field that can only be used for meet the needs of the traditional *Baduy Panamping* community (Raden Cecep Permana 2011).

The Baduy people believe that the forbidden forest is a place for the Almighty or what is known as *Nu Kuwasa* and is believed to be the place where the earth was created and the center of the world. *Dudungusan* forest is a forest that is protected to maintain the continuity of water needs and the vital needs of the community, while the arable forest is a place for the *Baduy* people to clear and work their fields. The *Baduy* people often carry out the *Ngararemokeun* ceremony (marrying) Nyi Pohaci Sanghyang Asri with the earth with the aim that the rice harvest of the traditional *Baduy* community can be abundant.

The *Baduy* community also has a tradition of local wisdom from the earthquake that can be seen in the traditional buildings of the *Baduy* people's houses, all houses in Kanekes village have the same shape. This is a form of the *Baduy* community's belief that the house is a center that has neutral power located between the underworld and the world above, so that the *Baduy* community's house should not touch the ground so that every pillar under the *Baduy* community's house uses pedestal stones. This is also increasingly supported by the form of house construction, connecting and binding techniques for buildings, and the use of houses. In short, the traditional house construction of the *Baduy* community uses traditional materials such as wood and bamboo, then all construction details are completed with the principles of ties, pedestals, pegs, interlocking pedestals, and hooked connections, so that when an earthquake occurs, the structure of the house will still move dynamically and be avoided from damage or destruction. The stone pedestal used as a support for the pillars under the traditional houses of the *Baduy* community shows that the *Baduy* people have "local intelligence" that the stone pedestal prevents termites or weathering of house poles due to wet air or humid air (Raden Cecep Permana 2011).

Disaster mitigation based on local wisdom of the Baduy community in Kanekes village shows that local wisdom is one of the strategies resulting from the form of human intelligence to reduce the risk of natural disasters, in this case it shows that the local wisdom of the *Baduy* community in the construction of traditional buildings and the efforts of the *Baduy* community in preserving the forest and water is proven to be one form of natural disaster mitigation in the traditional view.

The eruption of Mount Merapi which occurred in October 2010 is one of the natural disasters that is still remembered by all Indonesian people, especially local communities affected by the eruption of Mount Merapi. The eruption of Mount Merapi in 2010 caused quite a large loss for the people affected by the eruption of Mount Merapi, the eruption of Mount Merapi was not only detrimental materially but also caused psychological losses, so many people had to lose their property and relatives become victims of the eruption of Mount Merapi.

One of the areas that felt a fairly heavy impact due to the eruption of Mount Merapi, namely the Cangkringan sub-district, especially in the Umbulharjo village area in the Kaliadem as an area that was quite severely affected by the eruption of Mount Merapi, then in the northern part of Umbulharjo village which was quite severely affected by the eruption. Hot clouds as well as the hamlets of Kalitengah Lor and Kalitengah Kidul which were affected by "*Wedus Gembel*" from the eruption of Mount Merapi, it was noted that residents living in the Umbulharjo village area, Cangkringan sub-district, became victims who quite a lot died in this incident, then through the eruption of the mountain Merapi, which has claimed many lives in Cangkringan District, encourages people to gain new knowledge, especially in carrying out disaster mitigation efforts. The form of disaster mitigation carried out by the community in Cangkringan sub-district is through local wisdom related directly and indirectly as disaster mitigation efforts. The forms of local wisdom that are directly related to disaster mitigation carried out by the community in the Cangkringan sub-district are (1) maintenance of the social system which is carried out by holding meetings between residents in each hamlet and community, in addition to the factors that encourage the maintenance of the social system in the Cangkringan community as a disaster mitigation effort, the Cangkringan sub-district community has high trust in community leaders and strong social ties so that the Cangkringan sub-district community has succeeded in forming disaster response network nodes in each hamlet. (2) Utilization of "*titen*" as a guide for the Cangkringan sub-district community in dealing with the coming disaster of the eruption of Mount Merapi, "*titen*" is local wisdom on people's belief in the existence of a landscape in the form of a mountain child that protects the village from the threat of Mount Merapi, the Cangkringan sub-district community believes that as long as the hot clouds do not reach the hills in the north of Klangon hills, it is a sign if the community still feels safe from the threat of heat, besides that the science of "*titen*" is a guide for the

Cangkringan sub-district community in determining the time for people to evacuate to the refugee barracks that have been provided by the government. Another form of local wisdom believed by the Cangkringan sub-district community regarding the form of indirect disaster mitigation efforts is that the community carries out the tradition to treat and care for objects that are considered capable of protecting the community from the threat of the eruption of Mount Merapi, one of which is known as *ruwatan* carried out by the community of Jetis Sumur village. The people in this village think that the well is able to give a sign to the people of Jetis Sumur that the danger of the eruption of Mount Merapi will come, besides that the people also think that the well is a sacred object and is able to provide protection for the people of Jetis Sumur village (Candra Ragil 2020). The form of local wisdom that is not directly related as a form of disaster mitigation efforts is also carried out by the community in Tlogolele village, the *slametan* and *Sega gunung* carried out by the Tlogolele community are a form of asking for the protection of the Tlogolele community if Mount Merapi experiences increased activity (Prasojo 2015).

Indigenous knowledge believed by the people in Kanekes village and local communities around Mount Merapi are examples of indigenous knowledge found in several regions in Indonesia. Indigenous knowledge can be interpreted as an information which is passed down through generations in a given locality and acquired through the accumulation of experiences, relationships with the surrounding environment, and traditional community rituals, practices, and institutions (Ilan Keman 2012).

Based on this explanation, it can be concluded that local wisdom believed by traditional communities in various parts of Indonesia is believed to be able to become a disaster mitigation effort. Local wisdom also shows that indigenous people are important figures who produce various traditional knowledge that can be used by humans to establish a harmonious relationship with nature (Nesterova 2020).

Local wisdom can also be used by the government in increasing public awareness to be more concerned in learning and increasing knowledge about disaster mitigation efforts without losing the traditions or culture believed by the community. Local wisdom is able to become *instrument* that can be used by the government in attracting public trust and community leaders to be more concerned and able to create dynamics for the community in living and carrying out various forms of local wisdom that they believe in (Candra Ragil 2020).

3.9 Indigenous Education on Disaster Risk Reduction in Indonesia: Case Study in Mt. Merapi

Natural disasters such as volcanic eruptions are one of the disasters that often hit Indonesia, this is caused by the subduction zone between the Eurasian plate and the Indo-Australian plate. One of the biggest historical volcanic eruptions in Indonesia, namely the eruption of Mount Krakatau which occurred in 1883, Mount Merapi and Mount Kelut are the most active volcanoes in Indonesia (Arna Fariza 2016). Geographically, Mount Merapi is located on the border of four regencies, namely Klaten Regency in the southeast, Malang Regency in the west, and Boyolali Regency in the north and east. History shows that in the 1600s Mount Merapi erupted more than 80 times, in the nineteenth century eruptions occurred in 1768, 1822, 1849, and 1872. A large eruption of Mount Merapi occurred on June 14, 2006, which succeeded in destroying the Kaliadem hamlet and the eruption of Mount Merapi occurred again on October 25, 2010, which was then followed by a large eruption on October 26, 2010, (Rachmawati 2022). The eruption of Mount Merapi that occurred on October 26, 2010, caused 1705 injuries, consisting of 1412 lightly injured, 293 seriously injured, and 332 people died, and there were 4874 victims who experienced psychological disorders due to the mountain disaster. Merapi, besides the Mount Merapi disaster, 2447 houses were heavily damaged and 6472 houses were heavily damaged and 182 were damaged around Code River, Yogyakarta (Muh. Aris Marfai 2012) (Fig. 3.1).

The impact of a fairly large loss felt by the community around Mount Merapi caused changes in disaster mitigation efforts, especially in changing communication to create newer innovations in handling the eruption of Mount Merapi. Efforts to change innovation in disaster mitigation of Mount Merapi in 2010 have brought changes in the form of group communication, communication tools used, public attitudes toward information provided by the government to individual decision making in the evacuation process. If in the eruption of Mount Merapi before 2010 namely in 2006, there are still many people around Mount Merapi who depend on information from the surrounding groups and the community does not and does not trust

Fig. 3.1 Mt. Merapi miniature at Museum Gunung Merapi

information from outside communities, especially government institutions, but when Mount Merapi erupted in 2010 there were changes in the attitude and behavior of the community, namely the community already has readiness in making decisions and has prepared all the needs needed when evacuating. The community also has a more alert attitude to evacuate without having to wait for orders from the hamlet head. On the innovation side in the field of public information channels, they also have written guidelines containing population demographic data related to disaster mitigation and have used communication tools such as Handy Talkies (HT) in monitoring and providing information about the status of Mount Merapi (Wardyaningrum 2014). This was also reinforced by the head of Kepuharjo Village who stated that in fact the community already had a basic knowledge of disaster mitigation from generation to generation, namely considering the relationship between the community and Mount Merapi as "Enemies" and "Friends". The relationship as "the enemy" can be interpreted as a sign that the community must evacuate and stay away, besides that the community also has local wisdom-based disaster mitigation efforts, namely if there is a flash at the top of Mount Merapi, there is a possibility that an eruption will occur and a sign that people must evacuate. Another view of local wisdom that is considered a disaster mitigation effort for the community around Mount Merapi is that if the animals that live around the Mount Merapi forest go through transmigration to residential areas and there is a rusty sound, it is a sign that cold lava will descend (Syamsul Maarif 2012).

Changes in communication in the community are also very influential on the 2010 Mount Merapi disaster mitigation process, of course, showing that public awareness and community involvement are very important in disaster mitigation efforts. This is also in accordance with Law Number 24 of 2007 concerning Disaster Management in article 27 sections a to section c which explains that the community is required to maintain a harmonious relationship with nature, carry out disaster management activities, and provide correct information regarding disaster management. Another thing to note is that the traditional view held by the community around Mount Merapi is one of the disaster mitigation efforts that is still developing and used by traditional communities.

Local wisdom can be one of the efforts that can be used to anticipate disasters, even though local wisdom cannot be rationalized logically using academic formulas and theories, but local wisdom can effectively build awareness of traditional communities and be able to be accepted really quick by traditional communities, but sometimes Local wisdom can also be a factor that complicates disaster mitigation. One of them was in the eruption of Mount Merapi in 2010, people who are located on the slopes of Mount Merapi have confidence in informal figures called *juru kunci* or *dukun* (Pramono 2016). *Juru kunci* are believed to be able to communicate and interact with traditional values which is highly respected by the community and is able to provide solutions to problems that occur both individual problems and social problems (Roskusumah 2013).

The community's trust if *juru kunci* encourages public confidence that the eruption of Mount Merapi is not a disaster to be feared, besides that the community's trust in the *juru kunci* has caused people who live close to the Boyong and Gendol rivers to continue carrying out their daily activities even though the government has issued an appeal for the community to evacuate to areas determined by the government (Syamsul Maarif 2012). This shows that local wisdom believed by traditional communities around the slopes of Mount Merapi can sometimes become an inhibiting factor in the implementation of disaster mitigation efforts; therefore, a communication effort or approach is needed by the government to educate traditional community knowledge. This statement is also supported by the indicator question "*Are you sure the local community is ready to face a volcanic eruption?*" and survey results show that 42.3% of respondents chose "*doubtful*" and 39.4% of respondents chose "*not sure*" that local communities are ready to face natural disasters. This also means that respondents do not believe that local wisdom can overcome or reduce the impact of natural disasters.

3.10 Conclusions

Based on the results, the findings show that the understanding and views of indigenous people in seeing disasters show the value of surrender and acceptance of natural phenomena as a form of unpredictable events. This sense of acceptance of natural phenomena makes indigenous people still understand nature as their friend. The way indigenous peoples study and understand nature and disasters is to understand the signs of turbulent nature by feeling, remembering, and marking. Natural existence for indigenous people on the slopes of Merapi is part of their life. So they consider, the volcano is not a danger and a threat but a friend in their lives to seek life and life. The way that indigenous peoples carry out disaster risk reduction is to prepare themselves and always give offerings to nature so as not to be angry.

Acknowledgements The author would like to thank Arinal Haq Izzawati Nurrahma and Diorima Simatupang who have supported this writing to be realized. The authors also would like to thank the Research Center for Education, National Research and Innovation Agency.

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Chapter 4
Dispossessing 'Own People' from Their Homeland: Muslim Indigenous Ethnic Minority in Sri Lanka

Diotima Chattoraj and Anindya Basu

Abstract Sri Lanka, a conflict-ridden postcolonial nation-state, was ravaged by a 26 years long civil war. Largely excluded from mainstream representations of the ethnic conflict, Tamil-speaking Muslims in Sri Lanka (quaintly called as Moors) constitute the country's second largest minority group. Historically speaking, Moors have fostered an Arab Islamic identity in the twentieth century which has severed them from the Hindu and Christian Tamils. Thus, this chapter explores the experiences, aspirations, fears and challenges of the unheard stories of the Moors in Sri Lanka, who are at risk of losing their indigenous identity in their own country. Over the millennia, they have survived by adapting to and coping with external stresses. Unfortunately, since 2013, they have been continuously targeted by the majority forces of Sinhala-Buddhist supremacy, paving the way for a fresh round of inter-ethnic and inter-religious tensions leading to a new wave of Islamophobia. Therefore, Muslims have been struggling for their survival in their own country and the community apprehend a forced displacement. The study is based on qualitative method approach which was conducted with sixty respondents in two phases in Sri Lanka at Colombo and Jaffna: the first phase was in between January to April 2013 and the second was in between June 2020 till March 2022. From the detailed secondary literature survey, it is evident that the insight into the livelihood struggles of the Moors from their own perspective is lacking. Hence, this chapter attempts to construct a narrative of their life-politics addressing their lived experiences and investigating their future imaginaries. The concepts of 'capacity to aspire' and 'identity-construction' are used as theoretical standpoints to validate their dreams of having a dignified life in their own country.

Keywords Sri Lanka · Moors · Indigenous group · Minority · Homeland

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_4

4.1 Introduction

Sri Lanka, formerly known as Ceylon, is a small island country with a rich cultural diversity of people belonging to different religions, languages, ethnicity, race and culture. These people have developed their own sense of collective identity by combining their history, ethnicity, geographical location, language, religion, race and traditional characteristics. Sri Lanka has a population of 22.2 million people (as of 2022, World Data Atlas, 2022) which consists of the Sinhalese (74.9% or 15.17 million), followed by the Sri Lankan Tamils (11.2% or 2.27million), Muslims including Moors, Malays and India Muslims (9.2%), the Indian Tamils (4.2%) and others or foreigners (0.5%) including Chinese and a large number of European expatriates (Chattoraj 2022a, b). Therefore, less than 10% of Sri Lanka's population consists of Muslims, as compared to Sinhalese or Tamils, but these simple-sounding minority labels actually conceal more than they reveal of the island's ethnic complexity (Ethirajan 2022). These Tamil-speaking Muslims (quaintly called as Moors) constitute the country's second largest minority group who have been largely excluded from mainstream representations of the 26 years long ethnic conflict that took place between the national government and the Liberation Tigers of Tamil Eelam (LTTE). Historically speaking, Moors have fostered an Arab Islamic identity in the twentieth century which has severed them from the Dravidian separatist campaign of the Hindu and Christian Tamils.

Though an integral part of the Sri Lankan identity, the minority ethnic group of Moors have alienated themselves from the mainstream societal sphere and this has created a negative impact on their image and thus, the group has been cornered and marginalized further by the Sinhala-Buddhists and even the Tamils. But still, like any other community or individual the Moors also aspire for a secured life and a better future. This can be looked through the lens of 'capacity to aspire' Appadurai (2004). It is argued that in strengthening the capacity to aspire especially among the poor, the 'future-oriented logic of development' finds a natural ally, and the poor finds the resources to contest and alter the conditions of their own situation. According to Appadurai (2004), the concept of 'capacity to aspire' refers to the understanding of the complex relationship of the marginalized to the cultural regimes through aspiration. Aspirations are associated with preferences, choices and calculations—the good life that exists in all societies. Generally, the aspirations of common people are limited to ideas of well-being involving respectability, safety, good health, provision of leisure, convenience, etc. But these lists, apparently just bundles of individual and idiosyncratic wants, are inevitably tied up with more general norms, presumptions and axioms about the good life, and life more generally.

4.2 Literature Overview

There are several theories that link this inter-group bias and violence to psychological trauma, social disengagement and economic distress which enhances the widening of the socio-economic gap between the 'majority' and 'minority' (Horowitz 1985). Malik (2001) did point out that academic researchers concentrated more on racism than on religious discrimination. The term 'Islamophobia' probably inspired from the term xenophobia was first used in printed terms in a periodical in 1991 and formally included in Oxford English Dictionary in 1997 which implies a hatred for the Muslim community (Runnymede Trust 1997).

While carrying out a study on British Muslims considering the pre- and post-9/11 incident, Sherdian (2006) highlighted that incidents of indirect discrimination rose sharply and prejudices against the Muslim community became more engrained. This directly affected the mental health of the community members at the receiving end. Islamophobia is not only limited to the European and American spheres, but has been a major area of concern for the post-war Sri Lanka since 2009 (Imtiyaz 2020).

Like several countries of the Indian subcontinent, Sri Lanka was also colonized by the European powers and when it gained independence, a great deal of mutual respect and understanding were palpable among the several ethnic and religious groups through the entire process of power transfer which separated it from the neighbouring countries (Kearney 2016). The majority population of Sinhalese reposed its faith on a Tamil leader as their first Prime Minister upholding the bonhomie. But certain majoritarian trends were gradually visible such as the sanction of Sinhala language as the only official language and sporadic incidents of violence on Tamil minorities (Kearney 1967). A constitutional amendment was made in 1978, where the supremacy of Buddha's complete legacy was ensured (Schonthal 2016). This led to further dominance and marginalization of the minorities and that in turn inspired the separatist movements spearheaded by the LTTE against the Sinhala-Buddhists. The island country was embroiled in a 26 years long bloody civil war (Haviland 2009). The Muslim Moors, though Tamils at many instances, opposed the LTTE's separatist activities and became targets of the Tamils too. Despite Tamil being the Muslim's mother tongue, they wanted a separate unique identity. They did not feel a kinship with either Sri Lankan or Indian Tamils and, thus, instead wanted to highlight their own communal identity. For creating their own niche, they started placing their demands which led to further alienation and rivalry.

In October 1990, LTTE forcefully evicted around 80,000 Muslims from their homes in the North with the aim of making the North a 'mono-ethnic Tamil state' (Chattoraj 2022a: 5). Thus, they were dispossessed from their own lands. There was emergence of political parties based on communal lines who allegedly had connections with the Middle Eastern states (De Silva 1986). The major post-war incidence of communal violence was a mob destruction of a 400-year-old Muslim shrine in Anuradhapura, tacitly supported by Sinhalese Buddhists as they were threatened by the increment rate of population in the Muslim community (Subramanian 2015). De Votta (2018) highlighted various aspects of religious intolerance in post-civil war Sri Lanka where Muslim identity became synonymous for sheltering terrorists, vending narcotics, imposing anti-Buddhist policies, hurting Buddhist sentiments, etc.

Several incidents of violence, acts of restraints against the Sri Lankan Moor community have been instigated by extreme Sinhala-Buddhist groups which has often been under-reported by the government and mainstream media (Center for Policy

Alternatives 2015). Historically, there was a close relationship between the Sinhala-Buddhist led Sri Lankan state and the Muslim minority and it was believed that they even bridged the language gap between the Tamils and the Sinhalese (Imtiyaz 2020). No such root cause for the ethno-religious conflicts can be identified in most cases (Gurr 1994) but in Sri Lanka, it is probably due to the conflict of social, economic and political interests between the major communities. During the post-civil war period, BBS (Bodu Bala Sena) group became very active in spreading Islamophobia in Sri Lanka (De Votta 2011). It was reported by Verité Research (2017) that Sri Lanka was facing increasing acts of violence related with religious discrimination between the period 1994 and 2015 (Gunatilleke 2015). The perpetrators of communal violence put forward a weird logic that the Hindus, Muslims and Christians can avail asylum in India, Middle East and the West, respectively, but the Sinhalese Buddhists have only Sri Lanka as their 'homeland' (Savarkar (2003) 1923). The wish for the Moor community to stay recluse from the rest deepened the problem. The Muslim-only town of Kattankudy, in Batticaloa District, is one such example of Islamic fundamentalism entirely shielded from outer world (Imtiyaz and Mohamed-Saleem 2015).

The Religious Affairs Ministry reported that there were over twenty-thousand places of worship, majority being Buddhist temples alongside other religious monuments including 2500 mosques and a governmental decision was taken to restrict further construction of religious places, which might be influenced by the post-civil war anti-Muslim milieu (Gunaratna 2014).

4.3 Geographic Distribution and Attitudinal Difference

The Sri Lankan Muslim community is scattered across the island with the majority (62%) living in the Sinhalese-dominated areas in the south (Imtiyaz 2020), and the remaining 38% are present in the Tamil-dominated northern and eastern part, which is claimed by the Tamils as their 'traditional homeland'. Studies show that the Muslims predominated the Amparai District of eastern province (Department of Census and Statistics–Sri Lanka 2007). During the 1980s, when the Tamil insurrection started most Muslims remained aside. Due to this, the LTTE always stood against the Muslim participation in any peace talks. McGilvray (1997) and Ali (1997) believe that the Sri Lankan Muslims wish to develop their identity based on their religion, Islam rather than on their ethnicity.

North-eastern Muslims, therefore, being gripped by demographic anxiety and locked in competition with the Tamils for control over economic and land resources, turned to religion as a way to define themselves. This was one of the key factors in the formation of the Sri Lanka Muslim Congress (SLMC) in the mid-1980s. However, the southern and western Muslims were not supportive of an exclusive Muslim party, despite being increasingly marginalized by the majority Sinhalese.

In Sri Lanka, because of its ethno-nationalist identity politics, the Muslim community has been forced to define itself as a "other" as they are neither Sinhalese nor

Tamils but a different group. These formations, or how Muslims define themselves, are a by-product of social and political mobilization to secure rights and markets. Hence, the Muslims are the only Sri Lankan ethnic group which bears a religious rather than a linguistic, ethnic or racial name. The palpable tension is both along the racial and religious lines.

4.4 Objectives

The chapter tries to trace the ethnic diversity of island country of Sri Lanka with special emphasis on Muslim indigenous ethnic minority community of Moors; to delve deep into how the Moors have held their own in front of the majority forces of Sinhala-Buddhist supremacy and faced inter-ethnic and inter-religious tensions in the country; discuss about the newer stress faced by the said minority community and find out how the Muslims are struggling to repudiate their apprehensions of a forced displacement.

Thus, with the aim of proceeding, the authors developed the following research question which acted as the main guidance in this study: -

1. How are the Moors dispossessed by other ethnic groups like Sinhalese and Tamils in their own homeland?

   How did the civil war and displacement affect their lives? How are they coping with it?

Collected data show that the livelihood struggles of the Moors from their own perspective are lacking. Hence, this chapter attempts to construct a narrative of their life-politics addressing their lived experiences and investigating their future imaginaries. The concepts of 'capacity to aspire' and 'identity-construction' are used as theoretical standpoints to validate their dreams of having a dignified life in their own country.

4.5 Methodology

Based on a qualitative method approach, on which the article is written, this research was guided by a holistic understanding of complex issues and processes and increase the likelihood of uncovering unexpected and sensitive issues that are relevant to the essence of human existence (Cresswell 2003). A detailed view on how the civil war impacted the lives of the Moors in Jaffna, socially as well as emotionally, emerged from the data that were gradually gathered during fieldwork conducted in Sri Lanka (Colombo and Jaffna) in two phases: the first phase was in between January and April 2013 and the second was in between June 2020 till March 2022.

In 2013, methods like ethnography and focus group discussions were involved as without continuous direct interactions with several factions of the community it was impossible to bring out the feelings, aspersions and ambitions of the community members. Due to unavoidable circumstances encountered during the first phase of the field work, the data gathered during that period was not as ideally veritable as the author would have preferred. However, the authors kept in touch with the informants about the status-quo via email and WhatsApp. They were informed that displaced persons from Puttalam and Colombo were returning to and integrating back into Jaffna. The transformation that Jaffna was experiencing given the 2019 Easter attacks and with the changing new governments also added to the interest of revisiting and collecting data from the region. However, due to the COVID-19 pandemic, travelling for research was strictly forbidden, so visiting Sri Lanka in person was not possible. Therefore, the authors conducted virtual interviews in between June 2020 till March 2022 via Zoom, Skype and WhatsApp.

Respondents were encouraged to talk about their past lives, their experiences, aspirations and challenges after returning to their places of origin in Jaffna. During the study, a total of sixty interviews were conducted with 25 men and 35 women ranging in age from 30 to 55. In Colombo, the authors got the scope to interview 7 men and 12 women while in Jaffna the remaining 41 interviews were conducted with 18 men and 23 women. The respondents were within the age group of 30–55 years. The age of respondents from Jaffna was more on the higher side, i.e. above 40 years. The elder group expressed that with time they are feeling more alienated from the mainstream while comparatively younger lot was more at peace with the marginalization and took it in their stride. The authors adopted a purposive snowball technique to pick the samples for convenience. By using this technique, the authors were able to identify their research subjects by asking one respondent for the name of the second, who then provided the name of the third, and so on (Chattoraj 2022a) (Fig. 4.1).

The interviews were in-depth, informal and semi-structured. They were held in both English and Tamil. The Tamil interviews were, later, translated into English by an interpreter. Respondents were informed well before about the purpose of this work and the methodology, including the nature of questions they would be asked. They were also informed about the group of people who would be having access to the findings of the research and the means of its readings and publication. Each of the respondents had been given the freedom to openly partake and refuse or withdraw participation from the research at any point in time. The authors use pseudonyms and do not reveal private data identifying the subjects (Fig. 4.2).

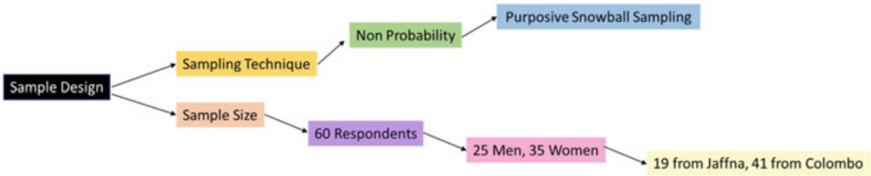

Fig. 4.1 Sampling design of the study. *Source* Authors

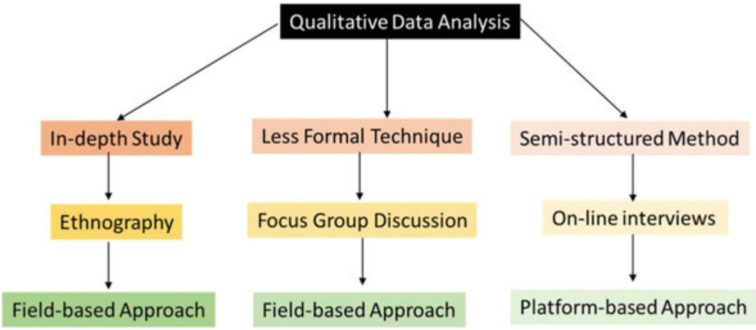

Fig. 4.2 Methodological framework of the study. *Source* Authors

4.6 Historical Background: The Moors of Sri Lanka

Historically, the Sri Lankan Muslim-Moor race descended from their ancestor Arab traders who settled in Sri Lanka more than 2500 years ago (Mohideen 2021). According to authenticated historical facts, Muslims were in the island-nation for more than 1400 years. Due to the scenic beauty and the warm reception from the locals, a huge number of the Muslim merchant visitors decided to settle on the island. The Malabar-Tamils, though, were all powerful in most of the commercial ports of the island, the Arab traders chose the coastal trading and agricultural communities to live with the aim of preserving their Islamic cultural heritage while adopting many South Asian customs. Their unique culture differentiates them from the dominant Sinhalese and Tamil ethnic groups on the island. Their culture has been strongly shaped by Islam; hence they admire and follow Islamic law. However, during the period of Portuguese colonization, they suffered from persecution which led many of them to move to the Central Highlands.

The Arabs learnt the language of the Tamils and married their women with whom they had business relationships for many centuries. Therefore, they adapted to the Tamil language but it is a type of "Arabic Tamil" that contains a large number of Arabic words. In spite of the fact that they speak Tamil at home and share many common practices and traditions, they do not consider themselves as 'ethnically Tamils' (Mohideen 2021). In colonial European, Tamil and Sinhalese contexts, the bewildering list of terms for Sri Lankan Muslims reflects the identity issues they have experienced over the centuries.

The Portuguese, since the beginning of the colonial period in the early sixteenth century, designated the Sri Lankan Muslim community as 'Moors' (Mouro, 'Moroccans') all over their African and Asian empires as well as by familiar European terms as 'Mohammedan' or 'Mussalman' (Mc Gilvray 1998). In common English parlance, Mc Gilvray (1998) stated that both 'Moor' and 'Muslim' are used interchangeably to refer to indigenous Tamil-speaking Muslim Sri Lankans. They even maintained a close relationship with the Tamils through mutual trust in trade and business and in their cultural practices (Yusoff et al. 2018). Several studies show that the Muslims are flexible with their language, as a number of Moors living in Sinhala-majority districts enrolled their children in Sinhala-medium schools. Muslims are the third largest religious group in the country. Of these, most are Tamil-speaking Moors (who make up 93% of the Muslim population and 9.2% or 1.86 million of the total population of the country (Perera et al. 2021). Most Sri Lankan Muslims are Sunnis. Muslims fall into three groups: (1) Tamil-speaking Muslim Moors (about 90% of the Muslims in Sri Lanka); (2) Malays (about 6% of the Muslims); (3) Indian Muslims, mostly Tamils originating from southern India (about 4% of the Muslims) and sometimes called Indian Moors. Muslims may be referred to as Moors or Malays. The ethnic identity and political stance of the Sri Lankan Muslim community have undergone change over the past century in response to colonial and postcolonial pressures and from the internal dynamics of the Muslim community itself. The Moors played a key part in post-Independence Sri Lankan politics but were placed in a precarious situation after 1983 as they were caught between the Sri Lankan security forces and the LTTE (Fig. 4.3).

The Moors are energetic, hardworking and successful in their agricultural and business profession and enjoy a robust, unequivocal self-definition as orthodox Muslims. This is clearly visible in their improved houses and growing material wealth. This is one of the main reasons of concern for the high-caste Tamils, because

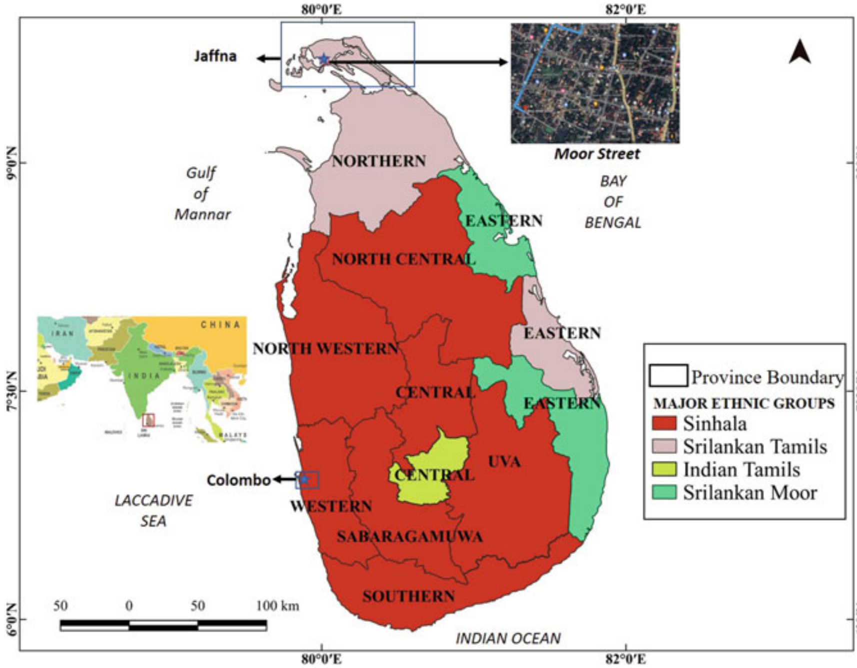

Fig. 4.3 Introducing the study area, taking note of the major ethnic groups of the island country of Sri Lanka and marking the case study points of Moor Street in Jaffna and Colombo. *Source* Authors

it challenges their traditionally dominant position in society. Besides the increasing prosperity, the Moors have also been accused of having too many children. As far as their economic position is concerned, they are loosely referred to as rich, when in fact it is just the opposite (Mohideen 2021).

There are two kinds of Moors found in Sri Lanka: one is an urban Muslim elite and the second is the rural Muslim agrarian population who are located on opposite sides of the island. The numerous northern and eastern Moor farmers are distanced geographically, socio-economically and culturally from the more affluent and cosmopolitan centres of Muslim trade and political influence in the central and western parts of the island. The west coast-based up-country Muslims are quite widely dispersed with few concentrated enclaves. The east coast towns represent nearly one-third of all Sri Lankan Muslims. In the south, half to three-quarters of the population are Moors.

In 1900 and 1903, the "Moors Union" and "Ceylon Muslim Association" were formed, respectively, to uplift the social, cultural and political life of the Muslim community contributed towards the maintenance of the separate identity of the community (Mohideen 2021). Nevertheless, they never played a strategic military or political role in the history of Sri Lanka (Ali 1981; Dewaraja 1986), and as a result they did not become identified with the state nor did they develop their own political or military ideology of sovereignty.

In 1915, the Sinhala-Muslim riots threatened racial harmony and peace among the Muslims and they started to feel helpless (Mohideen 2021). The bitter memories and the impact of the 1915 riots polarized the forces among the Muslims and encouraged them to form various organizations in order to defend their political rights as well as to better their social and cultural backwardness. The 'All Ceylon Muslim' political conference united all the political divisions among the Muslims and went before the Soulbury Commission on 5 February 1945 demanding that the communal representation to be replaced to safeguard their interests (Mohideen 2021).

The introduction of the Sinhala as the only official language across the country reduced Tamil language to an inferior position and placed the stamp of perpetual inferiority on Tamils and Muslims as their mother tongue is Tamil. It also resulted in their being denied equality of opportunity in employment in post-independence era. Additionally, due to the increase of population, Muslims and Tamils started facing acute shortage of lands for expansion which increased tension between the two communities. Despite the popular belief that Muslims and Tamils co-exist peacefully in the eastern and northern provinces, resentment and antipathy towards Muslims have grown among Tamils for nearly half a century, particularly after 1948.

During the civil war of 1983, they were victimized although they had never been a competing or conflicting party (Chattoraj and Gerharz 2019b). Their mass expulsion from the northern provinces, by the LTTE, was one of the greatest injustices meted out to them and from then on, their vulnerability has been on the rise.

With the defeat of the LTTE in May 2009 and with death of over 100,000 people and displacement of more than one million, the twenty-six-year long war came to an end. This inspired high hopes among the Muslims that their displaced life would come to an end soon and as citizens of Sri Lanka, they would return and resettle in their original homes assisted by the government, politicians and civil forces (Hasbullah 2004). However, they have been continuously neglected by the said bodies and remain little to unaided in the context of their return and resettlement—a clear denial of their right to live on their own lands.

Hence, resettling them along with the displaced Tamils would resolve their grievances and create room for the empowerment of their lives, livelihood and improve relations with the other ethnic groups in the post-war era. But resettling them is also a difficult issue as most of them have integrated into their displaced locales by building houses and establishing businesses. Moreover, their children, born and brought up in displacement, are comfortable staying on at their places of birth rather than moving back. On the other hand, those who do not own property and do not have sustainable livelihoods have considered returning to their original homes, literature and collected data have revealed that the lack of proper assistance and basic amenities pose a serious challenge to the resettlement of northern Muslims who have already returned to their original homes (Yusoff et al. 2018; Chattoraj 2017).

In 2011, several displaced Muslims registered to return to their original homes with the hope of getting some support from the government authorities in identifying and allocating lands for their resettlement, initiating housing projects and expanding livelihood opportunities (Yusoff et al. 2018; Fonseka and Raheem 2011). To their dismay, they found conditions at the return sites to be very poor and the assistance provided to them was very limited.

The Lessons Learnt and Reconciliation Commission (LLRC) in its final report (Sri Lanka, Report of the Commission of Inquiry on Lessons Learnt and Reconciliation 2011) acknowledged that displaced northern Muslims have been living in "dire conditions" for more than two decades and are experiencing trouble integrating. It was noted that, "the treatment given to the Muslim community of the northern province has led them to believe that they are at the bottom of the list of priorities of the government, INGOs, NGOs, and the donor community" (IRIN News 2013). The same report concluded that displaced Muslims remain one of the "key post-conflict challenges" with "significant impact" on reconciliation prospects. The LLRC opined that a plausible way out has to be chartered to address this age-old issue of dispossession of the Moors which otherwise, if unaddressed, will lead to further discord and tension (IRIN News 2013).

With the end of the war, several national and local developmental initiatives took place, however, none of the other Sinhalese or Tamil communities made meaningful initiatives to resettle the Muslims into their original homes. Most Tamils remain indifferent to the return of the Muslims which reflects the weakened Tamil-Muslim relations and a Tamil public sphere where little has been done to rebuild them (Kadirgamar 2015). Political debates have taken place among Tamil politicians regarding the eviction of northern Muslims who claimed the eviction was in the Muslim community's best interest. There are also instances which show the opposition of the Sinhalese nationalists regarding the resettlement of the Muslims at their original homes in Mannar district. The Sinhalese claimed that resettlement in those areas is 'illegal' as they belong to the national wildlife protection area although

Muslims held deeds to these lands (Asees 2015). The allegation went to the extent of claiming that the Muslims destroyed the national forest hampered the environment and even usurped government land.

Additionally, the fragmentation of Muslim politics has also negatively influenced the process of their resettlement. Several new Muslim parties and forces have emerged since 2000, but none prioritized the resettlement process of the northern Muslims. Unfortunately, the end of the war created no room for the improvement of the vulnerable lives of the Muslims.

Since 2013, Sri Lankan Muslims have always been targeted by the forces of Sinhala-Buddhist supremacy in their campaigns for several issues like ending halal meat certification and cattle slaughter, assaulting Islamic places of worship, arguments over dress codes and boycott of Muslim-owned businesses (Chattoraj 2022)a. Above all, the anti-Muslim riots of 2014 and 2018 resulted in looting and burning of hundreds of Muslim shops and homes (Chattoraj and Gerharz 2019a; Imtiyaz 2020). To make matters worse for the Muslims, the Easter Sunday attacks on 21 April 2019, which were Islamic terrorist suicide bombings, paved the way for a fresh round of inter-ethnic and inter-religious tensions (Imtiyaz 2020). Due to this attack, debates also arose around the banning of *burqa* and *niqab* types of face coverings of Muslim women in public in a bid to help police track down wanted terrorists (Imtiyaz 2020).

4.6.1 Moors of Jaffna

For primary survey, the article concentrates particularly on Moors of Jaffna, who had been evicted from the said region. Jaffna is known for being the heartland of Tamil nationalism. Investigating their case, which has often been overlooked by most scholars, is particularly insightful because, home refers mainly to the Muslim neighbourhood of Moor Street, located in a semi-urban region of Jaffna town (Ismail and Azeez 2014). Although Muslim settlements were found in many areas in the Jaffna peninsula since the early seventeenth century, the majority concentrated in 'Moor Street' which has had 17 mosques, six government schools and four large Madrasas. The affluent businessmen of this area had businesses of import–export of goods, gold and jewellery and hardware located outside and within Jaffna town. Despite the fact that this area was clearly demarcated as a Muslim quarter, with its own distinctive language, culture, and housing, there was a lot of interaction between Muslims living outside this area and Tamils living within it (Ismail and Azeez 2014). In the northern provinces, there are approximately 250,000 Muslims, but less than 30% have returned to their homes (Yusoff et al. 2018).

4.6.2 Moor Returnees in Jaffna

Though there was no official policy for repatriation from the government, with the end of the war in 2009, few Muslim groups started returning to Jaffna. The displaced Muslims, again and again, have voiced their grave concerns and wanted the government to facilitate their return and resettlement in their former areas, yet their case remains "a story of failure" that has undermined international recognition and sustainability of Sri Lanka's post-war resettlement (Yusoff et al. 2018: 2). With displacement, their identity, traditions and culture have already been transformed (Malkki 1995), and their return challenges them more individually than collectively: Their homes had either become ruins or were occupied by displaced Tamils, while old jobs and livelihoods had seen decades of disruption, and schools were hardly functional.

According to a local informant, only around 967 out of 10,500 Muslim families had returned from Puttalam refugee camps to their original homes by the end of 2017. And among them only 150 were provided housing by the Sri Lankan Government (Chattoraj and Gerharz 2019b). In addition, another 3000 returnees were expected to return soon. However, our data reveal the difficulties they face after return due to lack of job opportunities and suitable education facilities. In Puttalam, they had a good life with intensive agriculture, fishing and associated employment opportunities; however, the mistreatment and discrimination they faced there from the locals outweighed these advantages—the desire to get rid of their 'refugee statuses' got the highest priority.

Despite the joy and happiness which marked the moment of their return, several respondents described that they were upset about the demographic and socio-cultural changes which had occurred in Moor Street during their forced displacement—a pattern which is quite common among displaced persons who return after a lengthy period of time, including Tamils who sought refuge abroad (Gerharz 2010). Adding to the general feeling of alienation, many expressed that the availability of land and obtaining a job were the major hurdles. They were not offered land upon return from the local or the national Government. They were also excluded from receiving rations that repatriates were usually awarded due to their registrations.

4.7 Dispossessing 'Own People' from Their Homeland: The Narratives

"Who are you? […]"- the feeling of being dispossessed: After almost two decades, Surin (a 45-year-old Jaffna Moor who was displaced to Colombo in 1990 desired to return to his own land in Jaffna in 2011) went to visit his birthplace Jaffna: "In 2011, I alone went to Moor Street in Jaffna for the first time after 1990 and the first question I encountered was, "Who are you? Why are you here?" […]". There is a self-doubt lurching about the own identity of an individual. His family used to be well-known in the area, so he was taken aback to know that he was a stranger to those who now reside in that area. During the war, like his family, most of his former neighbourhood migrated to Colombo or to other parts of the country. Subsequently, most of their homes became occupied by strangers (Tamils). Therefore, his identity felt at stake as no one he knew remained. This identity problem strongly influenced his idea and feelings towards his homeland. He became ambivalent in making a decision to return, or not to. To him, his former relationships in and of the town, romanticized by distance in his imagination, changed over time and were unmatched by the experience of a returning to visit. He was disappointed that relationships were "not what they used to be". This also meant that he would not enjoy his family's former status as they were now the outsiders and newcomers to the present residents. Therefore, his first visit, which was supposed to be the first physical and emotional connection with his place of origin, a meeting of past and present, of imaginations about his (past) home and the reality of the present, turned out to be disappointing and painful. A complexity of feelings arose for him when he faced comments on entering the town: "[…] you are a stranger to us". His dissatisfied visit shattered his perception of home, further reinforcing Colombo, his present place of residence, as his home.

Working as a bus-driver in Colombo, this visit also gave him the scope to examine the aspects of life he would have if he returned in terms of his career, which would be very uncertain as there are no promising opportunities in Jaffna. His main desire was to get upliftment in the social status and setting up his own business in Jaffna with the savings he made in Colombo. However, the attitudes that he witnessed from the Tamil neighbourhoods, left him wondering about his decision. He felt like a stranger in his own land. All these realities left a strong negative impression on Surin's idea of homeland in Jaffna. He felt to have been dispossessed in his own land.

The struggles of being a Moor: in pre- and post-return days "I am originally from Moor Street in Jaffna. I have been born and brough up there. But all of a sudden in 1990, we were asked to leave by the LTTE. We went to Colombo. Life was so difficult there. We were considered as lower-class people there by the local Sinhalese and Tamils. So, when the war ended, we decided to return to our own place in Moor Street in 2011. We did not get the scope to visit Jaffna in all these years, so we were anxious about our home. When we finally visited Jaffna, we saw a Tamil family has been residing in our place. We narrated our situation to them and even offered them for sharing. They denied and said in no way, they are going to leave our house. What can we do? Our neighbourhood has changed totally, the area which used to be a Muslim dominant has become a mixed one. Tamils were everywhere. So, we rented a room with our savings and started looking for jobs. We faced terrible situation then. […] No one was ready to give us jobs as we are Muslims. After much hassle, my husband got a daily-wage masonry job and I got the scope to do some tailoring works in a nearby shop. We are surviving but this is not the life we imagined".

Shamiya, a 52-year-old Tamil-speaking Muslim lady, returned to her place of origin in Jaffna after struggling to live in Colombo where they were looked upon as lower-class people. Their decision to return, even though they were unaware of the situation of their home in Jaffna, can be understood as being related to their aspirations to a good life and to retrieve their own lost identity. However, her return experiences were not pleasant as well. Having been displaced for three decades, they too, have become unwanted and dispossessed in their own homeland.

The idea of returning to Jaffna developed as a connection to her past life. She described her past as one characterized by peacefulness, stability, a place where she and her family fitted in perfectly and did not face any obstacles in regard to their culture, religion and identity. This closely echoes Malkki's review of Geiger's work among Cambodian and Vietnamese refugees where he states that before becoming refugees, they enjoyed lives filled with peace, stability, enough food to survive and most importantly their very own place in society (Malkki 1995). During the evictions of 1990, Shamiya and her family were forcibly displaced to Colombo.

One of the main drivers for their return to Jaffna was their aspirations of a better life, one which would have been impossible in Colombo because of the negligence they experienced there being a Muslim. Also, the thought of return and resettlement offers a "sense of possibility with opportunity for change, improvement and the unexpected—that is, space for dreaming and imagining" as Hage (1997) puts it. The idea of resettlement does not automatically bring with it, a new sense of home, rather, it offers a hope that is a necessary prerequisite to construct a new home, where physical security and a sense of self and inclusion, would be met (Den Boer 2015).

> However, after return, we are disappointed! Things have changed; our community has changed. Tamils and Sinhalese are sharing our locality which was previously a Muslim-only locality. To add to our difficulties, no-one is ready to offer us jobs. Life is full of uncertainties now.

The actual experiences of return failed to meet Shamiya and her family's expectations. She was disappointed to see the changes that had taken place within their culture and among their community. The demographic composition of her locality, which used to be Muslims only, is now inhabited by both Tamils and Sinhalese often leading to communal tensions. In addition, job opportunities seemed to be far less in Jaffna. Their struggles remained the same as was in Colombo. The hope of having a better life and regaining their lost status did not materialize.

4.7.1 "Homeless at Home": Struggles After Return

Farzam, a 38-year-old Muslim from Moor Street decided to return to acquire what he had lost and also to end the feelings of uncertainty, insecurity and fear as he stated that "everything I did in Puttalam seemed fake… Returning to Jaffna will give my identity back. I love to be here, I grew up here, Jaffna gave me everything. I feel like belonging to this place […]". To Farzam, Jaffna presents itself as a choice, a desire or an identity. It centres on a community and a society. He had been raised up in the town which provided him with physical comfort and with a sense of connection and belonging not only to his family and household but also with his friends and neighbours. In Puttalam, he never felt like he belonged to anything.

However, like Shamiya, Farzam's return to Jaffna has not fulfilled his wish of regaining his lost old status which he enjoyed before displacement. Since his return in 2010, he has been staying in a rented place which is nearby to his old house. The old house is destroyed, and most of his old relations have moved to some other place in the country. He is left alone at his new locale in Jaffna which evoked the idea of being 'homeless at home' as has been shown by Chattoraj in her study on Tamil displaced persons (Chattoraj 2017). The new location has turned into an estrangement, as he neither knows his neighbours nor is he acquainted with the place. His rented place fails to provide the material and immaterial comforts that he expects (expected?) from his own home.

4.7.2 Broken Dreams, Unfulfilled Aspirations

Nusrat, a 30-year-old woman who is originally from Moor Street, returned to Jaffna in 2012 after almost two decades. During her interview in February 2013, she shared the story of her childhood, displacement and return. Childhood memories reflect her attachment to home while return reproduces the kind of disappointment she experiences at her home now: "In my 'home', we had a big well which provided pure drinking water. We had fields which were divided according to the trees […]. They provided firewood which acted as a side income for us. All these are totally lost due to the war […]. All our relations used to surround our home. I was a little girl then. I used to play in the fields with my relatives and neighbours. Mother during the day was at school, when she returned home, she used to play with me as well, besides doing the cooking and other household works […]. Comparing my present life, my past life was far better. I enjoyed a lot. It was a place where we knew each other […]. I think it is better to move abroad than staying here".

Nusrat's narrative points out the ways in which she experiences the changes which have occurred in Jaffna during the past 20 years. In its transformation from a rural to an urban space, Jaffna does not represent what Nusrat has kept alive in her childhood memories. Instead of being the idyllic place, where Nusrat used to play as a little girl, and which she has very fond memories of, the place now offers her far fewer possibilities for feeling at ease.

For Nusrat, home is linked to important life stages like childhood, adolescence and parenthood and expressed in terms of experience and memories. The childhood memories that Nusrat has translate into a degree of attachment to the place itself (Milligan 1998). On the one hand, memories of the childhood home are ingrained with fuzzy feelings of security and comfort and fixations of happiness (Bachelard 1964) while on the other hand, traumatic events like war and displacement penetrate the dreams of this childhood home. As a result, Nusrat's idea of home revolves around Jaffna, which is both an ideal place for her and a place of pain and violence.

Nusrat recollects from her childhood, "After being first displaced in 1990, we initially went to Puttalam and stayed at a rented place. Being a middle-class family, we did not have to stay in the camps. I was lucky to stay with my relatives and friends all throughout. The structure of our original home in Moor Street is still there, but if we want to return, we have to rebuild and renovate it. There are no basic facilities available. Also, none of our relatives or neighbours are there. All have migrated to other parts of the country. Since 2012, we have returned to Jaffna and have been living at my sister's house with my mother. My sister returned in 2011 with her husband and has already rebuilt her partially-destroyed home. Her home is very close to our original home in Moor Street, so we can have a close look at the present condition of our home".

Her consideration to move abroad stems from the temporary living arrangement at her sister's house as well as the lack of employment opportunities in Jaffna. Being a graduate, she cannot find a suitable job in Jaffna due to the high rate of unemployment. Thus, she is trying to balance the fond memories of her past with her future aspirations and her desire to achieve a 'good life'. But "aspirations to the good life are part of some sort of system of ideas which places them in a larger map of local ideas and beliefs about life and death, the nature of worldly possessions, the significance of material assets over social relations, the relative illusion of social permanence for a society and the value of peace or warfare" (Appadurai 2004). Currently being torn between the different priorities she has in her life, urges her to decide between staying at the place called 'home' and emigrating abroad, where job opportunities are far better. The feeling of alienation from Jaffna considering the absence of relatives and familiar neighbours relates to the "antagonistic sense of home", as pointed out by Den Boer (2015) reflecting on the Congolese refugees in Kampala. The lack of prospects and opportunities and the ill-treatment towards them has become a decisive consideration for many Muslims in Jaffna, who thus tend to move out for better opportunities.

4.7.3 Easter Sunday Attacks and Its Effect on the Moors: Narratives from the Women

In 2013, quite a number of Muslim returnees in Jaffna were fearful because of several anti-Muslim acts. And since the Easter bombings in April 2019, situation has gotten worse as one respondent pointed out: "[…] Easter Sunday attacks drove the nails to the coffin […]". Since 2013, Muslims have been routinely targeted by the forces of Sinhala-Buddhist supremacy. Things became worst with the Easter Sunday attacks of 2019 which paved the way for a new wave of Islamophobia (Imtiyaz 2020). Muslim villages were attacked in waves, properties were destroyed and people were threatened by the Sinhalese mobs as a result of the Easter attack (De Votta 2018).

> "I am a Muslim and I wear the burqa. After the Easter Sunday incident, I am scared that if I wear it outside, it will raise threats. So, I rarely go out […]".

This is the most common statement we heard from the female respondents in the second phase of our interviews. Almost all of them were threatened due to their Muslim identity, highlighted by wearing Burqa. For this reason, several Muslim ladies have stopped going out or do not wear Burqa while going out. One such example is Arifa, a 30-year-old woman who tried to hide her Muslim identity by not wearing the Burqa. "It is pointless to get labelled as a Muslim and provoke others", she uttered. In many cultures, distinct attires provide identity to a community. Muslim girls and women reveal their identity by wearing Burqa, which functions essentially as an ethnic marker and acts as a primary means of identifying a Muslim woman. At present, security concerns create an obstacle for a willingness to reveal one's 'own Muslim identity'. For some, this is a fundamental and emotional issue; for others, it is a pragmatic question.

This section, thus, shows the dilemma that the Muslim women are having in their own country. They feel dispossessed and always in threat because of their identity. This leads to a perpetual cycle of fear.

Another common phrase from the respondents during the second phase of data collection was "It has been more than a decade that the civil war has ended, but for us, the extreme repressions and the militarization continues until today". Mumtaz, in her late 40 s, stated, "How can we feel safe in our home (Moor Street) when it still (in 2021) remains a dangerous place to live in due to the active repression by the ruling government of Gotabaya Rajapaksa? Till now, the police and military have occupied thousands of acres of land in our neighbourhoods. And, since the election of president Gotabaya Rajapaksa in November 2019, instances of police brutality have escalated".

Post-war conditions have left Moor respondents feeling dispossessed, abandoned and constantly threatened. As a result of their displacement from their original homes, they had to establish a new home in their new location. However, most of them failed to do so and returned to their original places. But their original places lacked a sense of safety, security and happiness. They are still in threat, especially after the Easter attack and now because of the severe economic and political crisis prevailing countrywide. There is no longer a sense of comfort and home on Moor Street. Thus, they consider themselves as dispossessed in their 'own lands' and from their 'own people'.

4.8 Conclusion

While tracing the ethnic diversity of Sri Lanka, authors have tried to delve deep into the issues faced by the Moors, the Muslim indigenous ethnic minority. How the Moors have held their own in front of the majority forces of Sinhala-Buddhist supremacy and faced inter-ethnic and inter-religious tensions in their own country have been highlighted. This chapter has constructed a narrative of the life-politics of the Moors on the basis of the perspectives shared by themselves, addressing their lived experiences and investigating their future imaginaries. They show that the Moors, even in their own land, they are staying in constant threat and fear from the majority group whom they refer to their 'own people'. They feel like 'strangers and homeless in their own homes in Moor Street'.

In doing so, this chapter also discusses about the newer stress faced by the Moors and find out how they are struggling to repudiate their apprehensions of a forced displacement. To add to it, the ongoing political and economic crisis, caused by a serious Balance of Payment crisis, has worsened the situation ever further. The Rajapaksa government's unrealistic populist measures, such as tax rate reduction, led the country into a huge debt trap. Besides, the Covid-19 outbreak and the Russia-Ukraine war further deteriorated the situation (Chattoraj 2022)a. A large number of people are continuously protesting against the government. Though the politico-economic crisis has affected entire Sri Lanka, the ethnic component cannot be entirely ignored; the exodus of Tamils and especially Tamil Muslims have been noticeable (Narayanan 2022). To escape the recent crisis, around 150 poor Sri Lankan Tamils mainly from the North and East have already fled and took refuge in India along with few Singhalese (Silk Road Briefing 2022). Though out of humanitarian concern, the Sri Lankan asylum seekers, both then and now have been accommodated in the refugee camps, a proper legislation is still lacking barring the migrants from having a proper documentation to pursue livelihood options in India along with the absence of a repatriation policy affects voluntary deportation too (Ramanayake 2022). The Moors grappling with food shortage, unemployment in their own country is trying to find solace elsewhere but the situation for them is like 'frying pan to fire' and the already marginalized community facing another mass exodus is getting more traumatized. All the Muslim indigenous ethnic minority community of Sri Lanka is looking forward to getting back to their roots, their homeland where they can feel the long-lost warmth.

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Part II
Approaches to Disaster Management

Chapter 5
Mountainous Hazards and Sustainable Livelihood in Leh Valley

Deepa Bhattacharjee and Rupam Kumar Dutta

Abstract Availability of natural resources influences the daily livelihood of the people of an area. Livelihood in higher altitudinal environment is very challenging mainly in terms of climatic and geomorphic characteristics in Leh valley. Periglacial environment has exerted deep impact on the development of landform as well as the livelihood pattern in this higher mountainous area. Field-based perception study of the local people about their unique style of coping with local environmental hazards is very crucial in management and formation of policies for sustainable development in the study area. The longitudinally trending NW–SE Leh valley extends from Karoo in SE (33°54′48″N, 77°44′14″E) to Pathhar Sahib in NW (34°11′31″N, 77°22′19″E). The Leh valley bordered by snow covered mountainous Ladakh and Zanskar hill ranges. Ladakh range lies between the Indus and Shyok River valleys, stretching to 230 miles (370 km). Undoubtedly, different types of environmental hazards like earth quake, cloudburst induced flash flood, soil erosion, excessive snowfall have deeply impacted on the livelihood of the higher altitude cold desert area. Apart from these, scarcity of natural water resources and agricultural land has intensified problem in daily livelihood of the local people. The chapter has also illustrated the over interaction of human activities in natural environment that also amplified the potential of hazards and disaster in Leh valley.

Keywords Perception study · Mountainous hazards · Sustainable livelihood · Hazard management

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_5

5.1 Introduction

The present work reveals local people's perception of different types of mountainous hazards and changing livelihoods in Leh valley with special reference to the Stakmo village. The longitudinally trending NW–SE Leh valley extends from Karoo in SE (33°54′48″N, 77°44′14″E) to Pathhar Sahib in NW (34°11′31″N, 77°22′19″E). The Leh valley bordered by snow covered mountainous Ladakh and Zanskar hill ranges. Ladakh range lies between the Indus and Shyok River valleys, stretching to 230 miles (370 km). The Stakmo village (Fig. 5.1) is situated over dry fan (fan apex, 34° 7′ N and 77° 42′ 1″ E) in the Leh valley. Along the fan surface, the Stakmo village (77° 42′ 21.56″ E, 34° 01′ 36.90″ N) has been developed which is under Leh block. The local people of the study area are still dependent on agriculture and livestock for their food security and livelihoods, despite the involvement of a significant proportion of households in non-agricultural income-generating activities, such as tourist services and labour work in other areas (outmigration). Periglacial climate and higher mountainous environment have exerted deep impact on occurrences of hazards as well as the livelihood pattern in this area. Due to climatic, geologic and topographic conditions people of the study area face different types of environmental hazards like earthquake, cloudburst induced flash flood, landslides, avalanches, soil erosion, etc. The mentioned natural hazards have deep impact on the livelihood of the higher altitude cold desert area. Apart from these, scarcity of natural water resources and agricultural land has intensified problem in daily livelihood of the local people. Unscientific rapid growth of the settlement areas in the higher altitude mountainous environment is one of the prime reasons of unsustainability in livelihood of the local people in Leh valley.

Ladakh area has been several times emphasised for its cloud burst induced flash flood vulnerability previously in different years specially in Leh valley (Ziegler et al. 2016; Gupta and Arora 2017; Arya 2011). A number of scientists (Barrett 2014) have focused their studies on climate change and associated glacial retreat problems in the area. Searle (2011) had remarkable contribution in the study of geology in Ladakh and Karakoram ranges. Lal et al. (2019) have emphasised the tectonic influences on the landform development in Ladakh region. Many scientists (Sant et al. 2011) have also emphasised on geomorphological classification of Leh valley emphasising on periglacial landforms. Koul et al. (2016) published report on glacier status over the past 50 years (1962–2013) on remotely-sensed volumetric changes of glaciers in Drass glacier basin, Ladakh Mountain, North-West Himalaya. Gupta and Arora (2017) explained vividly the characteristics of the soils of Ladakh region. Mukhopadhyay (1980) had elaborated geomorphology of peri-glacierised area of upper Tista basin. Sangode et al. (2017) have analysed the sedimentary and geomorphic signatures of 2010 cloudburst triggered flash flood in Leh valley. Mujtaba et al. (2017) identified the geomorphic imprints of the palaeolakes, alluvial fans and other landforms around Leh. Many renowned scientists (Bisht et al. 2008; Raghuvanshi et al. 2019) have contributed their valuable research works on agricultural land use patterns and associated problems in Leh and its adjoining areas. Merrey et al. (2018)

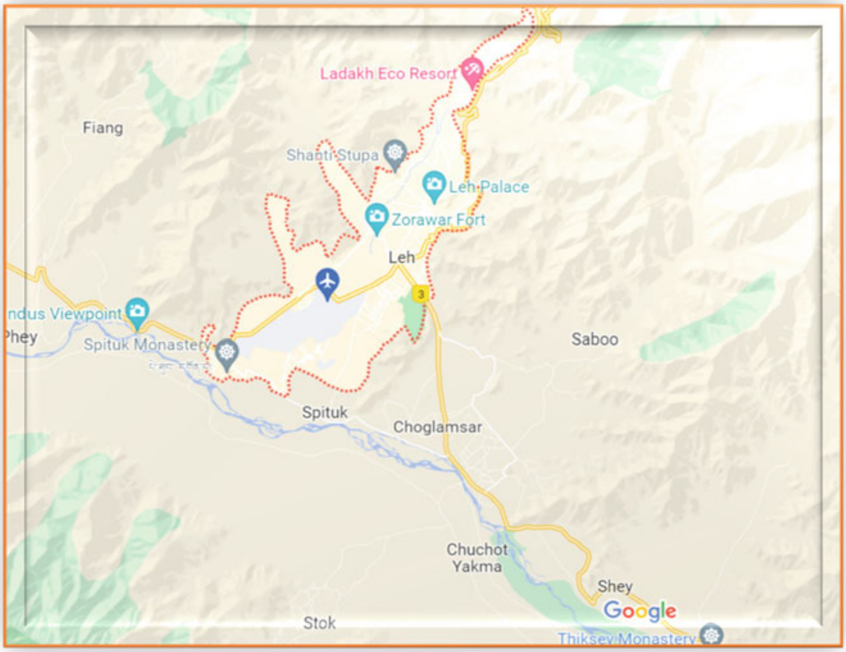

Fig. 5.1 Location of the Stakmo village and Leh city in part of Leh valley. *Source* Google Map and Toposheet, S.O.I

have contributed field-based study on evolving high altitude livelihoods and climate change of Rasuwa District, Nepal. Dame et al. (2019) nicely elaborated the scenario of rapid urbanisation of the Leh town as well as the conversion of the barren land and agricultural land into built up area. So, the study on mountainous hazards and sustainable livelihood is very relevant issue in case of Leh valley.

However, the objective of the chapter is to illustrate mountainous hazards and livelihood sustainability of the Leh valley in an integrated form. The present research has focused on qualitative and quantitative analysis of the Stakmo nala basin emphasising mountainous hazards and sustainable livelihood.

5.2 Materials and Methods

Stage-I: The chapter is prepared on several secondary data and primary data including field observation. The secondary data includes toposheet (SOI), satellite images (google earth, 2020), valuable literatures, and the primary data consists of local people perception and field recorded data with photographic evidences. Based on several previous literature review, specific research gap regarding mountainous hazards and sustainable livelihood in Leh valley has been identified.

Stage-II: Field verification was done to gather different types of primary data of the Stakmo nala basin (landform study, nala morphology analysis, observation of land use practices, etc.), photographic evidences including the people perception about the flash flood in Stakmo village and adjacent area.

Stage-III: Analysis of the secondary data regarding physical setup (physiography, ground water availability, climate, geology) was so import to explain the causes the natural environmental hazards in Leh valley and Stakmo nala basin. Morphometric interpretation of the basin has been done based on SRTM DEM. Study of different hazard and disaster related secondary data (incidences of different hazards and casualties) has been emphasised in this chapter for better understanding the magnitude and severity of those hazards. Tourism related data (year wise arrival of Indian and foreign tourists, number of hotels, guest house and travel agents, etc.) has been analysed to illustrate tourism potential and rapid growth of tourism activities of the study area. Involvement of workers in different economic sectors has been studied to focus the nature of livelihood of the local people. Field-based observation of land use pattern along the Stakmo dry fan was also very relevant for better understanding about the land use pattern of the area.

Stage-IV: Depending on the analysis of the collected primary and secondary data, special emphasis has been given on perception of the local people about the occurrence of hazards and their changing livelihood pattern in the study area. Few effective measures have been concluded towards the sustainability of the natural resources and livelihood of the people Stakmo village.

5.3 Results and Discussions

As a consequence of climatic, geologic and topographic setup people of the study area face different types of environmental hazards as well as disasters like earthquake, cloudburst induced flash flood, avalanches, landslides, soil erosion, etc. The mentioned natural hazards have deep impact on the livelihood of the higher altitude cold desert area. Every year a number of casualties caused by different natural disasters in Jammu and Kashmir including Leh areas. Though according to the report provided by Govt of India from 2005 to 2018, the numbers of casualties are decreasing (Table 5.1). Due emphasis on planning of pre-disaster management probably the reason of that falling trend in death. In order to discuss the natural environmental vulnerability of the local people, vivid understanding about the characteristics of different physical setup (climate, geology and geomorphological process) is required.

Table 5.1 Deaths due to natural disasters in Jammu and Kashmir including Leh

Year	Deaths due to natural disasters (J&K including Leh)
2005	1157
2006	345
2007	278
2008	307
2009	226
2010	575
2011	314
2012	321
2013	308
2014	518
2015	387
2016	280
2017	127
2018	131

Source NCRB, MHA, Govt of India

5.3.1 Climatic Characteristics and Flash Flood Hazards

Previous studies suggest Ladakh which has been transitioning into a new and increasingly more volatile environment due to climate change. Perhaps the most visible and tangible impact from rising global air temperatures has been the steady disappearance of regional glaciers. In the principle town of Leh for instance, where temperatures have increased by 1 °C since 1973, the snow line has risen more than 490 ft (150 m) and the remaining glaciers have retreated by as much as 6.2 miles (10 km) in the past century (Barrett 2014). From Table 5.2, trend of average monthly maximum and minimum temperature of Leh is very clearly observed. In the year 2010, the range between average maximum and minimum temperature was about 40 °C. The high range of temperature is suitable for physical weathering of rock surfaces. On the other hand, Table 5.3 clearly indicates temporal (2009, 2010, 2012, 2013, 2014, 2015, 2016) changes of precipitation including snowfall and rainfall of the study area.

Cloudburst induced flash flood: Cloudbursts are usually triggered by mountain formations that lead to lifting of moisture-laden winds and forming of a convective cloud. Cloudbursts are common in the western Himalaya. Western disturbances over the Leh region. A cloudburst in Ladakh is unnatural because it is a rain shadow area but according to data provided by the India Meteorological Department Leh experiences cloudburst events. During the month of August (2010), Leh received abnormally very high amount of rainfall (58.4 mm) (Table 5.3) that caused devastating flash flood resulting massive losses of lives and properties.

Table 5.2 Maximum and minimum temperature (°C) at Leh

Month	Year											
	2010		2012		2013		2014		2015		2016	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Jan	0.13	−15.39	0.1	−15.4	3.0	−10.54	−0.03	−13.53	0.8	−13	1.3	−13.4
Feb	0.59	−10.32	0.6	−10.7	1.67	−10.23	0.75	−9.88	3.3	−8.5	4.3	−10.2
March	8.9	−2.26	9.2	−2.3	8.48	−4.85	7.08	−5.15	7.0	−4.9	9.7	−5.1
April	12.62	1.53	12.7	1.5	12.6	−0.25	12.3	−0.48	12.5	−0.2	12.9	0.8
May	15.58	4.6	15.53	2.67	16.3	3.79	16.96	3.35	16.7	4.1	19.3	4.9
June	17.36	6.1	18.6	7.53	23.4	9.5	20.69	9.25	19.5	7.6	24.2	11.5
July	24.23	12.63	26.59	13.87	26.85	13.58	26.17	13.37	25	11.5	26.1	14
August	25.08	12.55	26	13.29	26.11	12.66	24.54	12.03	25.1	12.3	24.8	13.4
September	20.01	7.8	20.51	7.6	21.25	7.0	18.76	6.65	18.9	6.0	22.1	7.7
October	14.5	−1.85	11.77	−1.74	15.66	−0.03	14.59	−0.01	15	0.2	15	−0.3
November	9.5	−7.92	7.72	−5.05	13.8	−8.33	8.41	−8.08	9.1	−5.2	9.5	−6.3
December	3.23	−12.97	1.56	−12.5	2.95	−12.41	291	−11.69	2.2	−10.8	5.9	−11.6

Source Statistical Handbook, Leh, 2016

Table 5.3 Amount of rainfall and snowfall in Leh and its adjacent area

Month	Year						
	2009	2010	2012	2013	2014	2015	2016
Jan	6.6 cm (S)	1.5 cm (S)	1.5 cm (S)	3.9 cm (S)	6.0 cm (S)	0.5 cm (S)	1.8 cm (Snow)
Feb	2 cm (S)	7 cm (S)	7.0 cm (S)	4.6 cm (S)	0.4 cm (S)	0.6 cm (S)	1.8 cm (Snow)
March	0.5 cm (S)	1.1 cm (S)	1.0 cm (S)	–	–	3.6 cm (S)	NIL
April	NIL	8.8 cm (S) 41.1 mml	1.0 cm (S)	10.0 mml	–	8.5 mm (R)	4.6 mm (rain)
May	NIL	6.7 cm (S) 19.6 mml	NIL	–	–	0.2 mm (R)	NIL
June	4.4 mml	35.5 mm (R)	19.6 mm (rainfall)	15.7 mm (R)	–	11.2 mm (R)	NIL
July	3 mml	2.5 mml	1.9 mm (rainfall)	22.0 mm (R)	29 mm (R)	6.8 mm (R)	NIL
August	5.5 mml	**58.4 mm (R)**	9.1 mm (rainfall)	24.2 mm (R)	2.6 mm (R)	57.4 mm (R)	8.4 mm (rain)
September	10 mml	12.5 mm (R)	1 mm (rainfall)	2.9 mm (R)	45.4 mm (R)	23.4 mm (R)	NIL
October	4 mml	0.9 cm (S)	NIL	7.6 mm (R)	–	0.6 mm (R)	NIL
November	19 cm (S)	NIL	NIL	–	–	NIL	NIL
December	3 cm (S)	9.7 cm (S)	NIL	0.4 cm (S)	1.8 cm (S)	0.9 cm (S)	NIL

Source Statistical Handbook, Leh, 2016, R-rainfall, S-snowfall

5.3.2 *Geological Impact on Earthquake Hazards*

Geologically, the area is a desert of bare crags and granite dust with mostly rocks of sandstones, shales and conglomerates. The crystalline rocks-gneisses and schists occupy large areas. Because of lack of water action on the rocks, large quantity of detrital material is seen in the valleys and dry uplands, forming a peculiar kind of mantle rock or regolith which consists mostly of fresh unweathered rock material (Gupta and Arora 2017).

Lal et al. (2019) have emphasised the tectonic influences on the landform development in Ladakh region. According to their studies, there are different types of depositional landforms like terraces, fans, lake and moraines which contain records of several climatic fluctuations during the Quaternary period. The Indus River flows along NW–SE trending Karakoram Fault in its upper reaches and subsequently along the Indus Tsangpo Suture Zone (ITSZ) which separates the Indian continental part from the Asian continent. The Shyok Suture Zone (SSZ) lies to the north of this

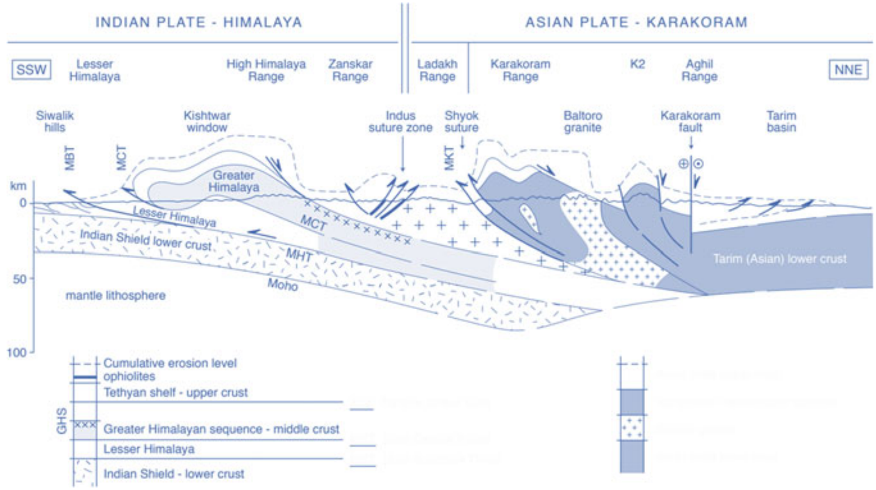

Fig. 5.2 Cross section of the Western Himalaya and Karakoram range showing tectonic vulnerability with several major thrusts, faults and suture zones of the Indian and Asian plate. *Source* obtained from Searle (2011)

Table 5.4 Events of earthquake in Ladakh

Earthquake event	Date	Latitude	Longitude	Magnitude
1	04.1.2003	39.62 N	76.99E	5.2
2	24.2.2003	39.68 N	77.23E	6.3
3	16.5.2003	39.44 N	77.09E	4.6
4	24.7.2003	39.74 N	76.71E	4.2
5	10.8.2003	27.22 N	75.74E	4.5

Source DMP, Leh, 2016

area separating the Karakoram Metamorphic Complex and Ladakh Batholith and associated rocks (Fig. 5.2). The nearly NW–SE trending Karakoram Fault Zone is an active crustal scaled fault zone which traverses the area between ITSZ and the SSZ (Lal et al. 2019; Searle 2011). As a result of active tectonic influences, the study area repeatedly experiences earthquake events (Table 5.4).

5.3.3 Geomorphological Impact on Hazards and Livelihood

Geomorphology of the Leh valley has a great influence on the development of ground and surface water availability in some parts of Leh valley. The present authors think that there are three important geomorphic zones where development of settlement area including land use patterns have been possible; (1) Indus floodplain, (2) Amphitheatre valley with nalas (3) dry alluvial fans.

In broad valley, snow fed surface and ground water is an important natural resource to sustain the lives. The broad glaciated valleys are mainly filled with glacio-fluvial alluvium, moraines, weathered materials including stone lag deposits, sand dunes, etc. The unconsolidated formations like alluvium, scree and talus deposits present along the river valleys which plays a vital role in terms of occurrence and movement of ground water. The moraine formations consist of boulders and clastic in a matrix of gravel, sand, silt and clay which from the aquifer. Depth of water level in moraine formations is very deep which varies from 60 to 75 m bgl (CGWB 2014). The Stakmo village is located along the Stakmo nala valley. The upper part bears prominent characteristics of amphitheatre valley, and the lower part the Stakmo nala has developed an elongated dry fan over which the Stakmo village has been developed.

Fluvial Process on Hazards and Livelihood

The study area is mainly drained by the river Indus. Two main rivers flowing in this area are Nubra and Shyok. Nubra is a perennial river and is originated from Siachen glacier and flows in North west to South east direction. Syok River is also a perennial river and it originates from South Rimo Glacier and Central Rimo Glacier. Beside the main rivers, in Leh valley, there are so many nalas flowing from the north-eastern Ladakh Batholith Ridge Crest. The nalas are locally termed as Lungpa. Those nalas are mainly fed with glaciers and snowmelt water. The important nalas are such as Taru nala, Phyang nala, Khardung nala, Sabu nala, Stakmo nala, Nang nala. Those nalas have great influence on the development of landforms and land use pattern in Leh valley. All of the alluvial fans in the Leh valley area develop important aquifers. Along the nalas, series of fans have developed and depending on the fan topography as well as water resources of the nalas a number of settlement areas and villages have been developed. Though during cloudburst triggered flash flood, these nalas (Figs. 5.5 and 5.7) cause excessive water and sediment discharge as well as debris flow from the Ladakh Batholith Ridge into Leh valley causing severe damage of lives and properties. A study by Sangode et al. (2017) on 2010 flash flood event reveals that the small stream drainage area produced extra stress on the pre-existing narrow channels, forcing the rapid lateral erosion and mass transfer.

Morphometric Analysis of the Stakmo Nala Basin

The Stakmo nala (Fig. 5.7) basin is extended from 34°0′ north to 34°12′ north and 77° 30′ east to 77° 47′ east. The river is mainly snowfed originated from the Ladakh range. It is fourth order nala (Fig. 5.4). The nala has developed an elongated dry fan which has been demarked in the basin map. A relative relief map (Fig. 5.3) of the entire basin has been prepared based on SRTM DEM. The apex of the fan (fan apex, 34° 7′ N and 77° 42′ 1″ E) is shown in the map. Above the apex of the fan, prominent amphitheatre valley is located (Fig. 5.3). Excessive terminal moraines are observed over the floor of the amphitheatre valley. The moraines are heavily weathered under periglacial environment. Heaps of weathered moraines are the source of sediment of the Stakmo fan (Fig. 5.7). According to the villagers during 2010, cloudburst induced flash flood debris flow from the upper course of the basin or from amphitheatre valley caused devastation in downstream settlement area over the Stakmo fan and the campus of the Druk a Lotus school.

Maximum relative relief is (600–834 m) seen at the upper part of the basin. The vast lower fan shows the relative relief from 47–225 m (Fig. 5.3). Maximum slope

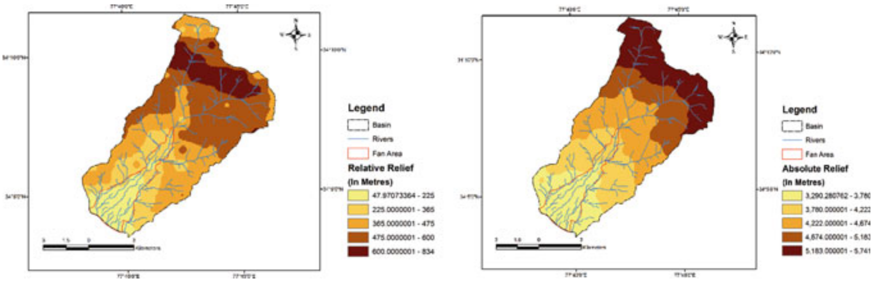

Fig. 5.3 Relative relief and absolute relief. *Source* SRTM, DEM

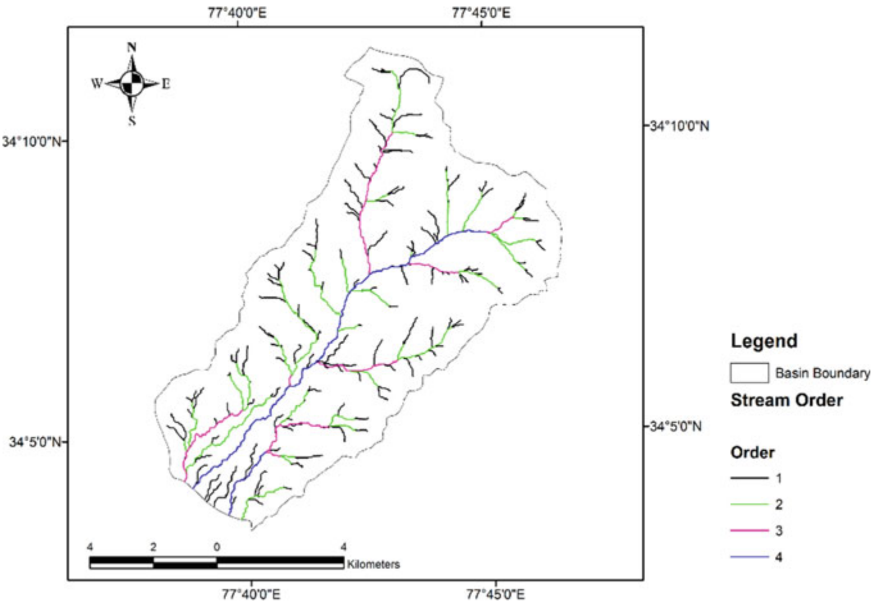

Fig. 5.4 Stream ordering of Stakmo nala basin. *Source* SRTM, DEM

Fig. 5.5 Upper reaches of the Stakmo nala indicates prominent incision due to flash flood in 2010. *Source* field survey, 2014

(41–69°) is observed in the upper part of the basin where mass wasting process is very active. Over the fan surface, the average slope is 0–12° where the Stakmo village is located. The Stakmo nala is flowing over this fan area with its characteristic channel forms. The absolute relief map (Fig. 5.3) of the Stakmo basin clearly indicates fan surface with gradual decline of the elevation. The elevation of the upper fan is 3780–4222 m. On the other hand, lower fan is located at the elevation of 3290–3780 m.

Periglacial Dry Stakmo Fan and Sustainable Livelihood

The landforms of the Stakmo basin indicate clear evidences of periglacial features. Several geomorphic processes are working over the entire landscape that are characterised with glacial, periglacial, glacio-fluvial, aeolian, lacustrine and tectonic processes. Sometimes periglacial processes cause problem of excessive snowfall and avalanches and landslides which result damage of lives and properties.

Avalanches: An avalanche is a rapid flow of snow down a slope, such as a hill or mountain.

Avalanches can be set off spontaneously, by such factors as increased precipitation or snowpack weakening, or by external means such as humans, animals and earthquakes.

Snow avalanche is one of the major hazards observed in the areas covered by glaciers. Several times Leh and its adjacent areas were hit by snow avalanches (Table 5.5) resulting casualties. Seven people lost their lives after an avalanche hit two trucks, carrying 10 people, at the Khardungla pass in Ladakh on 18 January 2019. Mainly from January to March, the frequency of occurrence of avalanches (Table 5.5) is very high in Ladakh area. Almost every year the area faces loss of lives and properties by avalanches. Apart from avalanches, excessive snowfall (Table 5.3) during winter season sometimes disturbs the normal lifestyle of the people. Heavy snowfall makes blockages of roads.

Landslides: Beside avalanches and snowfall problem, in the Leh valley specially in amphitheatre valley and deglaciated 'U' shaped valley, occurrences of landslides are very frequently observed. The roads constructed along the amphitheatre valley and 'U' shaped valley are very much landslide prone. A catastrophic landslide induced by intense rainfall occurred near Leh city in Ladakh region of western Himalayas (34.09 °N/77.34 °E) on 6 August 2010. The possible causes of landslides are shown in Table 5.6. Some major landslides events (Table 5.7) took place in the study area and its adjacent part causing serious loss of lives and properties.

Table 5.5 Casualties caused by snow avalanches in Leh and adjacent areas

Date	Intensity	Causalities, cause and area
5 Feb 2013	Moderate	22,000 livestock perished in Leh were hit by the avalanche
26 Apr 2013	Heavy	One person died and 6 others injured on Srinagar-Leh highway when 3 vehicles
3 Jan 2016	Heavy	4 number due to snow avalanche (Southern Glacier)
3 Feb 2016	Heavy	10 number due to snow avalanche (Siachin)
19 Mar 2016	Heavy	1 number due to snow avalanche (Kargil)
25 Mar 2016	Heavy	2 number due to snow avalanche (Turtuk)

Source GBPNIHE and Administration of Ladakh UT

Table 5.6 Causes of landslides in Ladakh area

Natural		Man-made
Geological	Morphological	
Rock mass discontinuities: - • Bedding • Fault • Unconformity	Steepening of slope by:- • Fluvial incision • Glacial incision • Undercutting	Tourism:- • Excavating slopes for buildings • Construction of paths for trekking
Rock mass strength	Precipitation: • Rainfall • Snowfall	Construction: • Building on slopes • Roads
Joints	Snowmelt water flow	Vibrations from lorries
Permeability	Freeze thaw weathering	Slope modification
	Decreased root cohesion	Forest fires
	Soil thickness	Agriculture: terracing
	Vegetation type	Deforestation

Source Geology for Global Development

Table 5.7 Events of landslide hazards in Leh and adjacent areas

Year	Location	Description	Injured	Dead
August 2013	Road at Chang La on the way to Pangong Tso	Rockfall caused roadblock	0	0
May 2013	National highway	Landslides caused roadblock	0	0
July 2012	Durbuk-Pass, Ladakh	Landslide	400 tourists	0
August 2010	Leh	Cloudburst	About 400	About 179–500
December 2007	15 December Landslide	Landslide-no reported trigger	6	2 (military)
October 2005	Kashmir	Earthquake on Pakistan/India border. Triggered landslides and mudslides	6266 (Jammu and Kashmir)	865–1350 (India)

Cloudburst induced flash flood and structural vulnerability are two major reasons of landslides in the area. Sometimes it has caused casualties and intervention in tourism.

The Stakmo valley (elevation about 3800 m.) is situated at a distance of 26 km from Leh city. The present investigators have studied the dry fan over which the village of Stakmo is located though according to the studies of several scientists (Sant et al. 2011) the Stakmo valley (upper part) is actually falls under amphitheatre valleys characterised with different types of moraines. The Stakmo valley is situated about 7 km. far towards the north-east direction of the Shey Fort as well as the famous Druk Padma Karpo School. Depending on the field verification, the authors have identified varied micro landforms and land use features over the fan (Fig. 5.6) specially along the Stakmo nala. A prominent trenching of more than 6 m height was observed along the Stakmo nala (upper course), which is very significant evidences regarding the supply of sediments from source area. The fan is comparatively steeper and the upper part is covered with the soils shallow to very shallow in depth.

Perception of the villagers on the local hazards: More than fifty families live in the Stakmo village. Based on survey of twenty-three families, a perception study of the villagers about the local hazards had been done. The survey was mainly conducted on the houses located along the nala. Total numbers of male and female persons were thirty and thirty-one, respectively, of the surveyed families. The age–sex structure of the families is shown in Table 5.8. Forty-five person were literate, and remaining sixteen persons were illiterate.

Prominent sustainable agro-based livelihood of the villagers has been observed during field survey in September 2014 by the authors. Apart from the agriculture, they depend on animal husbandry. Depending on the water resource and shallow soil resource of the Stakmo fan, a large portion of the area is utilized for cultivation of

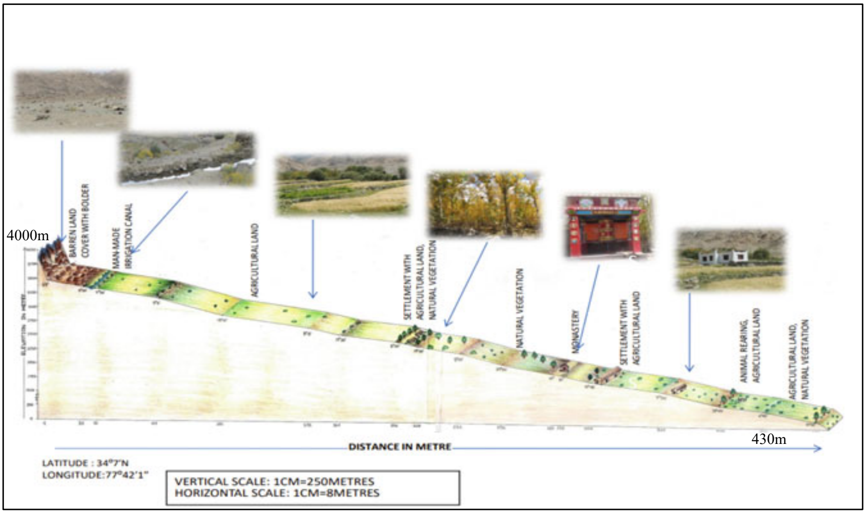

Fig. 5.6 Diagrammatic illustration of the Stakmo dry fan showing land cover land use types. *Source* field survey, 2014

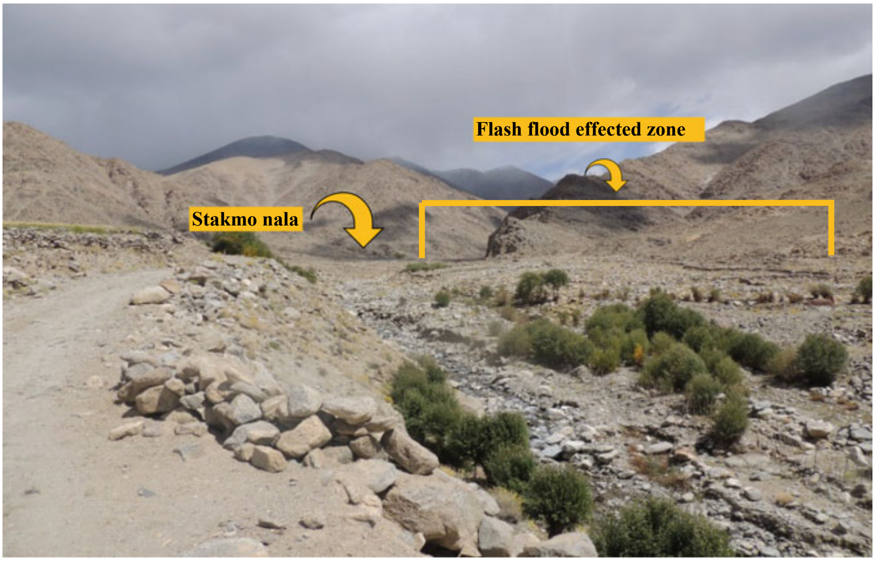

Fig. 5.7 Flash flood effected Stakmo nala reach. *Source* Field survey, 2014

Table 5.8 Age–sex structure of the Stakmo village

Age group	Male	Female
Below 4	03	02
5–8	00	04
9–14	01	01
15–24	02	03
25–34	07	06
35–44	06	06
45–54	01	01
Above 55	10	08

Source Field survey, September 2014

barley and also different type of vegetables and simultaneously used for orchard. Plantation of Willow trees is seen in different parts of the village. The Stakmo nala provides the water to the whole Stakmo village. Snowfall is the only sustainable source of water in Stakmo and other nalas. Scarcity of water for agriculture and other purposes is one of the major problems faced by the people. In order to mitigate the problem, the local people has developed irrigation network. Organised irrigation network of earthen channels (called 'yuras') is constructed to properly distribute of Stakmo River water into agricultural fields. Small reservoirs have been constructed to store the snow melt water. Stakmo River water is the only source of irrigation water. Along the elongated dry fan different types, land utilisation patterns are observed (Fig. 5.6). According to the local people perception cloudburst, flash flood and landslides are major natural hazards which cause loss of properties and lives. Most of the houses of the village were constructed over higher land areas. They have traditional belief that the higher land is comparatively safer from the flash flood induced debris flow. According to the local source, at the upper reach of the dry fan, mainly extensive part of the left bank (Fig. 5.7) was totally washed away in form of debris flow by the devastating 2010 flash flood. Distinct altitudinal variation in between the both sides fan surface of the river clearly indicates that there is an extended part of barren land covered with lag stone and deep weathered rocks mainly in the upper part of the fan area.

The researchers have observed that there is a large stretch of barren land which is being converted into agricultural and built-up area. Though different literatures (Bisht et al. 2008; Dame et al. 2019) also have described the rapid conversion of barren land into built-up area in the entire Leh valley. Undoubtedly, it can be said that sustainable livelihood of the people of Stakmo as well as Leh valley mainly depends on the snow-fed nala water resource and thin mountainous soils which are developed under periglacial environment.

The present researchers have evidently observed the geomorphic signature of the 2010 flash flood along the Stakmo nala (Fig. 5.5) in its upper reaches where the cloud burst resulted into significant vertical and lateral cutting increasing the channel width along with a sharp axial incision of Stakmo bed. The feeder nala (Stakmo nala) has actively eroded its bank in the form of toe erosion. The feeder channel is filled with granitic gravels in heterogeneric size that studied by the authors during field survey. The flash flood events have brought a lot of fresh gravels and boulders in the channel of Stakmo.

Sustainable Livelihood

The temperature of Leh district is not suitable for growing a wide range of crops. Apart from these, other climatic events (excessive snowfall, cloudburst, etc.) are challenging to sustainable agricultural production. Hence, people are more interested in tourism sector. Rapid urbanisation process and rising trend in tourism sector have direct and indirect impact on livelihood of the local people. The statistical data (Table 5.9) clearly indicates percentage of cultivators which is gradually declining from the year 1971 (65.48%) to 2011 (28.02%). Percentage of agricultural labourers is also in decreasing trend. In the year 1981, the percentage of agricultural labourers was 7.36. On the other hand, in the year 2011, the only 1.41% of total workers were engaged as agricultural labourers. So, the local people are becoming more interested in other economic activities (tourism economy, brick making activities) than traditional agriculture.

5.3.4 Tourism Economy and Livelihood

Tourism is one of the important economic contributor to the union territory of Ladakh in Northern India. Tourism is the prime source of income of the people of Leh and adjacent areas. Leh attracts a remarkable number of domestic and international tourists (Tables 5.10 and 5.11) towards it, because of its landscape, culture, tradition, environment, etc., and still the area has much potential for adventure tourism. Leh city has a great international significance in term of tourism. Every year thousands of domestic and foreign tourists (Fig. 5.9 and Table 5.12) visit the Leh city and its adjacent areas. Though tourism has key role towards the economic development of the area but unprecedented tourism sometimes cause ecological unsustainability in Leh and its adjacent areas. Over tourism in this high altitude area, sometimes directly and indirectly enhance the possibility of hazards and disasters mentioned above (Fig. 5.8).

As a result of remarkable growth in tourism sector, the lands which were used for subsistence type of agriculture earlier now are used for brick making activities and other constructional activities related with tourism. As the most of the land area is used for hotel, guesthouses (Table 5.11) and other constructional activities related to tourism, the trend of plantation is also falling due to lack of suitable land area and local people are more interest in tourism sector. According to the report provided by nursery department in the year 2010–11, the numbers of plants (willow, poplar, etc.) planted were 12,000. In the year 2015–16, this number has declined to 1516.

Table 5.9 Number of workers engaged in different category in Leh

S. No	Category	Number of workers							
		1971		1981		2001		2011	
		Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
1	Cultivators	14,305	65.48	17,415	58.49	22,041	37.92	20,869	28.02
2	Agricultural labourers	805	3.68	2191	7.36	2488	4.28	1047	1.41
3	Livestock, hunting and forestry, etc	1731	7.92	1442	4.85	NA	NA	NA	NA
4	Mining and quarrying	21	0.1	3	0.01	NA	NA	NA	NA
5	Manufacturing and processing other than household industry	102	0.47	451	1.51	NA	NA	NA	NA
6	Household industry workers	773	3.54	250	0.84	721	1.24	1020	1.37
7	Construction	564	2.58	546	1.83	NA	NA	NA	NA
8	Trade and commerce	297	1.36	735	2.47	NA	NA	NA	NA
9	Transport, storage and communication	279	1.28	305	1.03	NA	NA	NA	NA
10	Others	2970	13.59	6439	21.62	32,875	56.56	51,545	69.21
Total		21,847	100	29,777	100	58,125	100	74,481	100

Source Statistical Handbook, Leh, 2016

Table 5.10 Arrival of Indian and foreign tourists

Year	Indians	Foreign	Total
2002	2959	5109	8068
2003	13,031	15,362	28,393
2004	13,483	21,608	35,091
2005	13,444	24,536	37,980
2006	17,707	26,114	43,821
2007	22,007	28,178	50,185
2008	39,023	35,311	74,334
2009	48,517	30,570	79,087
2010	55,685	22,115	77,800
2011	142,829	36,662	179,491
2012	140,460	38,510	178,970
2013	107,412	31,883	139,295
2014	121,996	59,305	181,301
2015	116,887	29,614	146,501
2016	**197,693**	**38,005**	**235,698**

Source Tourism Department Leh

5.4 Recommendations

Based on overgoing discussion, few approaches can be taken towards the sustainable livelihood of the local people and minimising the intensity of the hazards in the Leh valley;

1. Favourable terrain characteristics like amphitheatre valley, series of dry alluvial fan surface, Indus floodplain have positive role for development of Leh town as well as many settlement areas like Stakmo village. Construction of settlement area should be maintained in comparatively safer zones where possibility of hazards like; landslides, avalanches, flash floods are comparatively lesser. In this case, land use planning should be guided by proper hazard zonation maps.
2. Glaciers and snow of the Ladakh ranges have crucial contribution in supply of water resource to the settlement areas. As the area is located in rain shadow zone, hence source of irrigated water and types of crop cultivation entirely depends on snow and glacier meltwater. Hence, scientific harvesting of snowmelt water should be emphasised.
3. Apart from the river Indus, there are many nalas (Taru, Phyang, Khardung, Sabu, Stakmo, Nang, etc.) that play significant role to develop elongated and slopy dry fans over which many settlement areas have been developed depending on its water and sediment resources. So the local people as well as tourists have crucial duty to keep the river and nala water free from anthropogenic pollution.
4. Cold arid climate has dominant outcome on crop cultivation and agricultural production. Due to heavy snowfall, both the Srinagar-Leh highway and the

Table 5.11 Number of hotels guest house and travel agents (Regd) in Leh as on ending March 2015

Year	Number of hotels		Number of guest house							Number of travel agents
As on ending March	3 Stars	(A +) Class	A-Class	B-Class	C-Class	D-Class	Upper class	Medium class	Economy class	
2011	0	0	65	51	19	14	51	27	308	352
2012	2	0	73	40	21	17	52	27	258	303
2013	3	0	14	76	53	29	77	40	303	379
2014	2	16	80	50	28	14	82	40	275	426
2015	2	19	95	55	28	14	95	50	288	468
2016	2	19	95	55	28	14	95	50	288	468

Source Tourism Department Leh

Table 5.12 Nationality-wise tourist arrival

S. no	Nationality	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	2	3	4	5	6	7	8	9	10	11
1	Canadian	636	823	785	409	585	785	586	1120	564
2	American	2313	290	1909	1654	2074	1909	2770	4798	1994
3	French	3777	3920	3677	2974	3715	3677	4913	8110	3842
4	German	1813	2585	1872	1380	2150	1872	2950	4429	2185
5	Swiss	1017	1279	867	770	852	867	1340	2860	1165
6	Australian	763	848	818	398	565	818	963	1886	948
7	English/ British	2000	3095	2605	1272	2099	2605	2639	4301	2419
8	Italian	1987	2204	1980	720	1341	1980	1599	3240	1245
9	Others	13,872	20,267	16,057	12,538	23,281	23,997	14,123	28,561	15,252
10	Indian	22,007	39,023	48,517	55,685	142,829	140,460	107,412	121,996	116,887
	Total	**50,185**	**74,334**	**79,087**	**77,800**	**179,491**	**180,993**	**139,295**	**181,301**	**146,501**

Source Tourism Department Leh

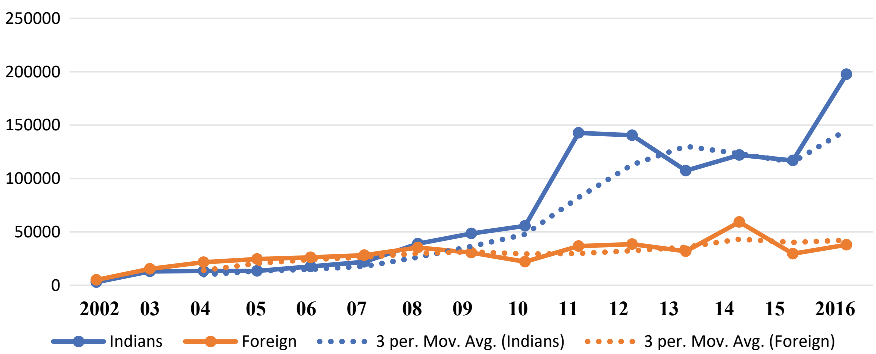

Fig. 5.8 Arrival of Indian and foreign tourists. *Source* Tourism Department, Leh

Manali-Leh highway roads remain closed for nearly six to seven months (October to May). During this time period, the area is totally isolated except air transport. This seasonal isolation is one of the reasons for the relatively high subsistence on agriculture on which Ladakh depends (Dame et al. 2019). Though tourism is a dominant economic sector but the local people should emphasis on their subsistence agricultural practices because agricultural practice is another important source of sustainable livelihood during seasonal isolation. If under any situation tourism activities suddenly declines (during warfare or pandemic situation) in Ladakh areas the people can survive depending on their traditional agricultural practices livestock farming.

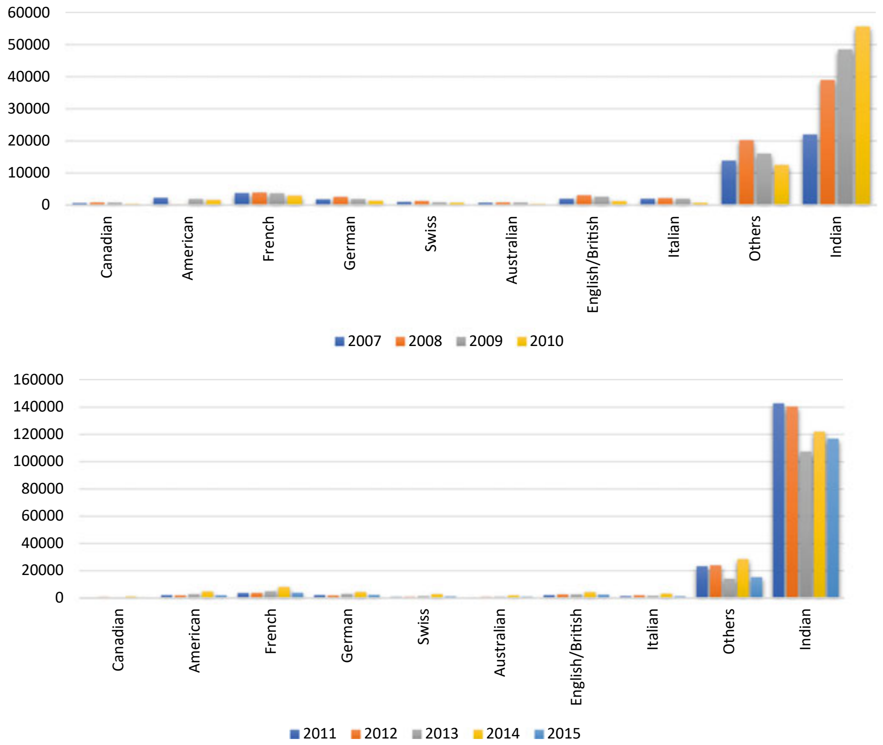

Fig. 5.9 Nationality wise tourist arrival in Leh from 2007–2015, Y axis represents number of tourists, *Source* Tourism Department, Leh

5. Many settlement areas like Choglamsar, Shey, Thiksay, Karu, etc., are also expanding along the floodplain of the Indus River. Leh-Manali highway is located over the favourable topography along the Indus valley. The investigators think that large river like Indus has potential to inundate its floodplain under the influence of strong cloudburst events in future. So the local people should restrict themselves to construct any permanent land use elements over the active floodplain of the river Indus.
6. The area has international significance of tourism activities. Every year thousands of domestic and international tourists enhance the economy of the Leh city. Sustainable tourism should be emphasised with social, ecological, and economic value of tourism in order to achieve a 'balanced' or 'wise' use of natural resources (barren land, agricultural land, land for plantation, river water, snow-melt water, etc.) of the area.

5.5 Conclusions

Susceptibility of extreme climatic events and tectonic vulnerability of the high rugged mountainous topography has a dominant impact on the changing land use pattern as well as livelihood of the people in Leh valley. Dry fans, amphitheatre valley, Indus floodplains are favourable areas where growth of settlement and tourism sector has been developed. Rapid urbanisation under extreme environmental condition in the high mountainous area has to be considered as risk factor in context of different natural hazards like cloudburst induced flash flood, earth quake, landslide, snowfall, etc. Unprecedented tourism, over utilisation of the local natural resources, unscientific land use planning will increase unsustainability in livelihood of the local people and these will also amplify the occurrence and magnitude of hazards in future.

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Chapter 6
Does Indigenous Wisdom Still Exist? Toward the Involvement of Indigenous Peoples in Disaster Risk Reduction

Hunggul Yudono Setio Hadi Nugroho, Dewi Retna Indrawati, Yonky Indrajaya, and Tri Wira Yuwati

Abstract Indigenous peoples are an integral part of environment management, and their interests and values should be considered. However, the loss of indigeneity, low capacity, distrust of the government, and the economic pragmatism of the indigenous people today are some of the most important factors that could spell the failure of long-term engagement with these communities. This chapter aims to provide an overview of the dynamics of indigenous peoples and the local wisdom that still exists, which is implemented in their daily lives in relation to their potential involvement in disaster risk management. Based on literatures review and the findings of the authors, we found that in the midst of the era of modernization that triggers the waning of cultural values and local wisdom of indigenous peoples, in several regions in Indonesia, several indigenous groups still follow local wisdom as a strategy in managing their environment and reducing the impact of disasters.

Keywords Norms and value · Indigeneity · Community engagement · Indigenous peoples · Local wisdom

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_6

6.1 Introduction

Due to rising global temperatures, climate change, and increasing disaster risk, the global need for climate adaptation and disaster risk reduction is also increasing, especially for developing countries whose populations are most vulnerable to disaster risk due to socioeconomic, behavioral, and geographical conditions (Ramstad et al. 2020). With more frequent and more intense disasters, disaster risk reduction (DRR) has become increasingly important as a fundamental approach to sustainable development (Lambert and Scott 2019). A single disaster event can cause loss of life and social and economic infrastructure that may take years to recover. Disaster risk can increase or decrease over time according to a country's ability to reduce its vulnerability and strengthen its risk governance capacity. DRR has become an integral component of sustainable development while increasing community resilience to disasters (Indigenous Corporate Training Inc. 2018). Conventional DRR, which does not involve the vulnerable community, which includes, among others, those who are often marginalized for economic or social reasons, inhabit unsafe lands, or lack access to information to reduce risk (PAHO 2014), has proven to fail to create a real and long-lasting impact (Newport and Jawahar 2003; Ramstad et al. 2020). Indigenous peoples are among the most vulnerable groups. They are known to be the poorest segment of society and the most vulnerable to disaster risk, and they often lose their resources for survival, both physical and cultural, which in turn weakens their capacity to deal with hazards, both natural and man-made (PAHO 2014).

In fact, although considered more vulnerable than non-indigenous groups, they are known to have Indigenous wisdom of hazards and disasters (Lambert and Scott 2019) and practice risk reduction strategies, adaptation, knowledge, and methods that are maintained and passed down from generation to generation throughout history (Bruchac 2014; Earthrise 2021; Lambert and Scott 2019; PAHO 2014). Indigenous wisdom (IW), which is often referred to as traditional knowledge or indigenous knowledge, is rooted in cultural experience, which guides the holistic relationship between human beings and their environment (Bruchac 2014; Earthrise 2021). IW extends beyond the scope of western scientific knowledge (Earthrise 2021). UNESCO defines local wisdom as understanding, skills, and philosophies developed by people with a long history of interaction with their natural surroundings (Indigenous Corporate Training Inc. 2018). IW, which has been acknowledged in several multilateral agreements on disasters since the mid-1990s, is not a static concept but is constantly being adapted and improved, which is often not easily understood by outsiders and even by indigenous peoples themselves (Lambert and Scott 2019).

Community-based disaster risk reduction emerged as a participatory bottom-up approach by promoting the importance of local community knowledge and involvement. This participation should be seen as a social process in which indigenous peoples organize themselves to identify existing needs and problems and solve them together, if necessary, with help from various sources (Newport and Jawahar 2003). By adopting local wisdom and collaborating ethically and respectfully with these communities, DRR policymakers can help these and other communities to create a safer future (Lambert and Scott 2019). Therefore, disaster mitigation measures must be part of a holistic socioeconomic program in the pre- and post-disaster phases (Newport and Jawahar 2003).

The question is, does this IW still exist? Is this local wisdom still a guide for indigenous peoples in their daily life? IW is known to have been under constant threat of being eroded, lost, or misused (Indigenous Corporate Training Inc. 2018; Lambert and Scott 2019), a factor contributing to greater vulnerability to disasters (Lambert and Scott 2019).

6.2 Methods

The chapter is written based on the literature review and the research experience of the authors through a series of activities of finding, reviewing, and evaluating relevant materials and synthesizing. All information is obtained from national and international research papers, research reports, rules and policies, as well as books and scientific publications related to DRR and IW. The chapter begins with an overview of indigenous people in Indonesia, which explains the terminology and the dynamics of ADAT as formal terminology for Indonesian indigenous people. The next sub-chapter explains the actual conditions surrounding the issue of the loss of local wisdom values of indigenous peoples in Indonesia, including the difficulty of determining whether a community group can be recognized as indigenous. In the last part of the chapter, this paper presents examples of local wisdom values that are still inherent and implemented by indigenous peoples in various parts of Indonesia in managing the environment to ensure its sustainability and avoid and reduce impact of disasters.

6.3 An Overview of Indigenous Peoples in Indonesia

The term "indigenous people" refers to people with historical ties to pre-colonial society. After being invaded by colonial powers, the aboriginal peoples of a given land were marginalized, and today, their people rule over the earlier occupants (UN 2009). This idea is less logical in Indonesia, where the colonial powers did not uproot entire populations (Klenke 2013; Tsing 2002). In Indonesia, it is difficult to distinguish between "indigenous" and "non-indigenous" groups (Henley and Davidson 2007; Tsing 2002). In contrast to other nations where indigenous peoples' identities are based on their assertions that they were the original inhabitants or owners of a particular region, in Indonesia, indigenous peoples have developed as a result of neglect, rejection, and recognition (Tamma and Duile 2020).

There were no "indigenous people" as such during Suharto's New Order era because all native Indonesians (pribumi) were considered to be indigenous (Royer et al. 2015; Tsing 2002). The Indonesian term ADAT means 'custom' or 'tradition'

(Henley and Davidson 2007). It is used to describe intricate customary systems, including rights to land and resources, a variety of traditional laws, social customs, conventions, principles, and moral concepts and beliefs (Affandi 2016; Royer et al. 2015; Rye and Kurniawan 2017; Tyson 2010). The term ADAT carries connotations of serene order and consensus (Henley and Davidson 2007). However, various ADAT laws governing access to land and resources may lead to variations in the interpretation of ADAT within villages and between ethnic groups (Royer et al. 2015; Tyson 2010). However, in order to "grab" attention, activists and community leaders who are fighting for the rights of poor rural communities are increasingly using the term "indigenous" (Tsing 2002). An essential component of the history of the ADAT revival is the encouragement and inspiration provided by the global indigenous movements (Henley and Davidson 2007).

The term "indigenous people" was chosen by indigenous activists as the "masyarakat ADAT" (ADAT community) (AMAN 2012; Royer et al. 2015; Tsing 2002). According to the Indigenous Peoples Alliance of the Archipelago (AMAN), the term "masyarakat ADAT" refers to a group of people with a common ancestry who live in a specific geographic area and have their own unique set of political, social, economic, and cultural systems and values (AMAN 2012). The term is intentionally different from the colonial phrase "masyarakat hukum ADAT" (literally, "ADAT law-abiding community"), which runs the risk of implying that the indigenous peoples will only be those who adhere to specific ADAT law practices (Arizona and Cahyadi 2013; Royer et al. 2015). The Basic Agrarian Law (BAL 5/1960), Indonesia's first legal document, used the term "masyarakat hukum ADAT" and imposed some limitations on the recognition of the land rights of ADAT communities under the term "hak ulayat" (customary rights): As long as these communities continue to exist, it cannot be contrary to national or state interests, nor can it be against higher-level laws and regulations (Republik Indonesia 1960). These limitations ultimately caused the indigenous people's land rights to vanish (Arizona and Cahyadi 2013).

According to the Ministry of Environment and Forestry, "masyarakat hukum ADAT" is defined as a group of people who have ancestry ties to and a unique relationship with the environment, have lived in a specific region for generations on the territory of the Republic of Indonesia, and who possess a value system that controls economics, politics, society, and a legal institution (Menteri Lingkungan Hidup dan Kehutanan 2015).

The majority of the ADAT community's territories are found within forested areas. According to Aliansi Masyarakat Adat Nusantara/Indigenous Peoples' Alliance of the Archipelago (AMAN), at least 84 million ha of the territories of ADAT communities are covered in forest, which, absent special measures, could result in claim contestation, stakeholder conflict, and forest destruction (Zakaria 2017). Therefore, if sustainable forest management is to be accomplished, practical approaches are crucial, considering the proper institution, mechanism, and tools to design and implement the strategy. Additionally, by integrating the concept of indigeneity from global discourse into the specific Indonesian context, indigenous peoples become "political actors" with ADAT as their primary political identity (Royer et al. 2015; Tamma and Duile 2020).

6.4 The Tendency to Lose Indigeneity in Indigenous People

Indigenous people and customary rights have long been seen as an interesting topic in Indonesia, a nation with over 1300 ethnic groups and over 2500 languages (BPS 2010). This has been the case, especially since the era of regional autonomy (Banjade et al. 2016; Royer et al. 2015). It is difficult to interact with ADAT people (the Indonesian term for indigenous people). It is still challenging to determine who is indigenous and who is not, despite adherence to the definition of ADAT law community, for those who have ancestor connections, a special relationship with the environment, and ownership of a value system that governs social, political, economic, and legal institutions (Arizona and Cahyadi 2013; Gauset et al. 2011; Muur 2015; Royer et al. 2015). It can be challenging to confirm the ADAT communities' legal status. Bosquet (2013) found that the issue of "representativeness" frequently arises when interacting with indigenous people in nations with sizable, diverse, and hard-to-reach indigenous populations. Participating in disaster risk reduction suggests communication between the local community and the government. It is critical to work with honest people. Engaging with individuals or groups that are not legitimate or that are legitimate but lack the motivation or capacity to manage forests may very well prevent goals from being met and cause future, protracted conflicts (Nugroho et al. 2020).

In order to confirm ADAT status, two factors must be taken into account. The first problem is whether the "indigenous people" are actually indigenous. A group of people who claim to be indigenous have emerged as a result of the discourse surrounding the revival of indigenous peoples being accepted more widely and the existence of supporting legal regulations (Badan Legislasi 2017; Chavers 2014; Kuper 2003; Linggasari 2016; McKenna 2016; Moeliono et al. 2010). Evidence from a number of sources demonstrated the emergence of "suddenly indigenous" activities from regional actors. Grumblies (2013), during her research on "Wana" people in Central Sulawesi, found the phenomena of "suddenly ADAT community." The "Wana" people had not previously participated in any indigenous people's political movements, but their recent and ongoing interactions with a particular NGO have now turned them into "masyarakat adat." Darmin Nasution, the Indonesian Coordinating Minister for Economy, observed that some people settled on state land and then abruptly claimed to have the right to customary land without offering any convincing evidence: "… while in fact they just moved there together" (Tribun bisnis 2017). Moeliono et al. (2010) mentioned the same problem that cropped up in East Kalimantan's Kutai National Park (KNP), where groups of people from other areas moved there after it was designated as such and claimed to be ADAT people. The Indonesian House of Representatives has also indicated a similar concern. They claimed to represent a group of interests working for the immediate economic and political benefit of the ADAT people, which could jeopardize long-standing traditions and customs (Badan Legislasi 2017).

The loss of indigenous identity is the second problem (Anthias 2017; Muur 2015). Indigeneity simply means the quality of being indigenous. Being known as a self-sufficient community with a strong bond to the forest connected by customs, values, and traditions (Arizona and Cahyadi 2013; Li and Murray 2010; Mulyoutami et al. 2009; Sasaoka and Laumonier 2012; Wachira 2010), anthropologists are not the only group posing serious challenges to the widely held belief that indigenous peoples face (Kuper 2003). Overly dramatic images of indigenous people have drawn a lot of criticism (Grumblies 2013; Muur 2015). These critics are based on the idea that indigenous peoples have altered in response to alterations in the social, economic, and environmental context. The region's growing population and cultural diversity, interactions with outsiders who hold different values and perspectives, and an increasing need for money could all affect how ADAT people generally feel about nature (Anthias 2017; Kothari 2007; Luz et al. 2015; Muur 2015; Nugroho et al. 2020).

The Ministry of Home Affairs Regulation 52/2014 stipulates five indicators of indigeneity for official recognition of legal ADAT communities: (a) a history of the legal ADAT law-abiding community; (b) ADAT territory; (c) ADAT law; (d) ADAT property relations, inheritance and ADAT artifacts; and (e) a customary governance system. Nevertheless, looking at the existing rules (Direktorat Jenderal Perhutanan Sosial dan Kemitraan Lingkungan 2016; Menteri Agraria dan Tata Ruang/Kepala Badan Pertanahan Nasional 2016; Menteri Dalam Negeri et al. 2014; Menteri Lingkungan Hidup dan Kehutanan 2015), the main approach to validate and verify the existence of ADAT peoples is still focused on a legal approach based on judicial and physical data. In their study in Kalimantan, Nugroho et al. (2020) combined institutional socioeconomic analysis with social analysis to verify indigeneity using two criteria: the presence of traditional knowledge and the degree of adherence to customary laws. It is insufficient to rely solely on judicial and empirical evidence to demonstrate the indigenousness of indigenous people. In order to assess indigenous peoples' capacity, capabilities, and awareness to manage their territory sustainably, a sufficient and well-controlled investigation must be used fairly and transparently (Nugroho et al. 2020).

Nugroho et al. (2020) also discovered the signs of "indigeneity purity" abrasion based on their observations of ADAT people in a few villages near Gunung Lumut Protected Forest (GLPF), in Paser District, East Kalimantan, between 2012 and 2014. Because no native people were willing to be appointed as a leader, the Lusan people, who claimed to be an ADAT people living in a territory covering 7500 ha of ADAT forest, appointed a migrant from the Banjar tribe in South Kalimantan as an ADAT leader. In the other villages, indigenous peoples' euphoria in response to MK 35[1]

[1] Customary forests are now officially legalized as belonging to indigenous communities, no longer belonging to the state. This acknowledgment came from the decision of the Constitutional Court (MK) number 35/PUU-X/2012 regarding customary forests which annulled a number of paragraphs and articles governing the existence of customary forests in Law Number 41 of 1999 concerning Forestry. This decision has brought a number of consequences, including the mechanism for confirming the existence of indigenous peoples, demarcating customary forest area boundaries, and the division of authority between indigenous peoples and the state in forest governance.

was colored by differences in indigenous peoples' perspectives on how customary forests will be managed. In Swan Slutung village, there was a debate about how their ADAT forest should be managed between politically weak ADAT leaders and the village head (formal administrative leader). ADAT leaders claim that ADAT forests cannot be sold or rented to outsiders. Meanwhile, village leaders planned to invite the investor to manage their forest. He stated, "If there is no investor to manage the forest, it will be unable to support our livelihood. If there are investors, there will be road access, which will benefit villagers, the economy, and people's welfare." We noticed the same trend when we met with Rantau Layung village members in 2013; a year after MK 35 was enacted. Some village members planned to either convert the forest into plantations in collaboration with investors or sell it to industrial companies in order to profit from it in the short term. Pragmatism and capitalism symptoms also emerged in response to the increasing necessities of life and the need for cash, which changed people's attitudes toward nature. In Rantau Buta villages, villagers with sufficient financial means hired several Madurese to cut trees from their claimed forested land for direct economic motif and sell the extracted timber covered by swidden farming activities. Despite the ADAT law's prohibition on selling the ADAT forest, several migrants in Rantau Layung purchased parcels of land near the village from the natives, planted permanent crops (rubber and oil palm), and left the natives to farm in areas far from the village.

6.5 Inspiration from Various Parts of Indonesia: The Implementation of IW in Disaster Risk Reduction

Indonesia is a disaster-prone country. The National Disaster Management Agency noted that 148.4 million people live in earthquake-prone areas, 5 million in tsunami-prone areas, 1.2 million people in volcanic eruption-prone areas, and around 63.7 million people in flood-prone areas, and 40.9 million people live in landslide prone areas (Ika 2016). Indigenous peoples, known to be the poorest segment of society, are among the most vulnerable groups. This can be seen during the 2004 Aceh tsunami that hit the Mentawai Island area which is inhabited by the Mentawai indigenous people, then there was also a forest fire case in Jambi in 2015 which forced The *Anak Dalam* tribal people to flee to the city because their house was in the middle of the forest burned by the suffocating smog (Pusat Krisis Kesehatan 2016).

In the midst of the era of modernization that triggers the waning of cultural values and local wisdom of indigenous peoples, in several regions in Indonesia, several indigenous groups (Fig. 6.1) still follow local wisdom as a strategy in reducing the impact of disasters. Some of the IW that is still being preserved and implemented include IW in forest protection, spring conservation, soil and water conservation, and tsunami disaster are presented below.

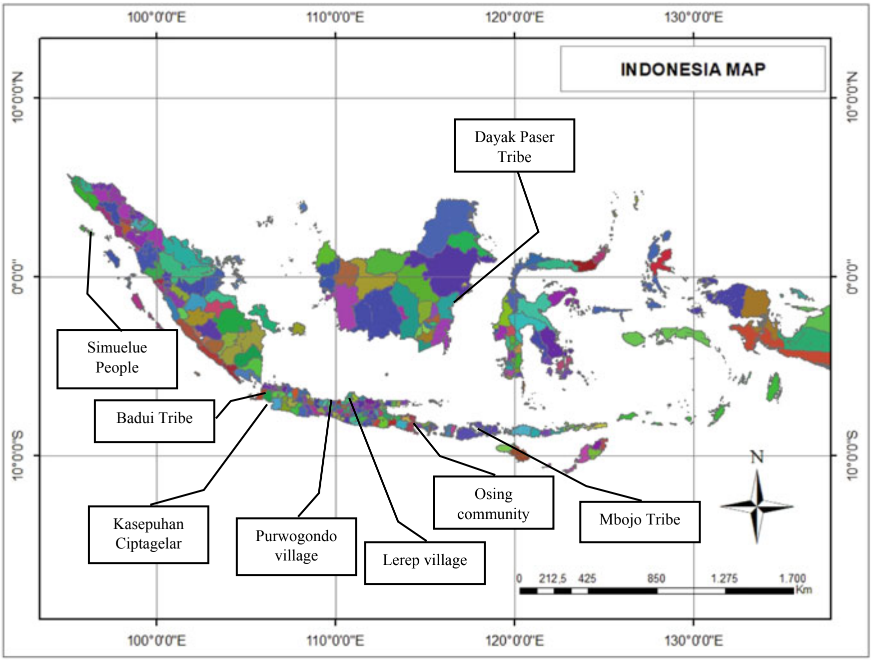

Fig. 6.1 Some indigenous peoples in Indonesia still apply IW in their environmental management

6.5.1 IW in Disaster Risk Reduction Through Good Forest Management

Good forest management is one of the examples of how indigenous peoples living around forest areas from various parts of Indonesia have taken an active role in reducing disaster risk, both hydrometeorological disasters such as floods and landslides as well as forest fires. This can be seen both in Java, which is densely populated with a high risk of hydrometeorological disasters, as well as in Kalimantan, which is sparsely populated with large forest areas and prone to forest fires.

Over the last ten years, population growth in Java has averaged 0.95% (Statistics 2022), leading to an increase in the land needed for settlements and businesses. As a result, there is the conversion of agricultural land to non-agriculture, as well as land use without regard to conservation rules, which can lead to disasters (Emilia et al. 2013; Innah et al. 2012; Suwarto et al. 2012). Disasters cannot be avoided, but mitigation efforts can reduce risks. Communities have some IW as disaster mitigation efforts have been passed down for generations. IW was developed because of the need to maintain and sustain life in accordance with existing situations and conditions so that IW becomes part of a social instrument to solve problems (Suparmini et al. 2013). Some of the IW that is still being preserved and implemented include IW in forest protection, IW in spring conservation, and IW in soil and water conservation.

Ekawati et al. (2015) stated that the forest area in Java Island is only 24% of the total area of Java Island, with a forest covering only 19%. Forests are ecosystem buffers. On the other hand, population growth also puts pressure on the forest. Therefore, in addition to its ecological function, the forest is required to contribute to the income of the community around the forest (Magdalena 2013). Although deforestation is often caused by human behavior, some indigenous peoples in Java still practice IW that can prevent from worsen deforestation.

A study by Suparmini et al. (2013) showed that the Baduy community has IW in preserving the forest. The Baduy Tribe area is located in Kanekes village, Leuwidamar sub-district, Lebak district, Banten, West Java. The daily life of the Baduy community is colored by a simple attitude, being friendly with nature, and the spirit of independence. The Baduy people divided the area into three zones. The lower zone in the valley is a residential zone (*rheuma* zone). The second zone is the middle zone (*heuma* zone) used as agricultural land. This agricultural land is secondary forest cleared for dry land and gardens. The farming land is cultivated once a year, and then the land is allowed to become forest again for at least three years. This is done to maintain the fertility and sustainability of the land. In addition, the Baduy people only practice organic farming and rely on rain for irrigation. It is feared that the community's habit of clearing secondary forests for agricultural land will damage other forest areas (Rahmawati et al. 2008). In reality, the forest remains protected because there are *pikukuh* (customary regulations) that serve as guidelines and social control on people's behavior (Suparmini et al. 2013). The third zone is the upper zone which is the area at the top of the hill. This zone is known as *leuweung kolot* (old forest). The *leuweung kolot* (old forest) area must be preserved, and the community is prohibited from entering it without the permission of traditional officials. Therefore, this area is rich in biodiversity and can maintain the local climate, prevent global warming, prevent erosion, save potential water reserves, and other aspects of environmental sustainability. The springs for the rivers in the vicinity come from old forests.

Similar to the Baduy community, the Kasepuhan Ciptagelar community, who live in the Cisolok sub-district, Sukabumi Regency, maintains the implementation of IW in managing their forest. The *kasepuhan* is Sundanese terminology for ADAT people who live around the Mount Halimun-Salak National Park (TNGHS) (Rahmawati et al. 2008). The Kasepuhan Ciptagelar community divides the area into three categories, namely (1) *Hutan Garapan* (arable forest) is an area where agricultural activities and settlement development can be carried out with the rules determined by custom; (2) *Hutan Tutupan* (protected forest) is a protected area, and (3) *Hutan Titipan* (entrusted forest) is a sacred area. *Hutan Titipan* dan *Hutan Tutupan* (forbidden forest) are strictly protected because they contain water and natural resources that are important for the continuity of the traditions of the Kasepuhan Ciptagelar (Astriani et al. 2020). In addition, the *kasepuhan* people also hold the concept of *Ibu Bumi* (earth as a mother), *Bapak Langit* (sky as a father), and *Guru Mangsa* (climate as a teacher) in farming. People only plant organically and only once a year to preserve the land and in honor of the earth which is considered the mother who feeds (*Ibu Bumi*). The concept of *Bapak Langit* and *Guru Mangsa* means that in cultivating the land and determining the right planting time, people look at the astrological sign and learn from the universe (Rahmawati et al. 2008). With the habit of the people who only plant once a year, the rice yields are only consumed by themselves. That is in line with the rules in the *kasepuhan* community, namely the prohibition to sell rice yields. Therefore, the government once obliged the *kasepuhan* people to plant rice twice a year in the hope that the rice yields could also meet the needs of people outside *kasepuhan.* But the results are getting worse and worse, even the costs incurred to buy fertilizers and pesticides are greater than the yields. Land that is cultivated continuously will be depleted of its nutrients.

The community around Alas Purwo National Park, Banyuwangi, East Java, also owns IW in forest conservation. The community in the buffer village of Alas Purwo National Park has strong ties to the forest area because the forest has not only economic but also social and cultural functions. The continuous interaction between the community and the forest finally forms local wisdom. Local wisdom in the form of traditions, rules, or prohibitions passed down for generations. It carried out to maintain biodiversity in Alas Purwo National Park, one of which is the prohibition on capturing and killing *Menco* (*Gracula religiosa)* and peacocks (*Pavo muticus muticus)* because they believe that peacocks and birds are the favorite animals of the spirits of Alas Purwo national park (Setiawan et al. 2021).

During their research in Gunung Lumut Protection Forest, Paser District, East Kalimantan from 2009 to 2015, concerning the expansion of traditional land use and deforestation, Nugroho et al. (2017) found the differences of villages with different characteristic, namely: Muluy (ADAT community), Rantau Layung and Rantau Buta (mixed ADAT and migrant community), and Swan Slutung (migrant community) in managing their ADAT forest. Based on spatial analysis of the three villages, Nugroho et al. (2017) showed that sociocultural characteristics, experiences, and farming systems affected deforestation per capita. The lowest deforestation per capita occurred in Muluy communities. This is in line with the study of Chi et al. (2013), who mentioned that the cultural characteristics of communities are one of the most important factors affecting land-use conversion. The ways indigenous people manage their forest resources are inextricably related to norms, beliefs, and traditions (Mulyoutami et al. 2009; Sasaoka and Laumonier 2012). In Rantau Layung and Muluy, apart from state law, ADAT law is applied in daily life as traditional guidelines and rules to define what is right or wrong, what can be done and what is forbidden for the whole community. The planting season, the best time to start land clearing, plowing, and planting, in which areas, how large an area can be utilized per household, and which trees are forbidden to cut are all guided by ADAT regulations and beliefs. In Muluy as well as Rantau Layung, it is prohibited to cut down honey trees (*Koompassia malaccensis*/*Kempas*) and to disturb an area dominated by ironwood trees (*Eusideroxylon zwageri/Ulin*) (Murniati et al. 2006; Wahyuni 2011). They conclude that, in general, ADAT people have a sustainable system for utilizing their woods based on interpretations of the ADAT map and a series of field visits. Cultivated areas from 1992 to 2012 were consistently located in areas designated for agriculture. Likewise, in Muluy Forest in the middle of the Mount Lumut Protection

Forest, people have been conducting subsistence shifting cultivation for years, but only in limited areas close to roads and rivers (Nugroho et al. 2017).

6.5.2 IW in Spring Conservation

The catchment area degradation causes 20–40% of springs in Indonesia to dry up and even disappear (Octaviyani 2018), thus requiring conservation efforts. In some areas, the community has IW to preserve springs. In Java, IW is often related to local culture and myths, so springs are considered sacred places that must be protected and respected (Setyowati et al. 2020; Siswadi et al. 2011; Sumarmi 2015).

This happened in Lerep village, West Ungaran sub-district, Semarang district, and Purwogondo village, Boja sub-district, Kendal district, Central Java (Setyowati et al. 2020). In Purwogondo village, there is a Tuk Serco spring whose discharge is relatively abundant and continuous, even though water availability in the Boja sub-district and its surroundings tends to decrease, which often causes conflicts between water users. The maintenance of Tuk Serco is related to the local wisdom of the community. People believe that Tuk Serco is a gift from God. In addition, Tuk Serco is considered a sacred place, so there are norms that must be obeyed, such as maintaining the sanctity of the water source environment, one of which is not littering, holding rituals and offerings to the spirit around the water resources area, and not changing Tuk Serco condition (Siswadi et al. 2011).

The people in Lerep village, Semarang district, Central Java have IW called *iriban. Iriban* is a tradition as an expression of gratitude to God for abundant water. *Iriban* rituals are carried out by bringing *bancaan klubanan* (traditional dishes served in traditional rituals) around the springs and eating together. People believe that if *iriban* is not carried out there will be disasters such as landslides, floods, and reduced water. The ritual was continued by cleaning up the area around springs and rivers in mutual cooperation (Setyowati et al. 2020). In both villages, there are norms that are useful for maintaining water sources as well as mutual cooperation efforts to clean springs regularly. However, these norms only relate to the condition of the springs but not to the preservation of their catchment areas.

Another case is the Osing community in Kemiren village, Glagah sub-district, Banyuwangi, East Java. Sumarmi (2015) stated that the livelihood of some Osing people is farming, so water is a crucial requirement to irrigate agricultural land and also for daily needs. They also have the belief that resources are not only for people living today but also for future generations. Therefore, they strive to preserve water resources as best as they can. To meet their daily water needs such as drinking, cooking, bathing, and washing, the people of Osing use paired springs, namely Belik Lanang and Belik Wadon. IW in conserving springs is in the form of values, norms, prohibitions, and sanctions. One form is the prohibition of cutting down trees around the springs accompanied by sanctions from the local government. The Osing people also plant the springs with various types of plants such as bamboo (*ori/Bambusa blumeana* and *petung/Dendrocalamus asper*), *bendo* (*Artocarpus elasticus*)*, kluwak*

(*Pangium edule*), candlenut trees, coconut trees, and fruit plantations. Some of that species are recommended species as spring conservation plant (Yuliantoro et al. 2016). The people of Osing also believe in the myth of the existence of a guardian spirit in the spring. For that, there is a traditional ritual called Selametan Rebo Wekasan (last Wednesday thanksgiving), performed once a year around the spring. The ritual is intended to make offerings to God or a trusted spirit.

The customary norms that are still being carried out today in protecting springs can also be seen in the community of Tegalwaton Village, Tengaran Sub-District, Semarang Regency, by not cutting down trees, not bathing in springs while menstruating, and carrying out mutual cooperation activities regularly taking care of trees and Cleansing the Senjoyo Spring through the traditional "dawuhan" ceremony, a Javanese term which means an order from the almighty (Setyowati 2017).

The Mbojo tribe in Bima Regency, NTB, has a *Parafu* tradition to preserve springs. In the valley of Mount Lambitu, especially in Kuta Village, Sambori Village and its surroundings, the term *Parafu* is synonymous with springs. *Parafu* is a certain spring which is hereditary guarded and cleaned by the descendants of the *Parafu* heirs. Villagers believe *Parafu* must be preserved. Trees and plants in the area around *Parafu* are not allowed to be cut down. Local residents are not allowed to litter and litter around the *Parafu* area. All of these restrictions are still being obeyed by local residents (Mulyanti 2022).

6.5.3 IW in Soil and Water Conservation to Prevent Erosion and Maintain Soil Fertility

One of the IWs in soil and water conservation is owned by the community in Bubakan and Sanan Village, Girimarto sub-district, Wonogiri district, Central Java. The area of the two villages is part of Naruan micro catchment, upstream of the Keduang watershed. The agricultural land is mostly on slopes land which is prone to erosion (Wahyuningrum and Supangat 2016). People realize that erosion that continues to occur will reduce soil fertility and become sediment in the downstream areas. On the other hand, the community must plant an annual crop to meet food and livelihood. Therefore, the community, for generations, has been applying contour planting to reduce surface erosion and protect soil fertility. The community also made a sediment trap (rorak/silt pit) at the bottom edge of the agricultural land to collect sediment from the eroded land and will be returned to the field back (Indrawati 2016). Another IW to reduce erosion is planting grass barrier in the waterways (panciran) and making mounds on strips for seasonal crops (Fig. 6.2).

Setyowati et al. (2020), from their study in Semarang, showed that the community of Lerep village, Semarang district also has IW in soil and water conservation. Lerep village is in a mountainous area, so they have a saying *Tunggu Gunung Kudu Wareg* (protecting the mountain, the stomach must be full), means for maintaining the environment or mountains where they live (*tunggu gunung*/protecting the mountain)

Fig. 6.2 Grass barriers in the waterways

for the food availability and living well (*kudu wareg*/the stomach must be full). The saying is implemented cooperatively in the form of an agroforestry system, does not cut down trees, preserves the surrounding environment, and utilizes natural products.

Forest, soil, and water conservation are an integral part of the life of traditional Javanese people. Some IW proves that environmental sustainability has an important meaning for traditional community (Witasari 2022). IW grows and develops as a result of the interaction and bond between humans and their environment (Setiawan et al. 2021; Sumarmi 2015). Currently, IW is under threat. IW is starting to be eroded by technology, cultural diversity, migration, economy, and social gaps (Hilman et al. 2019; Raharja et al. 2016). Therefore, Setyowati et al. (2020) and Siswadi et al. (2011) state that the younger generation must be prepared to preserve and internalize the values that exist in their lives.

6.5.4 IW in Dealing with the Tsunami Disaster

One of the local pearls of wisdom in Indonesia that is recognized by the world is the local knowledge of the people of the Simeulue Islands on the west coast of Aceh Province, Sumatra called Smong (Nationalgeographic.co.id 2019). When there was a 9.1 magnitude earthquake followed by a tsunami in 2014 that hit the mainland of Aceh, the residents of Simeulue Island managed to save themselves, guided by local wisdom known as Smong. The story of the Smong is told from generation to generation through Nafi from generation to generation. Nafi is the local culture of the Simeulue community in the form of traditional speeches or stories that contain life advice and advice for young people about how to live life. The beginning of the appearance of Smong is related to the start of the big wave that hit the coast of Simeulue Island, especially in the District of West Teupah, in 1907 ago (Setyaningrum 2004).

The 1907 earthquake with a magnitude of 7.6 followed by a tsunami is a dark history of disaster in the life of the people of Simeulue. More than half of Simeulue's population died as a result of the incident. The dark incident was finally poured into the Smong story, which was told orally from generation to generation. Simeulue community elders believe that this event can be repeated in the future. The development of Smong began to be embedded and strengthened after the incident. The word Smong comes from the Devayan language, which means crashing waves. Devayan speakers are generally people who live in the southern part of Simeulue Island. Meanwhile, another regional language, the Sigulai language, is spoken by the people who live in the northern part of the island (Nationalgeographic.co.id 2019).

6.6 Recommendations

It is critical to improving indigenous peoples' technical and financial capacities to engage them successfully in environment management as well as avoid and reduce impact of disasters. We suggest that IW and ADAT law must be revitalized and empowered in accordance with the enforcement of formal state regulations. In line with efforts to improve community welfare, there is a need for formal recognition and revitalization of customary law and IW to ensure that indigenous peoples have sufficient capacity in managing their environment and reducing the risk of various disasters. In addition, there is a need for a commitment to reorganizing the relationship between government and indigenous peoples that involves building capacity and trust and promoting dialogue. Indigenous peoples should have greater access to information about the effects of these man-made situations so that they can adapt their traditional knowledge, preparedness, and response patterns to reduce the risk of a disaster. The conceptualization and implementation of capacity-building strategies should balance frameworks and ADAT knowledge.

6.7 Conclusions

The phrase "indigenous community," or "masyarakat ADAT," in Indonesia, refers to a group of people who have a special relationship to the environment through their ancestors, dwell in a certain location, and have their own political, social, economic, and cultural systems and values. The majority of them live in forested environments. A bottom-up approach that stressed the relevance of local knowledge and engagement resulted in community-based catastrophe risk reduction. This involvement should be viewed as a social process in which indigenous people organize themselves to identify needs and issues and collaborate to solve them. Participating in disaster risk reduction necessitates communication between the local community and the government. It can be difficult to determine the legal status of ADAT communities. To be certain of ADAT status, two factors must be considered. The first is whether the "indigenous people" are truly indigenous, and the second is if the indigenous people are losing their identity. Although it is difficult to find, successful stories of IW implementation exist in forest management (Baduy tribes of West Java, Kasepuhan Ciptagelar at Mount Halimun Salak NP, Muluy and Rantau Layung village of East Kalimantan), spring conservation (Lerep village, Purwogondo villages, and Tegalwaton village in Central Java, Osing community in East Java, and Mbojo tribe in West Nusa Tenggara), soil and water conservation (Bubakan and Sanan village of Central Java), and tsunami disaster response (people of Simeuleue islands, Aceh province). To preserve indigenous knowledge, society requires strong bonds, trust, and obedience, all of which are aspects of social capital. It is critical to develop indigenous people's technical and financial skills in order to operate successfully with them. To address the major issues with land management, special steps combining traditional and scientific knowledge must be implemented. This would allow ADAT residents to envision a brighter future while protecting the environment. We believe that indigenous knowledge and ADAT legislation should be revitalized and given more force in accordance with formal state regulations. Traditional IW, beliefs, and customs are valuable risk reduction techniques. They must be appreciated, shared, and incorporated into national and worldwide catastrophe risk reduction programs. To be empowered, a community must be willing to make things better and have the social capital to move forward and collaborate in both traditional and dominant cultures.

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Chapter 7
Assessment of the Local Traditional Knowledge and Practices of Flood Risk Identification Techniques: A Case Study of Nadaro Village, Tailevu, Fiji

Sakul Kundra, Unaisi Nabobo-Baba, Nakul Kundra, Margaret Gabriel, Mohammad Afsar Alam, Sereima Takiveikata, and Katarina Toga

Abstract Fiji is a small island developing state (SIDS) in the South Pacific Ocean, which is vulnerable to the increasing frequency and intensity of climate change disasters like cyclones, storm surges, and floods. The major floods in Fiji occurred in 1999, 2009, and 2012. Rising flood events in Fiji's villages pressurize and continuously test the traditional local/indigenous knowledge of community resilience. There exists a lacuna in the current literature about indigenous knowledge of flood identification techniques adopted by Fiji's indigenous communities. The study attempts to ascertain the traditional understanding of flood risk identification of an indigenous Fijian (iTaukei) village named Nadaro, Tailevu, Fiji, which is prone to floods. The study examines the traditional and spiritual resilience and sustainable lifestyle strategies adopted by the villagers before, during, and after repeated floods. It also surveys the sociocultural values that indigenous communities continue to practice as a sustainable resilience measure to counter floods. For this chapter, qualitative

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*,
Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_7

research is conducted by undertaking a survey, followed by observations and follow-up interviews with a total of ten (females, heads of families) participants in the village. The fieldwork for the study was carried out from June to September 2022. The study follows *Talanoa's* (narrative) research methodology and explores the traditional/local knowledge of floods. The observations provide a lot of traditional, untapped knowledge about flood prevention measures, early flood identification, and cultural–religious beliefs followed by the sample village.

Keywords Indigenous knowledge · Flood risk reduction · Identification techniques · Religious values · Nadaro Village · Fiji

7.1 Introduction

The Fiji Islands, like other tropical Pacific Island nations, are especially vulnerable to climate-induced hazards such as cyclones, storm surges, and floods, which are expected to become more frequent and intense in the future (Lough et al. 2011; Chand et al. 2017; Neef et al. 2018). Flood disasters have become more common with each passing decade, wreaking havoc on the country's economic progress and urban infrastructure (Brown et al. 2017). Climate change in Fiji is expected to enhance the severity and frequency of severe weather events in the future in Fiji and other Pacific Islands (Campbell and Barnett 2010). Flooding in Fiji is being exacerbated by various reasons, including high rainfall intensity, increasing urbanization (Kundra et al. 2022), population pressure, deforestation, agricultural intensification, and uncontrolled tourist growth. Most rivers and streams in Fiji are short and steep, and there is a rapid increase in their water levels (Yeo 2013). Floods in Fiji have worsened in recent years; disastrous floods were noticed in 2009, 2012, and 2016 (Kundra et al. 2022). The climate change initiatives encountered challenges such as the lack of money and resource allocation, global action to decrease carbon emissions, and aid from developed countries to assist Small Island Developing States (SIDS) in implementing and funding the policies concerned (Narain 2016). Indigenous peoples' knowledge systems and practices are acknowledged as the primary resource for climate change adaptation, but they have been mostly overlooked in policies and research (Adger et al. 2014). Indigenous knowledge refers to the ideas, skills, and philosophies of indigenous peoples; it has been shaped by long-term interactions with the natural world and the need to adapt to changing social and ecological conditions, such as colonization and globalization. This knowledge is passed down through generations (Adger et al. 2014). Indigenous knowledge is omitted from the core literature due to some reasons. First, some beliefs rooted in indigenous knowledge are against the capitalist economic system. Second, the accessibility, legitimacy, and consistency of indigenous knowledge remain questionable (Petzold et al. 2020). Historically, indigenous knowledge was denied in academic research and considered a developmental hurdle. However, in recent years, it has gained currency in academic debates and research. It is synonymous with local knowledge, traditional ecological knowledge, folk knowledge, traditional environmental knowledge, community knowledge, and traditional knowledge (Naess 2013; Acharya and Paddar 2016). It is now considered to be important in lowering local catastrophic risks and developing resilient communities and sustainable livelihoods (Trogrlić et al. 2018). Indigenous knowledge has helped develop resilience mechanisms among communities. This knowledge is beneficial for forecasting, reducing, and mitigating the disastrous impact of recurrent events. It has evolved through time and has been handed down through generations. It has been constantly amended as per the need of society, and it is usually communicated orally in a non-formal manner (Shaw et al. 2009). Bwambale et al. (2022) indicate that indigenous knowledge is framed along lived experiences, supported by open knowledge production in cultural institutions. They further state that indigenous conceptualization demonstrates some gaps in the scientific evidence in the case of floods. Their research shows that flood risk is mainly the result of pressures that are related to sociopolitical and capitalistic factors; for socio-material gains, the indigenous knowledge of flood identification and mitigation, exasperated exposure, watershed degradation, and community-based investments is overlooked by many a person (Bwambale et al. 2022). Another study in the context of Fiji highlights the causes of why indigenous people fail to embrace scientific methods for curbing climate change; some of the reasons include financial difficulties, loss of cultural identities, low literacy level, and religious beliefs (Liligeto and Nakamura 2022).

The climate adaptation tactics used by indigenous Fijian groups and families are impacted by their sociocultural values as well as their access to resources, knowledge, and power (Neef et al. 2018). The flood hazards have been a huge impediment, especially in the villages, where many still depend on indigenous knowledge systems to counter floods. As there is a scarcity of scientific means to identify floods as an early warning system in the villages, indigenous people have developed many signs and indicators to reduce flood impact. Understanding the importance of indigenous knowledge and its potential in creating people-centered early warning systems is essential in light of the growing need for integrating indigenous and scientific information to help build community resilience against natural catastrophes (Trogrlić et al. 2018). Many inaccurate scientific forecasts misled the farmers about climatic hazards in the past; the villagers/farmers' inability to comprehend scientific means has forced them to continue relying on the indigenous knowledge system (Somerville 2012; Ebhuoma and Simatele 2019). The literature on flood identification, adaptation, and cultural–religious association is silent in the context of Fiji; thus, the research carries out the pilot project to fill this lacuna in the academic world.

7.2 Rationale of the Study

- Examine the local traditional knowledge and practice of early flood identification.
- Outline the adaptation measures taken by the indigenous villagers against rising floods.

- Survey of the cultural–religious values of the indigenous communities dealing with floods.

7.3 Materials and Methods

The chapter is based on qualitative research that includes conducting the survey and follow-up question-interview sessions. It depicts the survey conducted in ten households in a village from June to September 2022 by a team of researchers (Hereafter, participant 1 is referred to as P:1. Similarly, the other participants are mentioned as P:2, P:3, P:4, P:5, P:6, P:7, P:8, P:9, P:10). The survey comprises three sections: first, general information about the participants and their flood experiences; second, assessing the early warning system; and last, examining the villagers' religious and cultural implications on flood situations. The survey was followed up by prompt follow-up questions based on the information received during the survey. The research includes a narrative (*Talanoa*) and observational (*Vakadidigo*) research methodology. Ethical consent for conducting this research from the University, under the bigger project of Climate-U led by some of the co-authors, was taken. Consent was also taken from all the participants before conducting the survey and follow-up interview sessions. The survey participants are women (*iTaukei*-speaking participants), and their age ranges from 30 to 80 years. Due to their availability, these women participants were a convenient sample for the research. Notably, the village men were either occupied or out of the village for work during the field research. The study explores various aspects of the traditional/local knowledge of floods. The interviews were taken in English and the Fijian language. The notes in the Fijian language were translated into English.

7.4 Fiji Islands

Most of the population in Fiji lives on Viti Levu and Vanua Levu, Fiji's two main islands. This archipelago consists of 332 islands (111 of which are inhabited), with a total land area of 18,333 km^2. It is about 3200 km northeast of Sydney, Australia, and approximately 2100 km north of Auckland, New Zealand. Fiji has a total population of 884,887 people (2017 census, Fiji Bureau of Statistics), with urban regions housing half of the population. This island country is situated in the southwest Pacific Ocean's core area and has a tropical maritime climate with two seasons: summer/wet (November to April) and winter/dry (May to October) (March to October). The rivers of Fiji are presented in Fig. 7.1.

Floods in Fiji are most common during the rainy season (January, February, and March), and they may also occur on rare occasions during the dry season (June to October), as shown in Fig. 7.2. The climate of the island is tropical maritime, with a minimal change in temperature from cold to hot. Tropical cyclones often affect

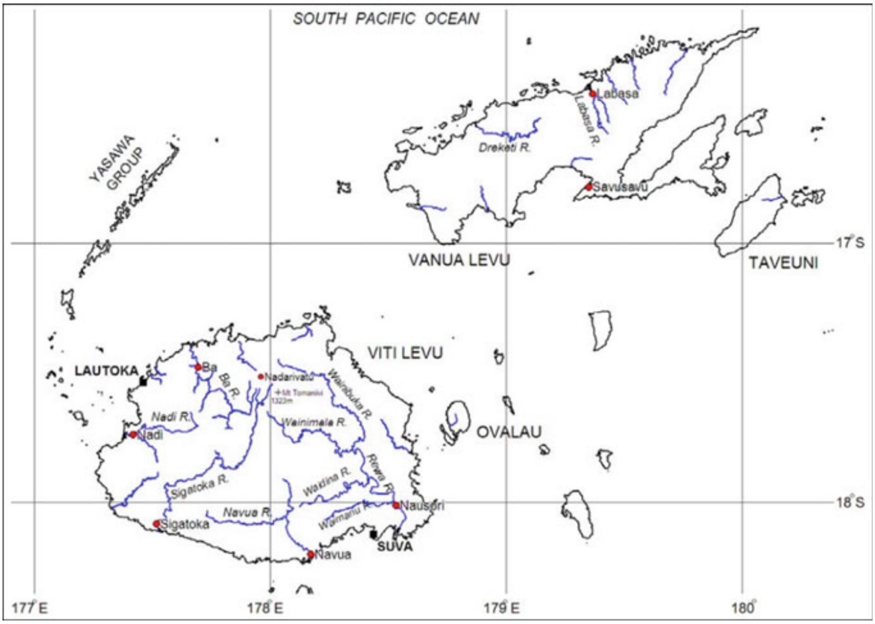

Fig. 7.1 Main islands, rivers, cities, and towns of Fiji. *Source* McGree et al. (2010)

Fiji from January to March, bringing heavy rain and high winds. Fiji is prone to natural catastrophes and sometimes struck by many disasters in a year. Between 1983 and 2012, 106 natural incidents were officially registered in Fiji, causing a loss of around US$ 1.2 billion (Holland 2014). The Western and Northern Divisions, which include densely inhabited flood plains and all the critical infrastructure, have the worst-affected watersheds (Prasad et al. 2022). Most of Fiji's main cities and towns are located along coastlines susceptible to cyclones, storm surges, and potential sea level rise due to climate change. The island is vulnerable to hydro-meteorological (floods, droughts, and tropical cyclones) and geophysical (landslides, tsunamis, and earthquakes) disasters (Bernard and Cook 2015). Different plans for development in Fiji take into account the need for watershed management activities to reduce the frequency of flooding, soil erosion, and sedimentation of river systems (Fiji National Assessment Report 2010).

7.4.1 Study Area: Nadaro Village, Tailevu

Geographically, Nadaro is located in the southeastern coastal area of Viti Levu in Fiji. This village comes under the district of Vugalei, which consists of seven villages (Sote, Naimasimasi, Savu, Namulomulo, Nadro, Natobuniquio, and Visa) (Nabobo-Baba 2006). Each of these seven villages is led by a local village chief known as

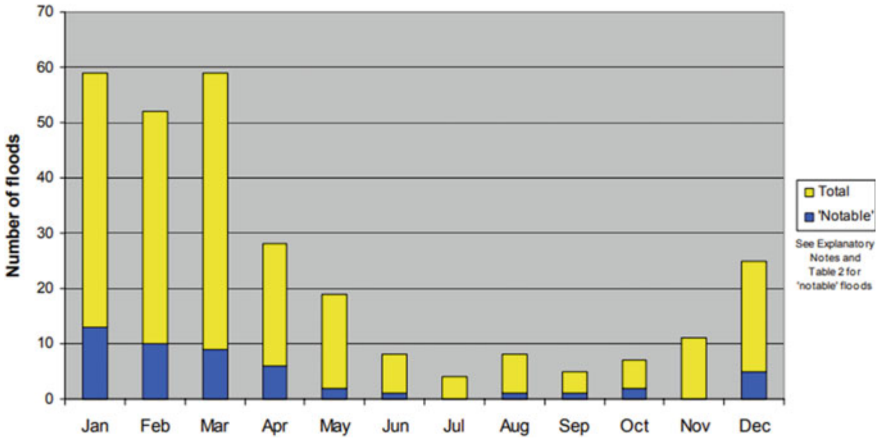

Fig. 7.2 Monthly distribution of floods in Fiji, 1840–2009. *Source* McGree et al. (2010)

Komai. It comprises mataqali (sub-clans), totkatoka (extended families), and vuvale (families) (Nabobo-Baba 2006). The village consists of four interdependent groups: semi-subsistence farmers, low-paid government and private sector workers, small entrepreneurs, and paid professionals (Nabobo-Baba 2006) (Fig. 7.3).

Climate change has made a considerable impact on Nadaro. In the past years, the village has faced floods due to heavy rainfall caused due to cyclones, and the villagers have been demanding to raise the retaining wall along Waisere Creek. There has been a rise in human activities on rivers, and the climatic change has destabilized the river banks and led to erosions. Thus, the river bank erosion has threatened the lives of the villagers living in Nadao. Waisere Creek surrounds this village, and during the peak season, the flood water rushes toward the village and produces scouring at the river bank, leading to instability, and eventually, the erosion of the bank. The crumbling bank of Waisere Creek presents an immediate danger to Nadaro Village. The bank's relocation toward the community has jeopardized the safety of a few dwellings and villagers. Waisere Creek is a river system with a high sinuosity index. As a result, the Creek's natural meandering makes the banks more unstable, adding to bank erosion.

In 2019, the Fiji Government aided the Nadaro Village Community by providing the infrastructure necessary for the protection of the river bank. They erected the gabion box retaining wall and groins. The 112-m long river bank protection works were completed; a sequence of gabion boxes was installed. It was expected that the measures would protect the river bank and benefit the Nadaro Village Community through the protection of land and the control of erosion. The stabilization of the river bank reduces land loss, reduces excessive sedimentation within watercourses, which silts up gravel beds and destroys spawning and invertebrate habitat, and reduces channel widening, which results in shallow flows, especially during the dry season, and which can cause an increase in water temperature and oxygen levels, affecting aquatic organisms. As per Fiji's Coastal Protection Program, the government spent $431,333.17 as a total cost for the coastal protection and maintenance

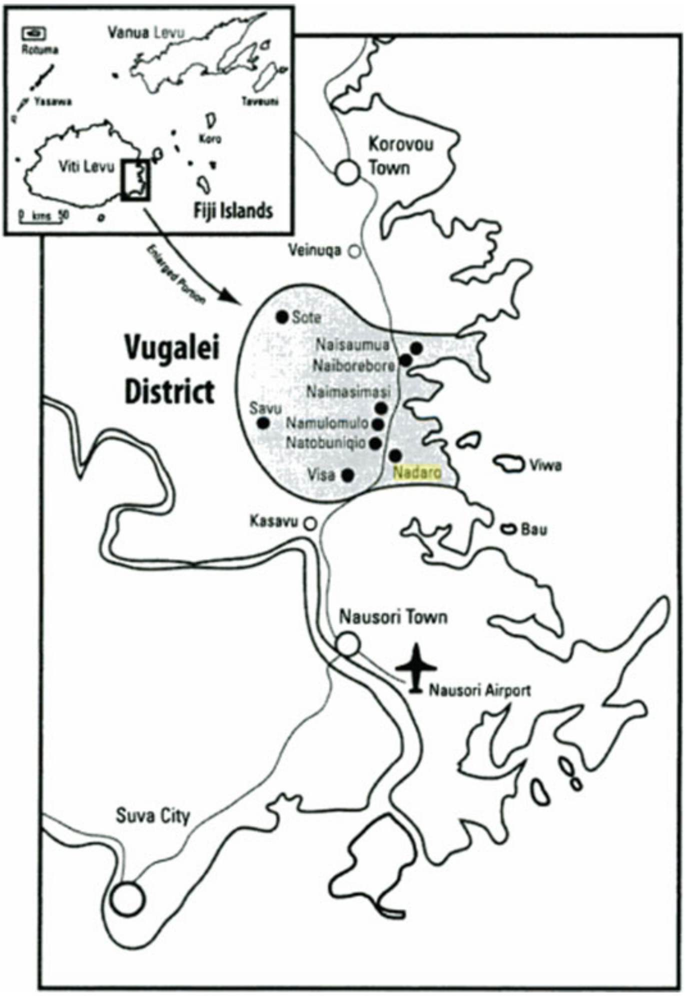

Fig. 7.3 Nadaro Village, Tailevu, Central Division Fiji. *Source* Nabobo-Baba (2006)

of Nadaro Village. Despite the Coastal Protection Program of the Fiji government, the villagers of Nadaro have raised concerns that the retaining wall, under the 2019 government-funded village protection project, was not high enough to prevent floods from approaching the village from Waisere Creek (Daucakacka, Fiji Times, February 1, 2021). The village headman said that the wall was just above the ground level. The village is inundated with water whenever the creek is flooded (Fig. 7.4), further increasing the chances of water-borne diseases (Daucakacka, Fiji Times, February 1, 2021).

Other climate protection stakeholders in Fiji, like Fiji National University's Team, Climate-U Participant Action Research Project (PARG), worked in Nadaro Village

Fig. 7.4 Floods in Nadaro Village, Fiji. *Source* Daucakacaka, 1st February 2021, Fiji Times

under a community project that focused on the enhancement of water sources by boring boreholes and piping, planting trees, finding alternative sources of water, installing solar lights and water tanks, improving the drainage system (FNUNIKUA 2022). There has been a need to protect the vulnerable Nadrao Village settlement from riverbank erosion. This construction was found inadequate as there were floods again after the construction of the retaining wall (Fig. 7.5).

Indigenous Fijians have learned about climate change primarily from their observations and interactions with their environment; the indigenous knowledge system is

Fig. 7.5 Retaining wall at Nadaro Village. *Source* The corresponding author took a photograph

usually based on everyday observations and experiences that are tested in real-world circumstances. This knowledge is transmitted through word of mouth and repeated practice from generation to generation (Orlove et al. 2010). According to Nabobo-Baba (2006), an indigenous Fijian's identity and individuality are not just confined to the flora and fauna of the land; it is deeply rooted in the spirit world of *bulu* (the underworld-considered dark) and *Iagi* (the heavens). Therefore, for the family, the environment is more than just the surroundings; it is the ecological relationship. Local I-Taukei has learned about climate forecast knowledge through their large number of experiences and observations and from their forefathers. However, this indigenous knowledge has been losing value due to several factors like lack of proper education, modernization, and globalization (Lagi 2015). There is a concerted effort to revive the traditional indigenous Fijian ways of weather forecasting and climate mitigation.

7.5 Results and Discussion

The observations provide a plethora of traditional untapped knowledge about the identification of flood risks and the techniques and adaptive community methods used by the community of the sample village. Further, the research highlights the community's religious, cultural, and social values in establishing resilience against flood disasters.

7.5.1 Section A: General Status and Flooding Experience

The observations are based on the data collected by the researchers. The numeric data are given in Table 7.1.

Observation 1

The ten survey participants, whose ages range from 30 to 80 years, were women of Fijian ethnicity. As the village population primarily belongs to the Fijian ethnicity, the villagers have rich indigenous knowledge of floods and mitigation techniques.

Observation 2

Each participant has over 3–10 family members living in the village. Thus, the present research includes 30–100 direct and indirect participants; the dataset represents the voice of a large number of the participants; it is based on comprehensive feedback. These participants migrated to Nadaro a long time ago; the time of their arrival ranged

Table 7.1 General information of the participants and their experience related to floods

Participant no.	Age	Ethnicity	Total family members	Year of relocation to Nadaro Village	Total flood experience	Willing to relocate due to repeated floods
P.1	55	Fijian	4	1966	8	Yes
P.2	70	Fijian	3	1980	4	Yes
P.3	80	Fijian	3	1980	4	Yes
P.4	50	Fijian	Over 10	1991	Several times	Yes
P.5	50	Fijian	5	1980	Several times	Yes
P.6	37	Fijian	5	Cannot remember	Several times	Yes
P.7	37	Fijian	5	1990s	6–7	Yes
P.8	52	Fijian	3	1987	7	Yes
P.9	58	Fijian	7	1980s	5	Yes
P.10	60	Fijian	8	1970s	7	Yes

between 21 and 52 years. Hence, they carry a substantial indigenous experience of indigenous Fijian knowledge to adapt themselves to the floods.

Most participants respond that the prime causes of floods in Nadaro Village include heavy rain, river surrounding the village, blockage of drainage channels, climate change, the village's geographical location in a low-lying area, sea level rise, and tropical cyclones. Other factors are the emission of greenhouse gases and tsunamis. Besides, God's will and religious beliefs are attached to these events.

Observation 3

Each participant has gone through a minimum of 4 and a maximum of 8 flood experiences. The repeated floods, especially due to heavy rain, have given them enough knowledge to develop traditional methods to counter flood occurrences. P.1 refers to the floods that covered almost half of the village; consequently, the village houses were submerged during those floods. This participant emphatically says that the villagers used boats to go around the village, and the village became like a swimming pool then. P.2 states that water fills the river gauge during heavy rains, and mostly, floods occur due to heavy rains. P.5 states that according to the oral history inherited from the ancestors, floods have been a part of Fijian life. P.3 states that floods have not significantly impacted farming income as their farms are in raised areas.

Observation 4

All ten participants have shown the intent to migrate/relocate from the village due to recurring floods. This reflects the intensity and repetition of the floods witnessed by the villagers. They have been suffering and bearing economic losses and sociocultural trauma. The history of the floods reflects that the participants mainly depend upon indigenous knowledge to safeguard themselves without much help from most of the other stakeholders.

All the participants acknowledge the FNU Climate-U Project team and the Fiji Government as prominent supporters, and they appreciate how both of these stakeholders are involved in the activities related to environment conversation and the preservation of traditional knowledge at Nadaro Village. They add that both have also extended financial help also from time to time.

Observation 5

As per Table 7.2, the participants have given feedback on their traditional knowledge of making necessary livelihood changes. After the early warning flood indicators, the livestock is taken to the raised platforms as per fifty percent of the participants. Food management by storing extra food and moving food reserves to the houses at uplands is quite common, whereas heading to maize mills prior to the rainy season is not largely practiced. Most participants state that livestock management has been effectively practiced due to indigenous knowledge; it is ensured that proactive measures should be taken to safeguard the livestock. Most participants have given feedback that the Nadaro villagers show awareness about livestock management before and during the floods. P.5, 7, and 9 share concerns that they lost their livestock during the floods.

The feedback related to relocation, early evacuation, and temporary shelters is encouraging. The villagers have learned from their experiences, observations, and forefathers. The villagers' feedback reflects the knowledge of taking measures to relocate and evacuate in times of flood events. They move to the uplands as an adaptive measure; women and children are the first ones to be transferred to the uplands.

7.5.2 Indigenous Traditional Knowledge: Early Warning Systems

Observation 6

Archarya and Poddar (2016) have given four categories to classify the indigenous flood forecast indicators: ecological, riverine, meteorological, and celestial. The

Table 7.2 Early preventive actions during floods

Early actions during floods		Participant's feedback	
		Yes	No
Livelihood changes	Conducting farming in upland areas	9	1
	Uplands areas are rented	8	2
	Accumulating extra seeds for replanting after floods	8	2
	Early planting before flood season	9	1
Food management	Collecting food before the rainy season	1	9
	Extra food deposited	10	-
	Transferring food reserves to high areas	9	1
Livestock management	Shifting livestock to uplands	9	1
	Protecting livestock to graze next to riverbanks	9	1
	Building raised platforms for livestock	5	5
Relocation, early evacuation, and temporary shelters	Moving to uplands for temporary relocation	8	2
	Building raised platforms in lowlands	9	1
	Constructing temporary shelters in uplands	6	4
	Planning the schools and churches in uplands to be used as temporary shelters	8	2

traditional knowledge of flood identification and early warning indicators in Nadaro Village has played a beneficial role against flood hazards. The participants' feedback is recorded in different categories and reflected in Table 7.3 and Section "Observation 6".

The phenomenological, ecological, metrological, celestial, and riverine categories of early flood identification are rich in traditional knowledge. This rich knowledge developed over time through experience and observation has supported the villagers of Nadaro Village. Some flood forecasting indications are noticed mostly preceding the flooding season (ecological); some suggest approaching floods (riverine), and others are observed throughout this period (meteorological and celestial).

The phenomenological indicators reflect the feeling of body pains, especially knees. It was also evident that some villagers felt itchy and restless before the floods. These indicators act as traditional knowledge pointers to predict floods.

The research highlights various ecological flood warning indicators. In the Nadaro case study, it is found that the indigenous villagers have found a wide variety of ecological indicators. These indicators can be categorized into two basic types:

Table 7.3 Identification of indigenous early warning indicators: indigenous traditional knowledge

Categories/indication	Participants' feedback
Phenomenological	P.1, 3, 5, 8, 9.: The elderly feel pain in certain body parts P.6.: People started to have knee pains
	P.4: Villagers' sleep is disrupted due to rising temperatures P.7: Some become restless and itchy
Ecological	P.1, 3, 5, 6, 9, 10 agree that there was a sudden increase in ants in the village P.1, 4, 7, 9 highlight a rise in the number of centipedes and insects
	P.2, 4, 8, 9 share the experience that animals started to migrate from the river to the fields and villages, which indicates the forecast of bad weather
	P. 1, 3, 7, 9, 10 state that birds produced specific sounds P.1 states that the birds named "mynah" started fighting among themselves and made a loud noise
	The majority of the participants agree that some trees/plants produce an increased number of flowers and fruits P.1: *Uto* (breadfruit) produces more than one fruit on a branch
Meteorological	Most of the participants agree that there is a rise in rainfall intensity, strong winds, change in rainfall duration, and hot temperature
Celestial	Some of the participants state that they noticed a Halo around the moon
Riverine	Over half of the participants agree that there is an increase in the water sounds of rivers and streams; water gets dirty and muddy, and there is an increase in debris after floods; changes in the color of water, i.e., usually brown. They also notice a rise in water levels. P.2: There is a noticeable increase in the sound of water and streams

changes in the behavior of animals and plants. Table 7.3 reflects the changes in animal and plant species in the case study. Ants are the most noticeable sign of heavy rains; residents also notice a rise in the number of centipedes and insects. Similar behavior of ants is noticed in other regions like Mexico (Eakin 1999) and India (Nkomwa et al. 2014). These insects emerge both inside and outside the houses, creating a disturbance to the villagers. The Nadaro residents get alarmed as ants appear in large numbers inside and outside the hamlets. There is a change in the number and behavior of many birds (Table 7.3), and the birds also produce loud noises as a prediction of heavy rain. Orlove et al. (2010) also corroborate the sudden change in the behavior of animals and migratory birds in other regions before floods. In addition, in the context of indicators in Fiji, long tenure indicators, for example, a decrease in the number of prawns and fish, forecast heavy rains. Other studies have shown that behaviors like frogs' croaking, ducks' continuous flapping of their wings on the ground, and swamp chickens' strange sounds indicate early rains (Ebhuoma and Simatele 2019). Fiji's indigenous knowledge indicates flood warnings if there is a rise in the number of fruits (*Uto*) and many flowers on some trees.

The meteorological indicators highlighted by the residents of Nadaro include an increase in wind speed, an increase in rainfall intensity, and a rise in temperature. The wind direction and difference in temperature have been used in other regions also to predict oncoming rains (Orlove et al. 2010). It is believed that hot temperatures will result in higher rainfall, and subsequently, in floods. Even the blowing of strong winds indicates forthcoming heavy rains and further floods. These occurrences act as indicators of upcoming floods. However, riverine indicators are considered to be highly useful in forecasting floods. Before floods, the water in the river becomes very muddy and filthy; it is accompanied by debris. The sound of the water in the river becomes hard and loud when the water level rises. The odor of the river also turns terrible. The celestial indicators include the halo around the moon, which is a sign of upcoming heavy rainfall. Other studies highlight the appearance of the full moon as an indicator of floods (Fabiyi and Oloukoi 2013). The participants have raised strong concerns that the village elders should preach and pass on this indigenous traditional knowledge to the younger generation. However, this is not happening as per the participants.

The early warning indications were communicated to the villagers at Nadaro by beating a *lali* (wooden drum cut out of the tree) with *tuki-ni-lali* (wooden sticks), as a process of announcement of impending floods. The village headman (turaga-ni-koro) makes a call announcement (*kaci*) after *lali* is done by walking around the village. Then, the village headman addresses the villagers and shares the necessary guidelines with them.

These indigenous early warning methods must be preserved, documented, communicated, and disseminated to utilize this valuable information. The preservation will enhance the resilience of the community against floods. These cost-effective measures will assist in achieving sustainability. P4 claims that these signs are beneficial to predict upcoming floods, and they are used by generations to safeguard the village. The adaptation, mitigation, and religious implication begin to work after the first sign of floods. This has helped reduce the severity of flood impacts and implement adaptation measures by taking early actions.

7.5.3 Religious and Cultural Implications

The survey included a section about the religious believed/practiced by the villagers around floods and other natural disasters.

Observation 7

Eight out of ten participants refer to the religious factors associated with floods. P.2 states when floods are disastrous, the villagers pray to God to recede water, and their spiritual belief has the power to heal every crisis. P.4 also states that the singing of hymns is practiced to get refuge from this crisis. Table 7.4 provides the participants' feedback on their cultural–religious beliefs associated with floods. P.4 states that floods are considered to be an "act of God". Another study notes that the villagers who were Christians viewed flood events in relation to God's will and plan, and the

Table 7.4 Religious beliefs and practices to control natural disasters

Categories	Description/feedback
Donations	Nine out of ten participants confirm that they did not make any donations during these floods
Prayers/hymns	All ten participants confirm the singing of prayers and hymns during floods. P.4. states that fasting is also observed to safeguard the village from floods. The church minister and elders decide on the duration of the fasting period A whole week of prayers (usually by leaders of churches and traditional leaders) to bless the earth, keep away evil spirits, and boost wellness for the village
Community singing	Eight participants agree that they do community singing before floods
Sacrifice (animals or birds)	P.4 states, "After natural disasters, the villagers come together for a **"**tabu" period where they abstain from practices like drinking yaqona (cultural drink of Fijians), maybe even sex and other things. This is done in hopes to purify the land and people". The majority of the participants agree to maintain a period of tabu after the floods to achieve purity of the community and land
Curse and magic spell	P.1: "Sometimes we go against our own religious beliefs. We believe that God comes first, and everything will come after. Lack of practice of our own religious beliefs"
Folk Narratives	P.3: "There's a *meke* that the people of Nadaro perform. It traces the lineage of our people and it includes safeguarding the land and resources. It's a 45 min to 1 h dance performance in the village green. The last time it was performed was many years ago-over a decade". Other participants also agree to be part of this *meke*. The *meke* is titled: *Vaka-Ra* (which intimates the people's connections to the peoples of the West of Viti Levu

church is consulted when the forecast warning is amiss at the local level (Ebhuoma and Simatele 2019).

Besides the above observation, P.1 states, "they accept the floods as God's will…when they have to die, they will die". Another participant notes that God's will causes a flood event as a punishment from an offended deity. Religious beliefs and traditional customs play a valuable role in preserving the indigenous knowledge system against recurrent floods.

The Nadaro villagers are staunch Christians who believe that natural disasters such as flooding indicate God's will. This belief is derived from the words in the Lord's prayer, a universal Christian prayer:

Our Father who art in Heaven,

Hallowed be thy Name;

Thy Kingdom come,

Thy Will be done on earth as in Heaven.

Give us his day our daily bread;

And forgive us our trespasses as we forgive those who trespass against us;

And lead us not into temptation,

But deliver us from evil.

This prayer begins with thanksgiving and praise (Lines 1 and 2). Lines 3 and 4 pray for the Lord's Kingdom and will. The remaining lines refer to the Supreme Being as the giver of "our daily bread". Christians pray to God for His mercy and forgiveness; they pray to Him to save them from temptation. This prayer shows their keenness to surrender themselves before the cosmic law or His Will. One of the important aspects of this prayer reveals that natural disasters like floods occur at His will and show His wrath.

These religious and cultural observations have not been documented in much of the preceding research. The villagers believe that they may have committed/made some crime/error, and God punishes the villagers through climatic hazards like floods. The Nadaro villagers make sacred prayers before and after flood events and observe fasts to purify their bodies and minds. The villagers pray to bless the earth and keep evil spirits away from the village. The custom of observing "tabu" is unique in Fiji; during this time, the villagers abstain from drinking their cultural drink, yaqona. Other practices related to the tabu phase include avoiding sex and vulgar words. The motive of these practices is to pray for the purity of the land and people. It is believed that flood occurrences are considered to be an "act of God", and they are the reaction of human sins. Some studies give reference to the belief that the "act of God" is responsible for climate extremities and "the act" is due to human errors (Simatele and Simatele 2015).

The religious beliefs related to indigenous knowledge remind the people to re-enforce their faith in God and seek His blessings. Observing *meke* in Fiji is related to safeguarding the natural resources and their land.

7.6 Limitations of the Study

This study is a pilot project assessing traditional knowledge and indigenous practices associated with floods. The limitation of the study is its narrowness in terms of feedback; the feedback is taken from one village, whereas a comparative study would have given new insights. The number of participants was less, and the interview sessions were conducted over three and half-day visits by a team of researchers from Fiji. Another limitation is that mitigation processes are not included in the chapter. However, the survey gathered information related to mitigation ways that included the raising of the retaining wall, afforestation, building better homes, cleaning the drainage, and implying traditional knowledge against floods.

7.7 Recommendations

The observations provide new insights into the traditional indigenous knowledge about flood identification, prevention methods, and sociocultural–religious association with the floods noticed at Nadaro Village. It is imperative to pass on this rich information to youngsters and conserve this knowledge, which has been neglected with the arrival of new scientific means of adaptation and mitigation of floods. Some villagers also intend to merge traditional and scientific knowledge to develop resilience against floods. At the same time, some participants blame scientific knowledge and daily weather forecast for limiting the reliability of the traditional knowledge system. The participants recommend that (i) the river wall should be raised to avoid floods, (ii) mangroves, big trees like mahogany, and native plants should be planted beside the riverbank, (iii) the drain should be regularly cleaned to prevent it from blocking, (iv) using better flooding warning systems and building homes on higher platforms are the need of the hour.

7.8 Conclusion

Indigenous traditional knowledge systems are based on experience, observations, and inputs from forefathers about flood identification and prevention, and they have an association with religious beliefs. Traditional knowledge is dying in the contemporary world scenario. Mostly, indigenous knowledge is considered accurate if the information based on it is transmitted promptly and if the frequency of missed occurrences is minimal. The same implication applies to scientific knowledge, which also has some uncertainty of false predictions. The indigenous communities believe in the dependence on traditional knowledge and consider it reliable, whereas scientific research may consider indigenous knowledge unreliable and unsuitable for flood indication. Due to rapid climate change, the predictions of the traditional knowledge indicator may not come true, but the reliability of the villagers persists in the case of the traditional indigenous knowledge system. The current study on the Nadaro rural community finds that the conventional methods to reduce floods are mostly reliable, and they help the villagers make suitable adaptations and reduce losses. All the participants have shown their will to transfer this rich knowledge to the younger generations. The chapter posits a new traditional knowledge base of the Nadaro villagers about flood indicators, adaptation methods, and religious associated. There has been a constant demand for integrating indigenous and scientific knowledge. The amalgamation will be an advantageous means to identify future floods and even reduce their impact.

Acknowledgements All the participants in this research must be acknowledged and thanked as their kind cooperation, hospitality, and motivation made this research possible. Special thanks are due to Prof. Unaisi Nabobo-Baba and FNU Climate-U team for their support during this research.

Appendix

(Some section of the sample questionnaire is borrowed from preceding research on traditional indigenous knowledge about climate change conducted in other regions of the world)

Survey Questions

Assessment of Local Traditional Knowledge and Practices of Flood Risk Identification Techniques: A Case Study of Nadaro Village, Tailevu, Fiji.

Would you like to voluntarily participate in the survey? Yes ☐ No. ☐
Participant number___________________________________
Investigator names___________________________________

Demographic Details

A. **General Questions**

1. **Name ……………………………………………………………….…**
2. **Gender (Male/Female)………………………………………….….…**
3. **Age……………………………………………………………….….**
4. **Marital Status……………………………………………………….**
5. **Profession…………………………………………………………….**
6. **Ethnicity……………………………………………………………..**
7. **Ancestral Village…………………………………………………….**
8. **Years of Stay in this Village…………………………………………..**
9. **Place of Birth……………………………….(If not, this village)**
   Follow-up question (If you were not born in this village):
   In which year, did you relocate to this village?..
10. **How many of your family members (including you) have been living in this village for more than 30 years?…………………………………………………..**
11. **What is the flood occurrence frequency in your village?……………………….**
12. **Do you want to relocate to another place due to recurrent flood disasters?…………………………..**

Research Questions

B. **Identification of floods and their mitigation through traditional indigenous knowledge.**

1. Share your memories of floods in your village. (Kindly mention at least one memory.)
2. Kindly mention if you have any cultural legacy/oral record/folk memory that helps your community prevent and/or combat floods.

3. What, to your mind, are the main reasons for recurrent floods in your village?

Tick: ✓ Or ×

Blocked drainage channels
Heavy rainfall
Overflowing rivers
Climate changes
Sea level rise
Rise in temperature
Tropical cyclone
Emission of greenhouse gases
Deforestation
Tsunami
Others factors

4. Do floods affect the livelihood of the villagers? If yes, specify how?
5. What are the local adaptation strategies to deal with floods?
6. Is there any community involvement to safeguard against floods? If yes, state it.
7. Do you follow any of the following adaptive techniques to sustain flood disasters? Write Yes or NO in the column.

Early actions during floods		Participant's feedback	
		Yes	No
Livelihood changes	Conducting farming in upland areas		
	Uplands areas are rented		
	Accumulating extra seeds for replanting after floods		
	Early planting before flood season		
Food management	Collecting food before the rainy season		
	Extra food deposited		
	Transferring food reserves to high areas		
Livestock management	Shifting livestock to uplands		
	Protecting livestock to graze next to riverbanks		
	Building raised platforms for livestock		
Relocation, early evacuation, and temporary shelters	Moving to uplands for temporary relocation		

(continued)

(continued)

Early actions during floods		Participant's feedback	
		Yes	No
	Building raised platforms in lowlands		
	Constructing temporary shelters in uplands		
	Planning the schools and churches in uplands to be used as temporary shelters		

C. **Explore the traditional and spiritual practices of indigenous villagers to minimize recurrent floods.**

1. Do you/your fellow villagers use any of the following traditional indicators to predict floods?

Identification of indigenous early warning indicators		(Yes or no)	Duration (months)
Phenomenological	The elderly feeling pain in certain body parts		
	Villagers' sleep is disrupted due to rising temperatures		
Ecological	A sudden increase in the number of ants in villages		
	Animals migrating from rivers to fields and villages		
	Birds producing specific sounds		
	Some trees/plants producing an increased number of flowers. Please specify the names of those trees/plants, if any:		
	Increase in the production of fruits on some trees. Please specify the names of those trees, if any:		
Meteorological	Change in rainfall intensity		
	Strong winds		
	Change in rainfall duration		
	Hot temperature		
Celestial	Halo around the moon		
	Visibility of Orion star		
	Full moon		
Riverine	Increase in the water sounds of rivers and streams		

(continued)

(continued)

Identification of indigenous early warning indicators		(Yes or no)	Duration (months)
	Waters getting dirty and muddy		
	Change in the color of waters		
	Increase in water levels		

2. Do you ever feel that religion has any role to play in minimizing flood incidences?
   i. Yes ☐ No ☐
      If yes, how? ……………………………………………………………

Do the following religious and other beliefs and practices can control natural disasters?		
	Yes/No	Details (if any)
Donations		
Prayers/hymns		
Community singing		
Sacrifice (animals or birds)		
Curse		
Magic spells		
Human fate		

3. Do you know any folk narratives, mythological stories, songs [sere], dance [meke], and cultural beliefs that claim to protect or have protected the village from floods in any way?

Narratives	Details
Folk narratives	
Mythological stories	
Songs	
Dance	
Religious hymns	
Cultural beliefs	
Ancestral wisdom	
Others (if any)	

4. Is the indigenous knowledge about flood prediction and mitigation gradually eroding? If yes, how?
5. Do the villagers safeguard the village during floods? Choose one option.

A. Individual level
B. Community level
C. Both individual and community levels

6. In your view, what is the limitation of the indigenous knowledge to identify and mitigation of floods in your village?

D. **What are the Fiji Government's policies and programs to protect the traditional local knowledge of identification and adaptation against floods?**

1. Is the indigenous knowledge combined with scientific knowledge to safeguard the village?
   Yes ☐ No ☐
   If Yes, how?..

2. Is there any government or donor-funded project or government policy that makes the villagers aware of different strategies to deal with floods?
   Yes ☐ No ☐

3. Is there any government or donor-funded project or policy to empower the villagers to deal with floods?
   Yes ☐ No ☐
   If yes, please specify the names of such policies. programs and projects:
   …………………………………………………..

4. Do the governmental/ non-governmental organizations and donors support and promote the traditional knowledge about floods? What is their attitude toward traditional knowledge? Please specify it.
   ………………………………………………………………
   ………………………………………………………………

Role of different bodies/institutions in flood risk management activities

Local level institutions and traditional leadership	Flood risk management activities	Yes/No
Village and area civil protection committees	Committee members as interpreters of local early warning indicators	
	Spreading awareness on the basis of local indicators and official warning information	
	Providing villagers living in the floodplain with advice	
	Identifying land for temporary relocation before/during floods	
	Making arrangements for temporary relocation before/during floods	
	Coordinating with external stakeholders (NGOs, donors, etc.)	

(continued)

(continued)

Local level institutions and traditional leadership	Flood risk management activities	Yes/No
	Encouraging plantation drives	
Religious institutions	Spreading awareness during religious ceremonies	
	Churches as shelter places during floods	
	Helping the villagers – to recover – to overcome the emotional loss – to overcome the material loss	
Community-based organizations	Performing drama on flooding to serve as a risk communication tool by local youth clubs	
	Assisting with temporary shelter construction	
	Assisting in afforestation initiatives	
Traditional leaders (i.e., chiefs)	Act as knowledge holders and communicators	
	Warning dissemination through meetings	
	Evacuation leaders	
	Facilitating collaborations with stakeholders	
	Making land provisions	
	Providing advisory services to community members	

5. Comment on the nature of the government projects/initiatives that have been undertaken to safeguard the village from floods.
6. Do you think that the indigenous knowledge should be combined with scientific knowledge to safeguard the village? If yes, how is it possible? Share your ideas with regard to it.
7. Do you have any collective funds in the village to adopt preventive measures against these floods?

   Yes ☐ No ☐
   If yes, how much amount have you collected?

Amount in FJD	TICK: ✓ Or ×
1–50	
51–100	
101–200	
201–500	

(continued)

(continued)

Amount in FJD	TICK: ✓ Or ×
501–1000	
1001–2000	
2001–5000	
Above 5001	

8. Do you want that your traditional knowledge should be inherited by your future generations?

   Yes ☐ No ☐
   If No, why?...

9. Do you want that your traditional knowledge should be shared with the world?

   Yes ☐ No ☐
   If No, why?...

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Chapter 8
Indigenous Knowledge and Strategic Approaches to Combat Drought: A Study from the Western Rarh Region (Bankura and Purulia Districts) in West Bengal

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Abstract Drought is a naturally occurring insidious phenomena that happens when precipitation falls drastically below average recorded levels, resulting in catastrophic hydrological imbalances that harm land resource production systems. The immediate direct impacts of drought are a lack of available water and food, as well as the propagation of terrible diseases due to contamination caused by a dearth of available water. Two of West Bengal's most prominent drought-prone areas are Bankura (23°14′1.5864″ N, 87°5′14.10004″ E) and Purulia (23°20′32.1252″ N, 86°21′46.2204″ E), both of which have semi-arid climates, patchy forested regions with uneven terrain. Several impoverished indigenous populations live in these two districts, mostly in the district's hilly and uneven terrain. Indigenous people have developed the sensitivity to detect environmental changes and develop adaptive strategies as a result of their close relationship with nature and the natural ecosystem. Interviews were employed as a type of data acquisition throughout the course of the study and were undertaken in a structured fashion, with a schedule comprising of a list of predefined questions and highly streamlined ways for recording. People in these places have developed a number of ways to manage drought, including the use of a pitcher watering system to hydrate the soil, the use of compost pits as water reservoirs, and the consumption of alternative food (a variety of wild edible botanicals, rice gruel, porridge) to secure critical nutrients to satisfy their requirements. Over time, indigenous people have accumulated knowledge, traditions, and abilities about disaster prevention and early warning systems. In this present study, an attempt was made to investigate indigenous local information, abilities, and traditional practices linked to drought management in these regions.

Keywords Indigenous · Drought · Strategy · Bankura · Purulia · Western Rarh

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*,
Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_8

8.1 Introduction

Drought is among the most highly prevalent climatic hazards, with no clear consensus, no fixed unified criterion to measure its severity, no precise starting or closing date for curbing its long-term impact on hydrogeology, the environment, economic growth, socio-cultural aspects, and so on (Bhunia et al. 2020). In a broad sense, drought refers to a natural phenomenon that occurs when there is less available water over a specific time period and throughout a specific geographic region (Beran and Rodier 1985). In the agricultural sector, drought reduces the availability of soil moisture, which in turn causes crop failures and a decline in grazing, posing threats to the country's food security (Lu et al. 2017). In the developing world, households that depend on farming and other natural resources are especially vulnerable to the devastating effects of drought. If they don't have a variety of ways to deal with it, it can threaten their livelihoods and their health (Gray and Mueller 2012).

Indigenous peoples are responsible for protecting a number of the most vital habitats for biodiversity on the planet. They are also responsible for the majority of the world's population speaking multiple languages, and the cultural heritage they have preserved is and will continue to be important for everyone. Indigenous peoples continue to be subjected to racism, disempowerment, appalling levels of poverty, and acts of violence (Tauli-Corpuz et al. 2010). Some people are compelled to relocate from their native homelands because the risks to their livelihoods are becoming too great. Additionally, their philosophies of religion, civilizations, languages, and approaches to life are all in peril, with some of these even being threatened with oblivion (Figueiredo and McDonald 2019). Governments throughout the world are actively taking steps to address indigenous peoples' concerns, ranging from landholdings and ballot proposals to symbolic proposals such as sincerely apologizing for past wrongdoing. In response to the difficulties they face, indigenous peoples have advocated for a Proclamation on Indigenous Peoples' Privileges and a perpetual UN forum to resolve indigenous peoples' issues and provide clearances to the United Nations system and beyond (Wani and Sahoo 2021).

The term "indigenous knowledge" (IK) refers to ideas, experiences, practices, and information that may have originated locally or elsewhere, but have been significantly changed by natives and integrated into the native way of living via legend, folklore, and rituals; it may also refer to information that has been passed down orally from generation to generation (Tarafdar and Debnath 2021). Senanayake (2006) argues that indigenous knowledge is usually created or passed down over a long period of time by the native people in a community as a way to deal with their socioeconomic and agro-ecological environment (Senanayake 2006). Indigenous people have valuable ways of doing things and know-how that can make a big difference for environmental sustainability (Eyong 2007). Several studies show that indigenous or traditional knowledge is passed on from one generation to the next through cultural rituals and word of mouth. In many parts of the world, this knowledge has been the basis for health care, farming, preservation, preparing meals, education, and a wide range of other activities that help people and the environment (Senanayake 2006).

Indigenous knowledge is mostly made up of technical and non-technical fields. These fields include different beliefs and customs, music, plants, social ecology, religious taboos, communication patterns, climate, and many more (Anandaraja et al. 2008). Indigenous knowledge is a key part of restoring ecosystems, including the management and maintenance of water in a sustainable way, the preservation of biodiversity, the management of important resources, and the revival of tropical ecology (Lakhani 2019). Traditional knowledge gives people at the ground level the basic information they need to make decisions, which can help with sustainable development. According to Sillitoe (1998), in regards to natural resource management, aquaculture, agriculture, ecological zones, forest management, indigenous people have a more comprehensive understanding than is generally acknowledged. Ulluwishewa (1993) says that sustainable development is linked to the maintenance of ecosystems and the sustainability of resources, and that any indigenous knowledge that has helped native people deal with their environment for centuries could be useful for sustainable development.

Due to their intimate contact with natural ecosystems and their dependency on them for their survival, indigenous and rural peoples have evolved the sensitivity necessary to recognize any changes that may occur in the environment and to build adaptive strategies in response to climate change (Timilsena and Devkota 2022). This kind of traditional knowledge has the potential to provide crucial insights that can be used to design solutions for disaster risk reduction that are cost-effective, inclusive, and sustainable (Timilsena and Devkota 2022). In spite of the growing interest in the application of IK, there is still scepticism regarding IK, and this is one of the attributes that prevents the widespread implementation of IK in quality management and science (Ifejika Speranza et al. 2010). For the people who constructed indigenous knowledge systems, including management of natural resources, it was a matter of survival. It guides local decision-making in farming, non-farm pursuits, health, resource extraction, serving, and other indigenous activities. This knowledge encompasses "any form of information that is scientific, agronomic, technical, and ecological", including "cultigens", "medicines", and "the rational use of flora and animals". Environmental change is humanity's biggest test (Cunningham 1992). Native peoples face the immediate effects of a global temperature change on the biological systems or settings they occupy due to their dependency on the climate and its resources (Food and Agriculture Organization of the United Nations 2020; Grieves 2009). Numerous institutional and legal impediments impede indigenous people's capacity to deal with and adapt to climate change, making it a civil rights and inequality concern. Strengthening and conserving indigenous people's adaptive capacity requires linking it with emergency preparedness, plan outlines, environmental conservation, and protracted growth plans (Abioye et al. 2011; Altman et al. 2018; Costanza et al. 2014). Adapting to changing situations requires additional financial resources and the transfer of technology that most indigenous people lack. While short-term adaptation methods continue, financial and skill constraints hinder long-term alternatives (Florin and Wandersman 1990).

In addition to having the world's second largest population, India is consistently ranked among the nations with the highest risk of natural disasters. One of the most common types of natural disasters that can be found across the country is drought (Table 8.1). Despite the fact that Bankura is a rain-fed district, it is usually considered to be the state's most drought-prone area. Throughout the north-western section of the district, drought is a common occurrence that must be dealt with in an emergency (Goswami 2017). In spite of the fact that this district receives an average of 1400 mm of rain per year, the region's agriculture and agricultural production are heavily dependent on a limited window of time with very unpredictable rainfall (Goswami 2017). Within the boundaries of West Bengal, the Purulia district is regarded as having the greatest susceptibility to the adverse effects of drought. Because of this, the area is known as "the region with a stone heart". Because the land in Bankura and Purulia is undulating, lateritic, and porous, it has inadequate subsoil moisture, which poses a significant risk to the crop. The fluctuating patterns of seasonal precipitation (Fig. 8.1) contribute to an even greater degree of variation in crop yield (Kar et al. 2012). Actual precipitation is expressed as a standardized departure from the rainfall probability distribution function by using an index called the Standardized Precipitation Index (SPI). According to the standard precipitation index (SPI), the frequency and intensity of seasonal droughts in Bankura and Purulia are, respectively, 9 and 10 during the pre-monsoon period; 3 and 3, respectively, during the monsoon period; and 4 and 4, respectively, during the post-monsoon period (Kar et al. 2012). Loss of crops, starvation of humans and cattle, degradation of land, impairment of many other economic activities, proliferation of disease, and displacement of individuals and livestock are the typical effects of agricultural drought (Hazra et al. 2017). Droughts can also cause an increase in the risk of wildfires and floods. Droughts not only have a negative impact on food security on farms, but they also have a negative impact on the economy of the nation as a whole and on overall food security (Hazra et al. 2017).

Table 8.1 Drought affected regions in India (Modified from Stephen 2012)

Serial number	Region	Sub division
1	North-West India	Haryana, Chandigarh and Delhi, East Rajasthan, West Rajasthan, Gujarat Region (Saurashtra & Kutch) and Punjab
2	West Central India	East Madhya Pradesh, West Madhya Pradesh, Konkan and Goa, Madhya Maharashtra, Marathwada, Vidarbha, Telangana, and North Interior Karnataka
3	Peninsular India	Coastal Andhra Pradesh, Rayalaseema, Tamil Nadu and Puducherry, Kerala, Coastal Karnataka, South Interior Karnataka
4	Central North-East India	Jharkhand, Bihar, Orissa, East Uttar Pradesh, West Uttar Pradesh
5	North-East India	Assam and Meghalaya, Nagaland, Manipur, Mizoram and Tripura, Sub-Himalayan West Bengal and Sikkim and Gangetic West Bengal
6	Hilly Regions	Jammu and Kashmir, Himachal Pradesh, Uttarakhand

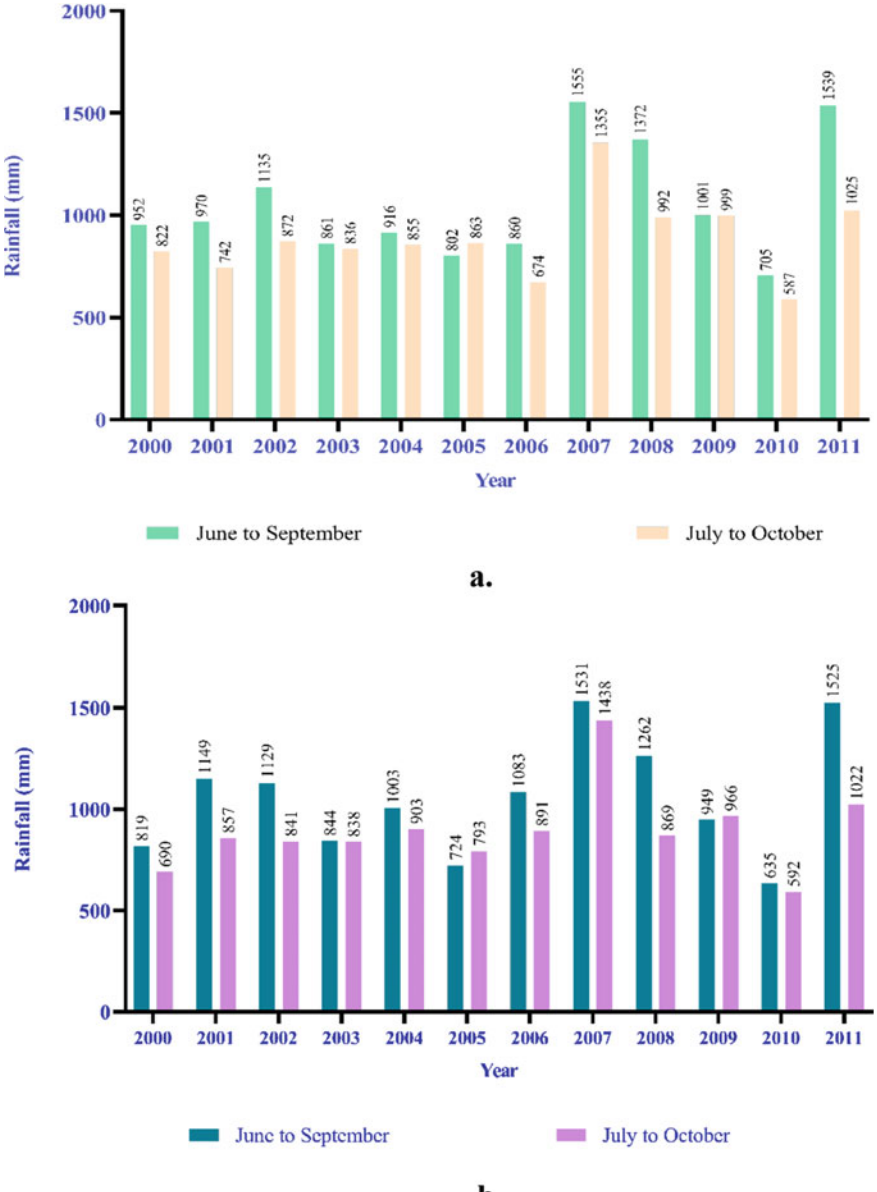


Fig. 8.1 **a** Annual monsoon rainfall (mm) in Bankura; **b** annual monsoon rainfall (mm) in Purulia. Modified from Halder and Sadhukha (2012)

The tribal people who live in India each have their own unique identity in addition to their rich heritage. The majority of Indian tribes still maintain their traditional lifestyles of living in remote areas of the country, such as forests and uneven terrain (Sarkar and Modak 2022). The entirety of the Purulia and Bankura districts are included in the Western Rarh region in West Bengal. In accordance with Article 342 of the Constitution of India, 40 different cultural groups are recognized as scheduled tribes (STs) in the state of West Bengal. 18.27% of the population in the Purulia district and 10.36% of the population in the Bankura district are members of scheduled tribes (ST) (Census of India 2011), along with a diverse cultural heritage (Basu 2020). The current study sets out to assess the indigenous local knowledge, capabilities, and traditional practices of food and water resource management in relation to combating drought in these areas.

8.2 Materials and Methods

8.2.1 Study Area

In the state of West Bengal, the Western Rarh region encompasses the entirety of the Purulia and Bankura districts (Fig. 8.2). The present research is mostly carried out in the communities of Bankura (23°13′52.68″ North and 87°4′42.24″ East) and Purulia (23°19′55.92″ North and 86°21′41.76″ East). The Western Rarh region of West Bengal is mostly made up of these two districts, which are primarily semi-arid, include uneven terrain, hilly sections, and dense woods, and have a name that literally translates to "Western Desert". The majority of tribal villages can be found in mountainous and forested areas like these. The districts are home to the most impoverished of the poor, as well as members of rural and indigenous communities. Some of the most well-known tribes are the *Santhals, Bhumijs, Kherias, Lodhas, Mundas, Oraons, Paharias, and Birhores.*

8.2.2 Data Collection

Interviews were used as a method of data collection for the primary data, and these interviews took the form of both direct personal investigations and indirect oral investigations. During the study period of June 2021 to May 2022, a routine question and answer session survey of 28 informants (22 males and 6 females) from primarily three tribes (Santhal, Bhumij, and Lodha) was conducted in several remote villages (Fig. 3a.). It was carried out in a structured manner, with a set of predetermined questions prepared as a schedule and highly streamlined recording techniques. A focused interview (Fig. 3b.) was also conducted to obtain more detailed information. Because of the existence of enlightened tribal members in those houses, certain

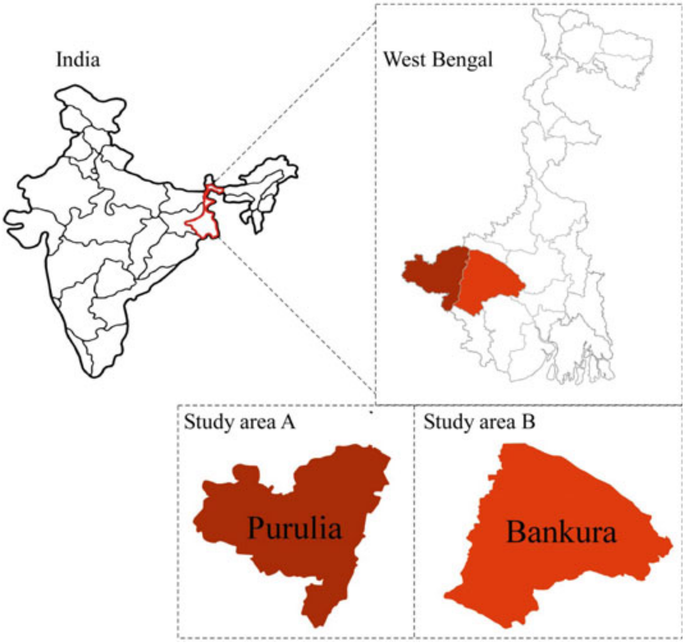


Fig. 8.2 Study area (Purulia and Bankura District) (*source* self)

houses were designated as "important" for interviews. This information was provided by key informants such as *Mukhiya* (village head person) or by a highly regarded school teacher of the concerned village. Each house had one specific male (the knowledgeable one) interviewed, and elderly female members of those residences also contributed valuable add-ons. Interactions with locals are important parts of the study, but they are usually very restrictive in terms of communication. As a result, during the field visits, a local guide who may or may not belong to the tribe but is very efficient in communicating with the tribes through their own vernacular was deployed and acted as a viaduct between interviewee and interviewer. Throughout the course of the research, close attention is paid to aspects of tribal lifestyle, mainly eating patterns, the consumption of water resources, and coping mechanisms. The survey's main impediment is the conservative approach to sharing information, which stems from the fear of losing their sacred, shielded, unharmed traditional coping mechanism. However, the present study only records information that is both specific and convincing, having been double-checked with the other interviewee.

a b

Fig. 8.3 **a** Beleshola Tribal Village Near Barjora Block; **b** interviewing with the tribal people about the strategies to combat drought (*source* self)

8.3 Result and Discussions

The results of our study, which encapsulated indigenous knowledge relevant to the fight against drought and included solutions to conserve water and food, are shown below.

8.3.1 Food and Feeding Habits to Combat Drought

"All people at all times have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO 2008). A person's food habits can be defined as the manner in which they select, obtain, store, prepare, distribute, and even dispose of food items. This can include everything from how they select foods to how they cook them. As a result of humans employing food in symbolic ways, for living beings, food is more than merely a source of nutrients. Food plays an important symbolic role in the preservation of one's ethnic traditions. In order to preserve their culture and their group identity, tribal people ensure adherence to such practices. The definition of indigenous peoples' traditional food systems is that they are made up of components that are sourced locally, are found naturally, and are culturally sanctioned (Kuhnlein et al. 2013). The diet chart that has been presented here includes many different kinds of food, some of which are common while others are not. Some of the foods are available year-round, although they are not often prioritized by the indigenous populations. As a result of the lack of available resources, these meals will have to be consumed as a necessary source of nutrition as the drought continues to spread over the area. As a result, there will be no choice in the matter of favoured food items. During times when there is not a drought, this is the reason why food products alter.

Following are the foods (Table 8.2) consumed by the indigenous people of these regions.

Various Cereals

During this time of extreme unrest, the indigenous people in this region are heavily reliant on cereal as one of their primary sources of food (Fig. 8.4). These are Marua (*Eleusine coracana*), Bajra (*Pennisetum typhoideum*), and Junar (*Sorghum bicolor).* In times of severe drought, they start preparing a unique form of food using a variety of cereals that are referred to in the area as "Lapsi Ghata". Patience and a solid grasp of fundamental cooking skills are required for the preparation of this dish. In the beginning, with the assistance of a "Dheki" (an agricultural tool used for threshing, to separate grains from their outer husks), they smashed the cereals. Second, when the grains are crushed, they are separated into three different size categories; a sieve is used to pick out the grains that are the smallest in size. Then, they prepare a clay pot in which the largest sized grains are placed in water and allowed to boil, followed by the addition of medium sized grains and followed by the addition of the smallest sized grains. A plate made from "sal" leaves (*Shorea robusta*) is used for the final presentation. With these cereals, they would occasionally also make some scrumptious "Pithas", which are similar to pancakes. Cereals are another staple food that is widely consumed by the indigenous people of Nigeria. One of the most well-known traditional foods in Nigeria is called "Akamu", and it is composed of millet cereals (Nwachukwu et al. 2010).

Rice and Rice Gruel

According to the findings of the study, rice is the primary source of nutrition for the vast majority of the tribal people (Bisai and Dutta 2021). They eat either twice or three times a day, depending on the day. Rice is almost always served with a dish that they make consisting of burnt potatoes and tomatoes cooked with a small amount of mustard oil and accompanied by roasted drumstick leaves. For lunch, they eat rice that has been boiled, accompanied by a variety of vegetables. One of the most well-known traditional foods consumed during times of drought is a dish called Marjhola, which consists of sticky rice made with a substantial quantity of rice gruel and sojne (*Moringa oleifera*). They used an oven made of clay to bring the rice and vegetables to a boil, at which point they cooked the rice. After that, the food is seasoned with salt and served. They consume the same food that was prepared for lunch at night time. It is sometimes in short supply for them because there is a significant lack of rainfall; during these times, they have no choice but to rely on rice gruel, which is made from broken up leftover rice and is referred to as "Dhala mar" in the local dialect. This "dhala mar" is very important for making up for the lack of water that is required during this time period.

Table 8.2 List of food consumed by Indigenous people of Bankura and Purulia (*source* self)

Category	Local name	Scientific name	Consumption type
Cereals	Marua	*Eleusine coracana*	Grains
	Bajra	*Pennisetum typhoideum*	Grains
	Junar	*Sorghum bicolor*	Grains
Rice and rice gruel	Marjhola/Dhalamar	*Oryza sativa*	Grains
Leafy green vegetables and others	Kana Saag	*Comellina benghalensis*	Leaves
	Hemcha Saag	*Enydra fluctuans*	Leaves
	Kural Saag	*Bauhinia* sp.	Leaves
	Notey Saag	*Amarantus viridis*	Leaves
	Pipre Saag	*Ficus* sp.	Leaves
	Lau Pata	*Macaranga harveyana*	Leaves
	Kumro Pata	*Cucurbita* sp.	Leaves
	Marchi Saag	*Catharanthus pusillus*	Leaves
	Hurhuria Saag	*Cleome monophylla*	Leaves
	Kolmi Saag	*Ipomoea aquatica*	Leaves
	Kulekhara Saag	*Leucas mollissima*	Leaves
	Kedo Saag	*Limnophila indica*	Leaves
	Gara Saag	*Polygonum barbatum*	Leaves
	Barial/Junka	*Sida cordata*	Leaves
	Satgithia	*Spermacoce hispida*	Leaves
	Mulhan (shoot of lotus plant)	*Nelumbo nucifera*	Shoot
	Kural (young shoot tip of bamboo plant)	*Bambusa* sp.	Shoot tip
Fruits	Bainchi	*Flacourtia indica*	Fruit
	Piyal	*Buchanania lanzan*	Fruit
	Vela	*Semecarpus anacardium*	Fruit
	Kusum	*Schleichera oleosa*	Fruit
	Amla	*Emblica officinalis*	Fruit
	Madal	*Annona squamosa*	Fruit
	Amra	*Spondias pinnata*	Fruit
	Dumur	*Ficus hispida*	Fruit

(continued)

Table 8.2 (continued)

Category	Local name	Scientific name	Consumption type
	Kochra	*Madhuca indica*	Fruit
	Kend	*Diospyros tomentosa*	Fruit
	Tentul	*Tamarindus indica*	Fruit
Tuber	Khesari	*Actinoscirpus grossus*	Roots
	Simchiru ara	*Cyanotis axillaris*	Roots
	Kana kanda	*Nymphoides indica*	Roots
	Dhai	*Tacca pinnatifida*	Roots
	Gittha	*Dioscorea bulbifera*	Roots
	Bhyakur	*Dioscorea pentaphylla*	Roots
	Tarul	*Dioscorea alata*	Roots
	Genthi	*Dioscorea hispida*	Roots
Mushrooms	Bali	*Agaricus* sp.	Thallus
	Puyal	*Agaricus* sp.	Thallus
	Putka	*Marasmius* sp.	Thallus
	Parab	*Agaricus campestris*	Thallus
	Patra	*Agaricus pracimosus*	Thallus
	Mura	*Psalliota* sp.	Thallus
Fodder plant	Assatha/Jore	*Ficus religiose*	Leaves
	Arjun	*Terminalia arjuna*	Leaves
	Vela	*Semecarpus anacardium*	Tender branches
	Ankra	*Alangium salvifolium*	Green leaves
	Buch	*Cordia nyxa*	Fresh foliage
	Kural	*Bauhinia racemose*	Leaves
	Bans/Bamboo	*Dendrocalamus strictus*	Leaves
	Gamhar	*Gomelina arborea*	Leaves
	Sisoo/Indian rosewood	*Dalbergia sissoo*	Leaves
	Sirish	*Albezia lebbeck*	Leaves
	Tun	*Toona ciliate*	Seeds and leaves
	Amlaki/Indian gooseberry	*Phyllanthus emblica*	Leaves

(continued)

Table 8.2 (continued)

Category	Local name	Scientific name	Consumption type
	Bohera	*Terminalia belerica*	Fruit
	Nishinda	*Vitex negundo*	Leaves
Insect	Kurkut (Weaver Ant)	*Oecophylla smaragdina*	Egg
	Lumang Tiju (Silk Worm)	*Bombyx mori*	Whole insect
Molluscs	Gugli	*Bellayma bengalensis*	Flesh
Fish	Velsa	*Glossogobius giuris*	Meat
	Magur	*Heteropneustes fossilis*	Meat
	Chang	*Channa puctatus*	Meat
	Gorui	*Channa stratus*	Meat
	Punti	*Puntius ticto*	Meat
	Darka	*Esomus danricus*	Meat
	Genti	*Macrognathus* sp.	Meat
Reptile	Gosaap/Satna (Monitor Lizard)	*Varanus* sp.	Meat
	Snake	*Ptyas* sp.	Meat
Aves	Bon Morog/Khukri (Red Jungle Fowl)	*Gallus gallus*	Meat
	Titir (Gray Francolin)	*Ortygormis pondicerianus*	Meat
	Ghughu (Indian Collared Dove)	*Streptopelia decaocto*	Meat
	Harial (Yellow footed green pigeon)	*Treron phoenicoptera*	Meat
Mammal	Indur (Wild Rat)	*Rattus norvegicus*	Meat
	Sahi (Porcupine)	*Hystrix indica*	Meat
	Banor (Monkey)	*Maccaca rhesus*	Meat
	Kathberali (Squirrel)	*Funambulus* sp.	Meat
	Khera (Rabbit)	*Lepus nigricolis*	Meat
	Badur (Bat)	*Pteropus* sp.	Meat

Leafy Green Vegetables and Others

Local tribal people are also dependent on a variety of vegetables, all of which are collectively referred to as "saag" (leafy green vegetables) (Fig. 8.5), especially during times of drought. In particular, they like Kana saag (*Comellina sinensis*), Hemcha saag (*Enydra fluctuans*), Kural saag (*Bauhinia* sp.), Marchi saag (*Catharanthus*

a. b. c.

Fig. 8.4 Some of the cereals and kurkut consumed by the tribal people of this region: **a** *Pennisetum typhoideum* (Bajra); **b** *Sorghum bicolor* (Junar); **c** the egg of weaver ant (*Oecophylla smaragdina*), locally known as "kurkut", wrapped by leaves

pusillus), Hurhuria saag (*Cleome monophylla*), Kolmi saag (*Ipomoea aquatica*), Kulekhara saag (*Leucas mollissima*), Kedo saag (*Limnophila indica*), Gara saag (*Polygonum barbatum*), Barial saag (*Sida cordata*), Satgithia saag (*Spermacoce hispida*), and Notey saag (*Amarantus viridis*). They gathered those specific green leafy vegetables from agricultural land with a limited supply of water, combined them with left-over broken grains of rice, and then boiled the mixture after adding a small amount of water to the mixture. The porridge that was made as a result was served with a pinch of salt and roasted green chilies. Another leafy green vegetable that is used during times of drought is known in the local dialect as pipre saag (*Ficus* sp.), and it possesses antipox features (Yarmolinsky et al. 2012). During this critical period, this porridge will be one of the primary sources of nourishment. During times of drought, bottle gourd leaves (*Macaranga harveyana*) and pumpkin leaves (*Cucurbita* sp.) are extensively used. Together with rice, they are ground into a paste and used. They **prefer** eating vegetables that they cultivate on their own land, but due to the extreme shortage of water supply, they prefer to pluck some wild leafy green vegetables, which will be cooked minimally to provide some essential nutrients. These leafy green vegetables are rich sources of calcium, iron, and beta-carotene (Ghosh-Jerath et al. 2016). They are also pretty fond of *Mulhan,* i.e. the shoot of the lotus plant (*Nelumbo nucifera*); *Koril,* i.e. the young shoot tip of bamboo *(Bambusa* sp.); and the rhizome of lotus plants.

Fruits and Tubers

To combat the scarcity during drought, indigenous people of these regions have to depend on wild edible fruit and tuber resources as an alternative or non-conventional food source (Fig. 8.6) against the conventional ones in the near future to cope with the increasing demand for food during climatic hazards and to fulfil nutritional requirements. Thus, plant resources play a vital role in sorting out various problems related to food. Beside this, many of these wild edibles have immense cultural value among the local inhabitants and are consequently associated with their indigenous traditions (Bhujel et al. 2018). Traditional practices include boiling *Dioscorea* species tubers as

Fig. 8.5 Leafy green vegetables consumed by tribal people to combat drought. **a** *Amaranthus viridis* (Notey Saag); **b** *Moringa oleifera* (Sojne Saag); **c** *Commelina sinensis* (Kana Saag); **d** *Bauhinia* sp. (Kural Saag); **e** *Enydra fluctuans* (Hemcha Saag); **f** *Cucurbita* sp (Kumro leaves); **g** *Ipomoea aquatica* (Kolmi Saag); **h** *Leucas mollissima* (Kulekhara Saag); **i** *Mulhan,* i.e. the shoot of lotus plant (*Nelumbo nucifera*); **j** *Koril,* i.e. young shoot tip of bamboo *(Bambusa* sp.); and **k** Rhizome of lotus plants

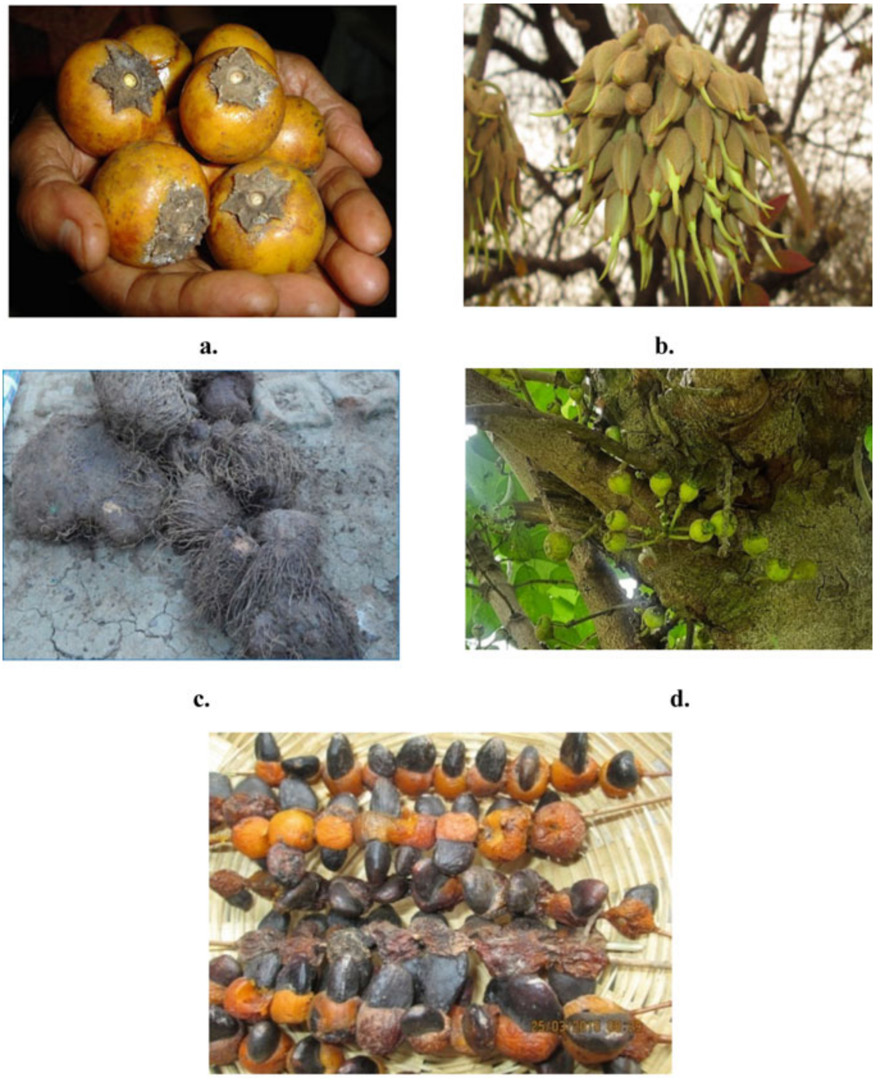
well as different varieties of tubers such as Khesari (*Actinoscirpus grossus*), Simchiru ara (*Cyanotis axillaris*), Kana Kanda (*Nymphoides indica*), Dhai (*Tacca pinnatifida*), and fruits such as Piyal (*Buchanania lanzan*), Vela (*Semecarpus anacardium*), Kusum (*Schleichera oleosa*), Amla (*Emblica officinalis*), Madal (*Annona squamosa*), Amra (*Spondias pinnata*), Dumur (*Ficus hispida*), Tentul (*Tamarindus indica*), Kend (*Diospyros tomentosa*), and Kochra (*Madhuca indica*). Both the fruit and the seed of the piyal (*Buchanania lanzan*) plant are used as food. The seed is a nut that can be eaten and is called "chironji". The dried leaves of tentul (*Tamarindus indica*) are ground into a powder that is used to make soup, mixed with the water from cooked rice, known as "paula", and consumed. Its fruits, both green and ripe, are used to make different kinds of prickles. Kend (*Diospyros tomentosa*) fruit is delectable and edible. Locals believe that eating this fruit provides both a refreshing and an astringent impact (Kumari and Kumar 2021), so they make it a practice to consume it throughout the hotter months of the year. In these areas, the indigenous people, particularly the Bihors, traditionally habituated a hilly region called Kanda (*Dioscorea* sp.), which is locally referred to as "Baula". This tastes very bitter, but the native people have developed a number of methods to eliminate this bitterness, making it possible to prepare the cereal as a tasty snack as well as in roasted, pelletized, and other forms (Kumar et al. 2017). The local indigenous people of this region cut the plant into a round shape, washed it twice in a nearby stream (if water was available; otherwise, this step was skipped), and then dried it in the sun. The expulsion of its resentment can be attributed to this particular reason. The following day, they boil it together with tamarind seed and consume it in that form. Therefore, the total refurbishment of Baula requires two days to complete.

Potom (Left Over Food)

As a result of the drought, many indigenous people living in remote areas are unable to make daily food preparations for themselves. They subsist almost exclusively on a specialized variety of food that is referred to as "Potom" in the area. The above food is nothing more than the scraps and discarded edible components from a ceremony that took place in a nearby town or village. The leftover foods are first collected, then sun-dried to the fullest extent possible, and finally, sal leaves (*Shorea robusta*) are used to make a wrapper for the food. During this time of extreme destitution, this potom will be of great assistance. This food item can only be found in remote tribal villages; in communities where rations are provided, it is difficult to stumble across this potom.

Mohul Latha (Mahul Fruit with Tamarind Seed)

During this time period, "Mohul latha" was one of the most well-known dishes consumed by the indigenous people of this region. This dish is made with dried Mohul fruit (*Madhuca indica*) and tamarind seed that has been boiled. After that, a



a. b. c. d. e.

Fig. 8.6 Some of the edible fruits and tubers used by the native people of this community. **a** Kend (*Diospyros tomentosa*); **b** Kochra (*Madhuca indica*); **c** Genthi (*Discorea hispida*); **d** Dumur (*Ficus hispida*); and **e** Vela (*Semecarpus anacardium*) semi-solid circular shape is formed from it, and it is consumed. In addition to this, the tamarind seed was sun-dried, then crushed into a powder, which was then combined with sticky rice and consumed. Each of these foods is liquid in nature, and they contain enough water to compensate for the significant loss of water throughout this catastrophic period.

Animal Eggs and Animals as Food

Protein is a key component of a healthy human diet that is absolutely necessary for life. However, during this catastrophic period, the indigenous people who live in these regions satisfied their need for protein by eating a wide variety of foods. One of the most well-liked foods is called "Kurkut" (Fig. 8.4c), and it consists of nothing more than the eggs of weaver ants (*Oecophylla smaragdina*). Eggs of this kind are referred to as "Hau" by the Santhal people. After being collected from the trees, the eggs are prepared as food by being fried in mustard oil with salt, chilli spices, and other seasonings. Additionally, this egg of the red ant is very well-liked among the native people of the eastern Himalayas (Chowdhury et al. 2015). They also consume the mulberry silk worm (*Bombyx mori),* which is popularly known as "Lumang tiju". Every day, the indigenous people in these areas ate "gugli" (snail) (*Bellayma bengalensis*), which was taken from the murky part of the waterbody. In spite of the sweltering heat and the fact that the rivers, lakes, and ponds have more or less dried up, they have been successful in catching fish (Fig. 8.7). They typically obtain Velsa (*Glossogobius giuris*), Magur (*Heteropneustes fossilis*), Chang (*Channa puctatus*), Gorui (*Channa stratus*), Puti (*Puntius ticto*), Darka (*Esomus danricus*), and Genti (*Macrognathus* sp.). They mostly ate the fish grilled, with only a small amount of mustered oil. Some of the native people who live in this area, particularly the Santhals, are accustomed to eating the meat of monitor lizards (*Varanus* sp.) and wild brown rats (*Rattus norvegicus*). From the neighbouring forest, they bring back birds such as the Bon Morog/Khukri (*Gallus gallus*), Titir (*Ortygormis pondicerianus*) (Fig. 8.7e), Harial (*Treron phoenicoptera*), and Ghughu (*Streptopelia decaocto*) (Fig. 8.7f) (Chanda and Mukherjee 2012). They will eventually become accustomed to eating the meat prepared in a curry with various spices such as turmeric, cumin, coriander, chillies, and black pepper, among others (Gorai et al. 2022). More than 25 non-conventional animals, such as the monkey (*Maccaca rhesus*), bat (*Pteropus* sp.), porcupine (*Hystrix indica*), Kathberali (*Funambulus* sp.), Khera (*Lepus nigricolis*), rat (*Rattus norvegicus*), snake (*Ptyas* sp.), and Indian Monitor Lizard (*Varanus* sp.), are pursued for their flesh by the less fortunate residents of this area. Some of the peasants who are struggling financially are accustomed to making curries with dried blood. It has also been reported that some indigenous cultures like the practice of eating raw snake blood with steamed rice (Modak 2010). The native people of Africa, Australia, and many regions of Asia have a strong preference for the meat of monitor lizards (*Varanus* sp.) and wild brown rats (*Rattus norvegicus*) (Hoffman and Cawthorn 2012).

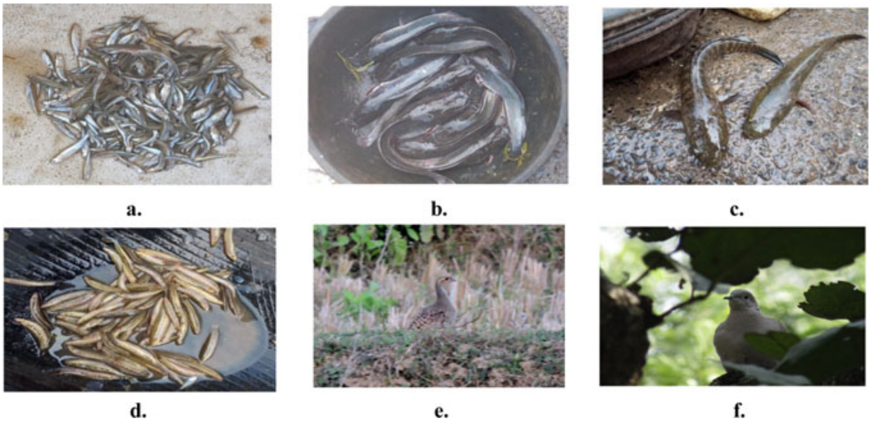


Fig. 8.7 Some of the edible fish and birds that are consumed by the tribal: **a** Darka (*Esomus danricus*); **b** Magur (*Heteropneustes fossilis*); **c** Goroi (*Channa stratus*); **d** Genti (*Macrognathus* sp.); **e** Titir/Gray Francolin (*Ortygormis pondicerianus*); and **f** Ghughu/Indian Collared Dove (*Streptopelia decaocto*)

Community Hunting in Forests (Hunting Festival/Disum Sendra)

One of the most well-attended hunting celebrations among the indigenous people, particularly in the Santhal community, is known as *Disum Sendra*. This adventurous celebration is restricted to only the male inhabitants of the village. The sounds of various musical instruments being played, including drums being beaten, can be heard from a considerable distance late at night. It is thought that the creatures will emerge from their slumber in response to these noises. The young men and women who are taking part in the hunt begin their day by petitioning *Banadevi*, the everlasting goddess of the woods, for her blessing before moving into the hill forest to begin their day of hunting. The males are able to regain their agility, which had been diminished during the summer months when there were no agricultural operations taking place. They do not kill any animals that are pregnant, sick, or frail, and they never slaughter any young animals because it is against both their culture and their religion. They always go for the adult animals that are the nimblest, as they offer a plentiful supply of essential nutrients during this period of resource scarcity. They will receive the necessary nutrients from the prey, which will help to restore the tribal people's agility and, as a result, contribute to the preservation of a healthy existence despite the severe scarcity (Sarkar and Modak 2022). This festival isn't about murdering animals. Even if they miss their target, tribal hunters return to their homes. If animal killing was the only goal, they wouldn't return until they caught something. As resources are scarce during the hot summer, wild creatures compete for them. Pregnant animals and babies aren't killed. The most resource-hungry, fast-moving, and prolific creatures are the ones they aim for instead. Predation on older and stronger animals keeps the forest in balance. Tribal participants can improve wild animals' movement, awareness, and muscular activity by producing instrumental and manufactured sounds. This event celebrates youth, maintains the robust reproductive life of young, minimizes competition among wild animals, increases their movement, and maintains the forest's environmental balance (Sarkar and Modak 2022). Between September and December, the *Pasikau* tribe of the Bunun people of Taiwan, China, holds a hunting festival. Additionally, according to their custom, it is forbidden to take the lives of animals in their youth, as well as alpha males or females (Chao and Liao 2015).

Hariya (A Traditional Alcoholic Beverage)

Hariya is the primary traditional alcoholic beverage consumed by the indigenous communities of West Bengal. These communities include the Santals, Mundas, Oraons, and Lodhas. Hariya is consumed almost everywhere in the state. Hariya is a traditional liquor that is consumed by the tribal communities that can be found in eastern and central India. Additionally, it is a rice beer. The rice that has been cooked is the primary component (*Oryza sativa*). Rice is combined with a traditional starter culture known as "bakhar" and then fermented. It is also known as "Renuboti" in certain parts of the country. The starter culture is of the utmost significance in the production of the dish known as "Hariya". In order to inoculate microorganisms, the starter culture known as "Bakhar" or "Renuboti" is made by fermenting rice dust with the extracts of various plants, roots, and leaves, as well as rice dust (Dhal et al. 2010). Bakhar is stored in a cool, dry location. It is typically mixed in at a ratio of 2–3 g per 200 g of boiled rice. In order to make "Hariya", a sterile earthen vessel must be used, and this vessel must then be exposed to sunlight in order for it to be purified. After that, the rice is boiled, and after that, it is spread out on a mat to dry. After that, the dehydrated rice is mixed in the appropriate manner with the starter culture known as "Bakhar". In addition, the mixture is preserved in the earthen vessel, and the lid is sealed with lead. The vessel is then placed in a dark location, where it will remain in the same position for the next three to four days. After three to four days, potable water is added to the mixture at a ratio of one to six. After that, the liquid goes through a filtration process using a very fine and clean cloth. The drink known as "Hariya" can now be consumed. Following the conclusion of the fermentation process, it was determined that the alcohol content of "Hariya" has a concentration of 11–12% (Ghosh et al. 2014). Under the scorching heat of the sun during the summer, the indigenous societies that lived in this area made heavy use of hariya, and they believed that it provided an enormous amount of energy.

Mushrooms

Indigenous communities have used non-timber forest products since the beginning of time by utilizing ethnomycological knowledge to collect wild mushrooms (Fig. 8.8), prepare them with food items, and consume them for their various daily uses, such as edible and medicinal, and have been regarded as secondary food resources. This is

Fig. 8.8 Some of the mushrooms consumed by tribal people in this region. **a** Bali Chattu (*Agaricus* sp.); **b** Parab Chattu (*Agaricus* sp.); **c** Puyal Chattu (*Agaricus campestris*)

done by collecting the mushrooms, preparing them with food items, and consuming them (Debnath et al. 2019). During this time of year, the native people who live in this region incorporate many different kinds of wild mushrooms into their diet. Among these, the Bali (*Agaricus* sp.), Puyal (*Agaricus* sp.), Putka (*Marasmius* sp.), Parab (*Agaricus campestris*), Patra (*Agaricus pracimosus*), and Mura (*Psalliota* sp.) mushrooms are considered to be some of the most significant. It has been found that edible wild species of mushrooms tend to have a flavour, palatability, and nutritional profile that is preferable to that of their cultivated equivalents (Lampman 2010).

Fodder Used for Domestic Animal

Taking care of themselves and the domestic animals simultaneously when the temperature soars to dangerous heights is an absolute necessity. The native inhabitants who once inhabited this area fed their animals with many different kinds of plant material, such as the fruit and the leaves. During times of famine, native people in these areas rely on their knowledge of native plants to obtain vegetables for subsistence. They gather young plants and various parts of those plants from the jungles nearby (Dangol 2008). Here are some names of the plants, parts of which are used as fodder: Assatha/Jore (*Ficus religiosa):* leaves are used as fodder, the leaves of Arjun (*Terminalia arjuna*) are used as fodder. Vela (*Semecarpus anacardium*): tender branches are also used as fodder. Ankra (*Alangium salvifolium*): its green leaves are used as fodder, Buch (*Cordia nyxa*): fresh foliage is quite useful as fodder for cattle, Kural (*Bauhinia racemose*): leaves used as fodder, Bans/Bamboo (Dendrocalamus strictus): "rai bans" leaves are used as fodder. Gamhar (*Gomelina arborea*): green leaves are used as fodder, Sisoo/Indian rosewood (*Dalbergia sissoo)*—leaves are used as fodder, Sirish (*Albezia lebbeck)*—leaves are used as fodder, Tun (*Toona ciliate)—the* seeds and leaves are used as cattle fodder, Amlaki/Indian gooseberry (*Phyllanthus emblica*): leaves are used as fodder, Bohera (*Terminalia belerica*): it is considered good fodder for cattle; Nishinda (*Vitex negundo*): leaves are used as cattle fodder.

8.3.2 Water Resource Management to Combat Drought

The overarching goal of water resource management is to keep water supply and demand in equilibrium through the implementation of all feasible water conservation measures. The social, medical, and financial aspects of development are all inextricably linked to water's presence. When looking at the current situation, which is marked by an ever-increasing demand for water, it is essential to engage in careful management planning that considers all possible types of developmental thinking. It is very important to achieve optimal implementation and to differentiate groundwater potential zones for the purpose of conservation (Hutti and Nijagunappa 2011). Because of its inherent dynamism and renewability, groundwater plays a pivotal role in determining the quantity and quality of water available for and put to use by agricultural systems (Bera and Das 2021). Managing watersheds should begin with the overarching goal of preserving existing water resources while also creating new ones for future use. Therefore, in regions that are prone to drought, development based on micro-watersheds might be considered the most effective strategy for the general advancement of a region (Deshpande and Narayanmoorthy 2000). Below, some water resource management strategies (Fig. 8.9) that are used by the indigenous people in this region are described.

Pitcher Watering System or Clay Pot System

Pitcher irrigation is a time-honoured method that has been used in many dry places all over the world, including those in India, Iran, Africa, and South America (Mondal 1974; Stein 1997). The method is uncomplicated and does not require a lot of money, and it has the ability to save a significant amount of water (Mondal 1978; Bainbridge 1998). It is of particular value in challenging environments such as those characterized by high salinity, extreme aridity, restricted water supply, and limited resources (Tripathi et al. 2017). In this method, water-filled jars known as "Kalsi" are buried next to the plants that are the focus of the procedure. These vessels have a small opening at the bottom. A little piece of fabric is then threaded through the opening in order to enable the water to escape from the container through the fabric and moisten the soil in the surrounding area. This assists the plants in obtaining the necessary amount of water. Because this method prevents the plant from drying out, it only takes one litre of water to keep a 7–8 foot plant alive during the summer (April–June).

Drip Watering System

A promising method of water conservation that is available to agriculturalists who are seeking to keep or grow their existing output rates while simultaneously reducing the amount of water they use is drip or trickle irrigation (Grant DiGeorge 1994). It has also been claimed by the indigenous farmers in Nepal (Ghimire 2021) and in

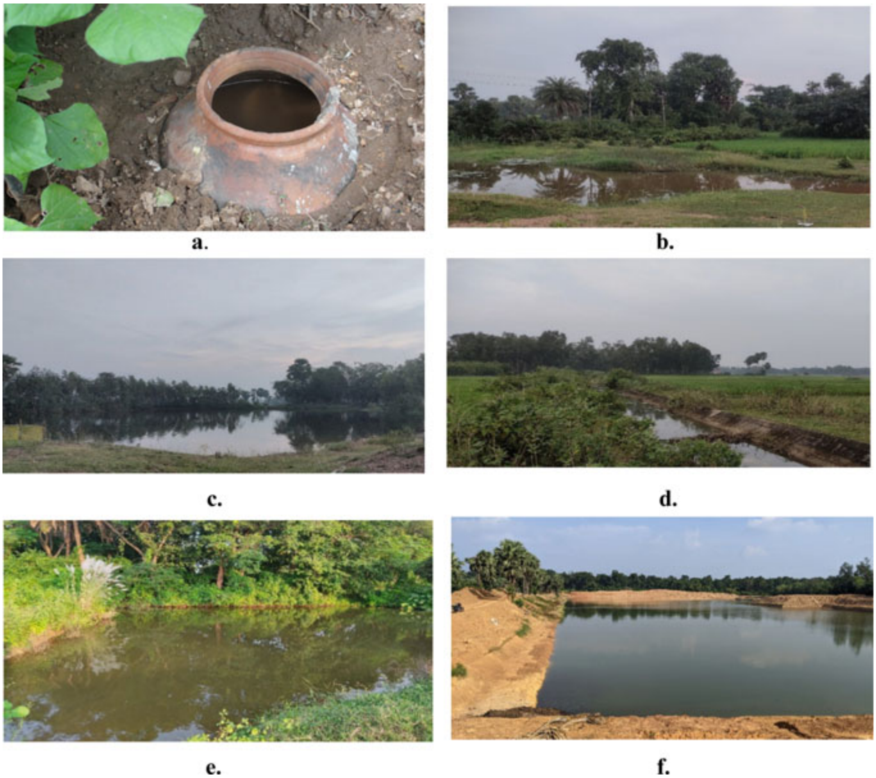


Fig. 8.9 Some of the water storage strategies of tribal people in this region. **a** Pitcher watering system. *Source* https://commons.wikimedia.org/; **b**, **c** Hapa and Doba for collection of rainwater; **d** water canal in between two agricultural field. These canals hold some of the edible fish and water; **e** a sacred pond, indirectly, helps in water storage through religious believe system; **f** rain water harvesting through digging a large area

Tamil Nadu that they use this drip watering system (Kumar and Palanisami 2010). To make a pipe-like structure, the inner joints (nodes) of a whole piece of bamboo that is long enough for an agricultural field are cut out. A few holes are drilled into the bamboo at regular intervals (determined by the space between the plants). Now, water is sprayed into the bamboo so that it can drip down the bamboo and out of the holes all the way across the bamboo. In this manner, vegetables are planted in accordance with the placement of the holes to ensure that they receive a steady stream of water droplets whenever water is put into the bamboo. This method allows for the cultivation of a number of vegetable plants while requiring only a small amount of water.

Cultivation of Sugarcane

In March and April, farmers use the water that has been stored in the channels along the riverbanks to grow seedlings by submerging the lower parts of the seedlings in the water. Before planting, the farmer tills the soil in the afternoon so that the land will be dampened by dew when it falls during the night. At dawn, they properly harrow the land so that the moisture can soak into the soil and not evaporate during the day. They do this process for ten to twelve days, depending on the conditions, and it assists the soil in maintaining its moisture content so that sugarcane plants can be grown. Both soil that has been changed with cow manure and soil that is sandy are very good at soaking up water.

Embankment on River

In this tragic moment, when waterbodies are steadily drying up, the situation for farmers is difficult. It has a significant impact on the crops that are grown throughout the summer when there is not enough water. Embanking the river is an additional solution that can be utilized to escape such a predicament. The native people who live in this area choose a section of the river's lower section for the purpose of embanking. These embanked sections of the stream contain enough water throughout the summer, when the river's flow slows down, for people to maintain their normal household and farming practices. These river embankment sites benefit the growth of plants, grasses, and other forage crops that are used for domestic animals because water is readily available at these locations. This method of embarkation is also known to have been practised by the indigenous inhabitants of Bangladesh (Dewan et al. 2015).

Sacred Pond

As a result of the local population's reluctance to pollute the environment and the water due to their religious beliefs, the bodies of water in the vicinity of temples are typically pristine and hygienic throughout the year. The indigenous people who originally inhabited these areas rely on these bodies of water, which are referred to as sacred ponds, as their primary source of potable water. These ponds, which serve as a central point for the distribution of water throughout the summer, are important to the local people, and they make every effort to ensure that they are well maintained. There is a small pond in Chhandar village, close to Beliatore in Bankura district that is associated with the deity Manasa. The villagers have the misconception that the goddess may become displeased if the pond is used by humans and that anyone who pollutes the water of the pond will suffer the wrath of the goddess in the form of a fatal punishment. The residents of the village strictly adhere to the prohibition against using the water from the pond (Deb and Malhotra 2001). One can find temples with tanks in Kerala, and these tanks also play an important part in the water harvesting and preservation processes. (Maya 2003).

Roof Rain Water Harvesting System

Indigenous people suffer from water crisis for which rural people try to make use of the rainwater in every possible way. They dig a pit near their house, called "*Hapa*" or "*Doba*", measuring about 50 ft. × 50 ft. × 10 ft. Heavy rainfall during Kal Baisakhi (heavy storm with rain) or in rainy season and water from roof top is directed to the pit through earthen open drainage for using the water for daily household purposes at least for three months. Besides it also recharges the groundwater system. This roof rainwater harvesting has also been reported from the native people of Amazon in north-western Peru (Morales Rojas et al. 2021).

Naturally Occurred Water Storages Beside the River

The region of Bankura and Purulia is regarded as a plateau; however, one can find within this region a large number of low hills and rippling lands that are the contributors to a number of rivers. These hills and lands serve as the headwaters for a number of rivers (Bauri et al. 2020). The majority of these rivers become dry during the summer months, but during the monsoon season, they are brimming with water. However, there is still water available in the innately generated water storages along the river bed. These water storages were formed as a result of soil erosion and are of great assistance to the local villagers. People will walk a long way from their homes along the river to get to these natural water storages, so they can drink, bathe, and do other things with the water.

Creation of Aquifer

An aquifer, also known as "Bhurbhuri" in the region, is a water source that was formed naturally and is characterized by water that spontaneously emerges from a depth in the ground and is stored there. Because it comes from a natural source, it does not become depleted of water during the summer months. This makes it an exceptional source of water for the native people, who rely on it for drinking. In addition to this, the water that is carried away by run-off from this source typically forms a stream, which is either the body of freshwater for a large body of water or a stream that is used for agricultural purposes. People in the area also take showers in the water that comes from the run-off. One of the local indigenous communities in South America is responsible for creating one of the world's largest aquifers, which is called the Gurani Aquifer (Leonard 2017). "Baudi" is the name given to this type of naturally occurring water source in the Indian state of Himachal Pradesh (Sharma and Kanwar 2009).

Creating a Large Opening in the Pond's Centre

During the hot summer days, when most of the ponds dry up, the indigenous people of this region devised an additional method of water storage in Happa, which is either a large hole in the middle of the pond or a Happa. This hole is normally filled with water, either as a result of rapid rainfall or with water from the subsurface that has been trapped underneath the rocks or dirt. The villagers were able to survive the dry season by using the water from these holes.

Waterfalls/Springs

In the uneven terrain of this region, natural waterfalls are an essential component of the way of life of the local tribes. There are several distinct types of waterfalls, each of which is capable of transporting a tremendous volume of water during the wet season. The water bodies in the area that are served by this runoff are improved as a result. Even though these waterfalls eventually dry up, particularly during the summer months, the water that remains slows down and runs like a small stream. This stream is the only source of drinking water for the people and animals who live in the area.

Providing Water to a Plant as Part of a Religious Practice

During the summer months, it is common practice to make a religious gift of water to certain historically significant plants in the faith that doing so will assist in making their wishes come true. During the scorching summer months, following this age-old practice helps to keep a variety of the region's important plants alive. Another example of this type of conservation can be seen with the alpine plants *Saussurea obvallata* and *Delphinium vestitum*, also known as "Dongar" and "Loshkar", respectively. These plants have been linked with a local deity, and as a result, local customs and beliefs have protected them by prohibiting anyone from the village or from outside the village from picking the flowers except for the village priest, who is only allowed to do so on specific days and times (Kandari et al. 2014).

Water and food are the two necessities for life for every kind of organism. The majority of life forms, such as humans, are now experiencing a water crisis that may be qualitative, quantitative, or both. This crisis may affect food and water quality or quantity, or both. This ever-worsening water and food crisis is primarily the result of the rapidly expanding human population as well as a wide variety of anthropogenic activities, all of which ultimately contribute to the phenomenon of climate change and global warming. FAO predicts "one billion people eat wild foods" (Aberoumand 2009). Non-timber forest products (NTFPs) feed and sustain 300 million people. Food security and NTFPs are linked in agricultural communities as well, particularly among the most marginalized members of society (Belcher et al. 2005). Wild foods assist urban and rural youngsters in Rajasthan, India (Rathore 2009). Wild foods give consumers more dietary variety. More than 7000 kinds of wild plants have been used as human nourishment, according to ethnobotanical research (Grivetti and Ogle 2000). As many as two hundred different plant species are used as food by some indigenous groups (Kuhnlein et al. 2009); 600 plant species in India are recognized to have nutritional benefit (Rathore 2009); and DeFoliart (1992) lists one thousand distinct species of edible insects as being consumed around the world. 1069 wild fungus species are important protein sources worldwide (Boa 2004). In 60 developing countries, bushmeat and fish contribute 20% of protein (Bennet and Robinson 2000).

The native people of this area were aware of the several ways that food may be used for regular consumption as well as the methods of preservation that could be put to use at times of the year when they were unavailable due to factors such as environmental risk. In addition, the consumption of these foods may prove to be an effective strategy for enhancing the nutrient supplementation that **is** being carried out in these communities with the goal of bettering the micronutrient status of the community. In order to effectively address the unique problems faced by indigenous peoples, it will be necessary to draw attention to and make better use of the unconventional feedstuffs that are inherent in indigenous food contexts. The community knows the edibility of a vast diversity of indigenous flora and fauna. The nutritional value of some foods may be lacking, resulting in inadequate intakes (Ghosh-Jerath et al. 2016). As a result, there is a requirement to raise knowledge about the nutritional qualities of these indigenous foods and adequately combine the message with the advocacy of indigenous foods via nutritional campaigns and education. So, the native people of these places might benefit from continuing to use native and wild foods in a sustainable way. This could be a great way to make sure they have enough food to eat and live a healthy, long life.

The current water crisis, which affects people all over the world, is primarily the result of excessive and inefficient use of this valuable natural resource. The districts of Bankura and Purulia in West Bengal are not an exception to this rule. Both Bankura and Purulia are included on the list of West Bengal districts that are at the greatest risk of experiencing a drought. It is a common sight in the rural village, where the women of the village are accustomed to walking long distances with earthen pots in order to collect water, particularly during the hotter months. They are acutely aware of the significance of water conservation as a result of the difficult fight for water they have had to wage. The people who live in rural areas of these districts have, quite naturally and going back into the distant past, developed a number of water management strategies that have helped them get through difficult times. However, as of right now, water consumption in urban Purulia has increased by more than double as a result of population growth (Halder and Saha 2015). This means that the increase in demand for water is significantly higher than the rate at which the population of this district is increasing. A possible technological intervention has been used to either collect water or tap it. The use of groundwater, however, has not been done in a way that is sustainable. Therefore, it is necessary for the municipal authority to take better care of conserving water or properly managing the water supply. They rely on a variety of time-honoured practices to satisfy their daily needs for food and water.

The term "indigenous knowledge" refers to concepts, experiences, practices, and information that may have originated locally or elsewhere, but have been modified by community residents and integrated into the native way of life. Indigenous knowledge can be passed down from generation to generation (Bleik and Veldhuizen 1993). The traditional people who live in Bankura and Purulia districts have been doing so in areas that are prone to natural disasters for a succession of generations. As a result, they have acquired some local knowledge that is adaptable to disasters in order to lessen the impact of natural disasters. Indigenous knowledge serves as the foundation for the coping strategies that local communities have developed over time and that have been essential to those communities' continued existence. This expertise has been derived from indigenous people's interactions with their native surroundings. It provides useful information with regard to the local environment and has the potential to be adapted for use in the elimination of risks in other communities in the area. Utilizing local communities' indigenous knowledge is one way to achieve local empowerment, an empowerment that ultimately results in increased community participation and the education of individuals on how to reduce their exposure to the risk of natural disasters (Shaw et al. 2008). The ingenuity of the human brain has made it possible for local communities to consider how they can manage their environment in a way that is both sustainable and conducive to development at the same time. Nevertheless, well-funded scientific development belief systems with goals that are typically based on profit have posed a threat to eradicating this localized body of information (Goonatilake 1984).

8.4 Recommendations

Every single human being, regardless of whether or not they are members of any community, is entitled to a life that is just, free, and dignified. The Universal Declaration of Human Rights recognizes that each of these rights possesses an element of an international nature (Nickel 1987). Freedom and safety are fundamental human rights that go hand in hand with the right to live. These rights ensure that individuals are free to associate with whichever organization, class, community, or state best suits their interests. It is imperative that these rights be granted to indigenous people, many of whom have been coerced into giving up their formerly free way of life over the course of millennia. The field of social work ought to play a major role in ensuring that indigenous people have adequate social support and security (Gray et al. 2008). The need to uphold human values should take precedence over any authority structure. International social work is in charge of making sure that the rights of indigenous peoples are protected when it comes to social security.

Traditional knowledge is a vast storehouse of information that can be drawn upon by all communities. However, because some of the traditional practices may not ensure people's health, it is necessary to adapt them so that they are in line with current knowledge. Following this step, individuals must be educated on how to use the new procedures effectively. Indigenous knowledge has the potential to be trustworthy and efficient during times of drought; however, this will only be the case if it is first identified, then seamlessly blended with scientific understanding, and finally applied. Even though indigenous knowledge incorporates some forward-thinking processes that are still useful in the modern world, putting them into practice without considering the findings of scientific research makes it impossible to ensure the continued health of communities during times of drought. By making use of the native abilities of the people who reside in these areas, the government and non-governmental organizations (NGOs) should foster an improvement in the quality of life and means of subsistence for the indigenous groups. The original residents of these regions have been removed from the forest, and the jungles themselves are gradually disappearing from the surrounding territories (Firdos 2005). They are gradually becoming frustrated because they are losing their culture that is associated with the forest (Gorai et al. 2022). In order to ensure that indigenous communities are properly developed, decision-makers should place an emphasis on programmes and activities that are not only founded on the requirements and innate capabilities of the communities but also contribute to the preservation of their cultural identities.

8.5 Conclusions

In order to effectively handle contemporary issues such as climate change, it is essential to rekindle and strengthen indigenous knowledge systems. Traditional knowledge is now widely acknowledged as an essential resource that needs to be disseminated in order to maintain livelihoods and ensure food security, which frequently occur in environments where the climate is changeable or subject to change. The goal of this publication is to compile a list of communal and indigenous climate change adaptation techniques.

The foundation of indigenous knowledge is the accumulation of synchronic and diachronic observations made by local people through many generations of careful observation and engagement with their surrounding environments (Dekens 2007). Their understanding is different from scientific understanding, which is usually based on simultaneous observations and is more quantitative and broader in scope. They put more emphasis on the quality and regional specificity of how it is used (Dekens 2007). On the other hand, modern science has a tendency to ignore or downplay the importance of other things. This means that indigenous knowledge is often overlooked or ignored.

Indigenous tribes overcame their early reluctance thanks to governmental and non-governmental efforts. Indigenous people in Bankura and Purulia have been urged to embrace modernization. Young people initially respond slowly but adapt over time. Due to their instinctive remoteness, their progress is slower than that of other indigenous peoples in the country. Middle-aged and older people are still hesitant to participate in developmental activities. In the past, indigenous people had few needs, but today, especially the younger generation, enjoys modern conveniences. Young people prefer daily wage work to their century-old forest economy. Although these pursuits undoubtedly improve the quality of life for today's youth, at the same time, a generation's worth of expertise in managing forest resources is being lost (Gorai et al. 2022). Their culture and religion are diluted. Improving people's lives and livelihoods is important for national development. It would be preferable if life and livelihood were improved while keeping cultural uniqueness and identity. Although indigenous people have a natural talent for using a variety of natural resources, many are increasingly being changed into unskilled labourers, and young members of the tribe have the same level of understanding about the forest and other forest products as their forefathers. Degrading traditional knowledge threatens biocultural frameworks, biodiversity, and ecological functions. The conservation and sustainability development problems that are cropping up in the world's natural ecosystems call for a diverse variety of nature-based solutions that can help strengthen their resistance to disasters and promote harmony of mind among indigenous peoples and their environments. The current research shows that indigenous communities already have a significant number of methods up their sleeves to deal with the threat posed by natural disasters. These techniques include reducing the scope of their operations to the point where the negative effects of a disaster will have the least possible impact. They make use of natural resources, the majority of which are farmed by them; as a result, their typical eating routine has become more straightforward; nonetheless, the foods they eat still provide them with the necessary nutrients. They come up with extremely astute ways to administer the water resource. These methods are not only incredibly helpful but also quite inexpensive and simple to implement. Given that climate change is likely to make our environment worse and increase the number and severity of natural disasters in the coming years, these native solutions may one day be seen as the best way to deal with environmental disasters.

Acknowledgements The authors remain thankful to Dr. Jaladhar Karmakar, whose work on indigenous knowledge has been invaluable, the writers express their heartfelt thanks. We also can't thank the neighbouring indigenous people enough for their help and cooperation during the research process.

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Chapter 9
Use of Biotic and Abiotic Factors to Predict Natural Calamities: A Case Study Concerning the Santali Tribe in Four Districts of West Bengal, India

Sanjib Gorain, Shuli Barik, Monoj Patra, Jayeeta Pal, Parimal Pramanik, Madhumita Mahato, Santosh Kumar Giri, Mrinal Mandal, and Surjyo Jyoti Biswas

Abstract Natural disasters significantly deplete development resources and gains and are thus a major obstacle to sustainable development. Tribal people use the traditional knowledge to overcome disaster mitigation by observing certain biotic and abiotic factors carried forward from one generation to other. There is neither any documentation of these resources nor are there locally available reports. Hence, the present survey is an attempt to assimilate traditional knowledge of the Santal community from four districts of West Bengal viz. Purulia, Bankura, Bardhaman and East Midnapore. It was carried out with the aid of semi-structured questionnaires. A total of 36 knowledgeable informants were interviewed, and the data were analyzed through traditional knowledge use value in disaster management (TKUVDM), informant consensus factor (ICF), fidelity level (FL), informant agreement ratio (IAR), cultural important index (CI) and cultural significance index (CSI). Highest TKUVDM value for biotic factors was for mammals (0.461) and lowest for fish (0.138) while for abiotic factors it was highest for waves (0.83) while lowest for drought (0.083). Fidelity level of mammals was more when compared to other vertebrates. Analysis of the data revealed that even though two Santali communities live apart there were certain common biotic and abiotic resources which were used as predictors of natural calamities. There is a dearth in proper documentation of these valuable resources, and hence, it is recommended that these tribals be included to recognize their practices that complement scientific understanding in disaster risk assessment.

Keywords Biotic and abiotic factors · ICF · Indigenous knowledge · Santal

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9.1 Introduction

A disaster is a significant issue that occurs over a period of time and results in widespread loss of life, property or resources that is greater than the capacity of the afflicted community or society to cope with using its own resources. In short, hazard, vulnerability and capacity all determine disaster. The knowledge that an indigenous community has accumulated over many generations in a certain location can be summed up as indigenous knowledge. It is a vast concept that encompasses all types of knowledge, including innovations, know-how, skills, customs and beliefs that assist the community to maintain stable livelihoods in their surroundings. Intellectual, technological, ecological and medical knowledge are part of this traditional cultural knowledge (Kumar et al. 2020). Natural disasters continue to cause severe suffering and fatalities throughout the world. Natural disasters substantially undercut development gains and resources and prove to be a significant barrier to sustainable development (Gomula et al. 2022).

According to the Global Humanitarian Overview 2019 report by the UN, between 2014 and 2017, 870 million people from 160 countries either lost their lives, means of sustenance or were forcibly displaced due to natural catastrophes (Ocha 2021). Over 90% of all natural calamities are caused by floods, severe storms, droughts and other climate-related extremes, which have the greatest impact on human beings (Chan et al. 2019; Hung et al. 2021). Global trends indicate rising disaster losses, which are correlated with rising anthropogenic activity. People and civilizations are thus becoming highly vulnerable/exposed (https://www.adb.org/news/infographics/recent-significant-disasters-asia-and-pacific-region).

Dramatic natural phenomena may occur frequently, but human activity also contributes to their enhanced intensity. Impact is dependent on development techniques, environmental protection, controlled city expansion, population and wealth distribution and governmental institutions (UNISDR 2002).

Natural disasters are unforeseen and inevitable, but their consequences can be reduced through knowledge and practicing preparedness (Shanon 2015; Cartwright et al. 2017). Due to their low health literacy and disparate cultural ideas and attitudes, vulnerable nations like India, Nepal, Pakistan, Sri Lanka and China may suffer more in crisis scenarios (World Disaster Report 2014). Numerous studies conducted in Japan have already demonstrated how difficult it is for people to receive health care due to linguistic and cultural hurdles (Shanon 2015). A few developed nations, like Japan, have their own disaster management protocols, which have historically proved successful in reducing morbidity and mortality (Tam et al. 2018).

Tropical cyclones have a terrible impact on society, and in addition to the storm surge and devastation caused by the cyclonic winds, heavy rain, these events frequently result in floods and landslides (Malilay 1997). A few examples of human elements are land use and habitation patterns, building design and construction, forecasting and warning systems, risk perception, evacuation and shelters. A variety of negative effects on public health are brought on by tropical cyclones, including fatalities, injuries and the spread of infectious diseases (Gray 1979; Shultz et al.

2005). Significant property damage results in population displacement and economic hardship (Parks et al. 2022). Flood disasters have recently grown greater and more common in India because of constant population growth, poorly planned infrastructure development and extensive flood control efforts in floodplain environments and various anthropogenic activities (Patwary and Rodriguez-Morales 2022). The population having a low socioeconomic status mostly reside in flood-prone areas, with the number of poor people residing in high-risk flood zones increases continuously. Floods have a significant detrimental socioeconomic impact (Rahman et al. 2022; Pathan et al. 2022). Most rivers of India such as Ganga, Bramhaputra, Kosi, Narmada and Cauvery frequently overflow their banks during the rainy season surpassing their typical channel capacity, wreaking havoc on people's lives and property. Flooding is a major issue in several states of India in recent days. The main goal of defining flood-prone zones is to control land use in order to limit the potential for damage and to lessen the detrimental effects of floods on people and the economy of the country (Dandapat and Panda 2018). Development on flood plains or low-lying areas in the cities are all well-known major causes for urban flooding also. Additionally, urban heat islands have been blamed for causing floods by increasing convective rainfall in and around cities. Increased paved areas, fewer water bodies, less groundwater recharge and a reduction in the urban drainage routes capacity are all effects of rapid urbanization (O'Driscoll et al. 2010). The existence of economic prospects has led to a significant influx of rural residents into urban areas. To make matters worse, cities like Mumbai, Kolkata, Coimbatore, parts of Rajasthan and Gujrat receive a huge amount of rain in shorter intervals of time leading to inundation of large areas. The supply of water takes priority at other times of the year. Further, there are frantic releases of water from dams during heavy rains as the reservoirs must be kept full throughout the monsoon to assure water supply for the remaining six dry months (Jameel et al. 2020; Gupta 2020). All these contribute to flood risk.

Traditional local communities have relied largely on indigenous wisdom to protect the environment and cope with natural disasters throughout history and they still do so now. A substantial reservoir of indigenous knowledge on disaster prevention and mitigation, early warning, preparations and response and post-disaster rehabilitation has been generated by traditional communities, specifically those in hazard-prone areas.

This knowledge is the culmination of all the information that was passed down from generation to generation, learned via observation or through experience. Communities immediately recognize the indigenous knowledge systems which have allowed them to coexist with their surroundings peacefully for years. Such systems are crucial instruments in managing natural disasters and preserving the environment. The United Nations Environment Programme (UNEP) acknowledges the value of indigenous knowledge in preserving the environment and managing natural disasters. India is susceptible to a range of natural disasters, including earthquakes and floods. Weaker and poorer members of society have always been more at risk from all kinds of disasters. Unacceptably high rates of sickness and mortality occur in the affected community because of disasters (Jain 2022). The economic costs can include damage to the infrastructure and a decline in revenue for the affected area as a result of low yield. Poor local coordination, a lack of early warning systems, slow response times, a dearth of specially trained clinicians, a lack of search and rescue infrastructure and a lack of community empowerment are just a few examples that have always contributed to poor response times after disasters (Jayawardene et al. 2021; Jain et al. 2022).

Indigenous knowledge offers details and understanding that support established science and environmental observations. Additionally, it can ensure a comprehensive grasp of how indigenous people interact with the environment, natural resources and cultures (Galloway McLean 2010; Nakashima et al. 2013; Tauli-Corpuz et al. 2009; Rahmani et al. 2022). Therefore, skipping over the engagement of indigenous populations in the program planning stages may have an impact on their lives and could lead to a detrimental effect on the project's outcome and impact. Studies conducted by others emphasize the value of local communities' indigenous knowledge systems and explain why such information should be considered when formulating policies for disaster risk reduction (Shaw et al. 2009; Brown et al. 2021). Indigenous knowledge is significant as it can be applied to other communities in comparable circumstances, stimulate community involvement and also provide people power. Further, it can offer essential information about the local context, inspire community involvement and empower communities in decreasing disaster risk. Additionally, its non-formal methods of transmission can serve as a model for disaster risk reduction instruction. Therefore, the present investigation was undertaken to gather/assimilate the knowledge from the Santal community present in the four districts of West Bengal of the various strategies they adapt to encounter varied inclement weather conditions in the area.

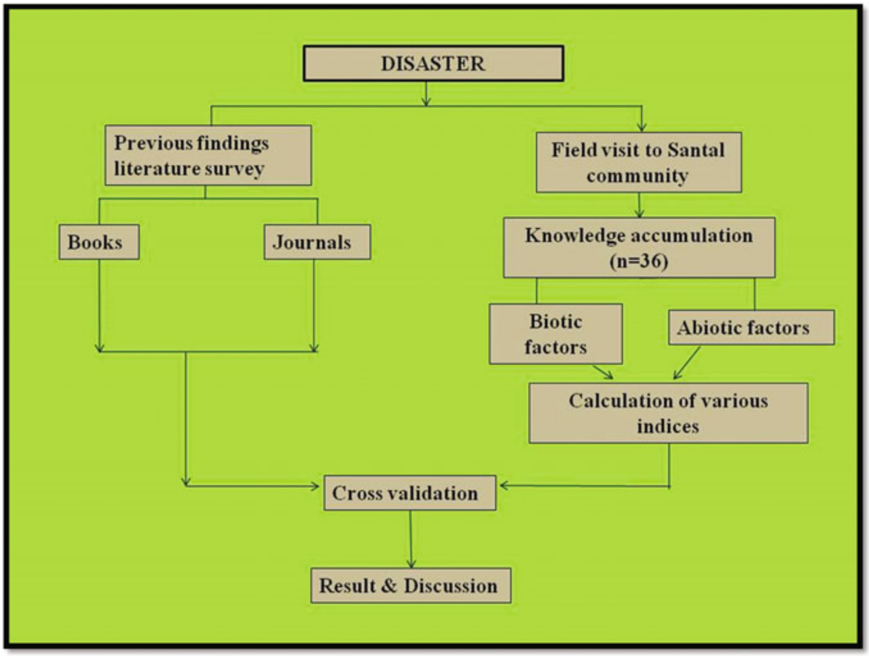
9.2 Materials and Methods

9.2.1 Study Area

The survey was undertaken 3–4 days per month between December 2020 and December 2021 and was extended to four districts of West Bengal viz. Purulia, Bankura, Bardhaman and East Midnapore as tribals are dominant in these districts which are frequented by natural calamities.

9.2.2 Methodology

Data were gathered through general interviews/conversation with village elders and/or others conversant with disaster issues. The survey was carried out by means of semi-structured questionnaires. The method to recruit informants was based on the dispersion of competent locals. They were asked to gather knowledge on how they deciphered the ensuing disasters. As most members of the tribal community in the study zone had limited access to warning systems, they relied on practices and disseminated the information among the community. Direct view, cluster discussion and semi-structured interview were used to gather evidence. Further, methods of intervention and the behavior of animals they follow were also recorded during the survey. The flow chart below represents the step by step process from data collection to findings. The key documentation of fauna was done in the field with the support of these people and other locals available. As most informants did not have much education, they pass information on through the oral tradition from one generation to the next. All 36 informants including 32 men and 4 female were interviewed and segregated into varied age groups viz. 30–39, 40–49, 50–59, 60–69, 70–79 and 80–89 years.



9.2.3 *Analysis of the Data Through Various Indices*

Traditional Knowledge Use Value in Disaster Management (TKUVDM)

Use value is a quantitative assessment that was derived using the following equation to estimate the relative state of use of a species or abiotic factors documented locally.

$$UV = \Sigma U/N$$

where U is the total number of citations per species substantiated and N is the number of informants quizzed for a given species or factor.

Informant Consensus Factor (ICF)

The ICF value describes informants' agreement on the use of biotic and abiotic factors and assesses changeability in the use reported. A high ICF score close to 1 indicates that well-known species are used by a substantial proportion of local communities due to the authenticity in disaster prediction, whereas a low ICF index close to 0 indicates that informants use the biotic and abiotic factors at random. This was calculated by the following equation:

$$\mathrm{ICF} = N_{\mathrm{ur}} - N_t/N_{\mathrm{ur}} - 1$$

where N_{ur} is the total number of use reports for each category and N_t the number of factor used in the said category.

Fidelity Level (FL)

The percentage of informants who claimed that different biotic and abiotic factors used to predict disaster in a study location are referred to as FL. As previously stated, the FL index was calculated using a formula (Alexiades and Sheldon 1996). FL (%) = $Np/N \times 100$ where 'Np' is the number of informants that claimed use of a certain factor for a particular disaster and 'N' is the total number of informants mentioning the factor in any disaster.

Informant Agreement Ratio (IAR)

The metric used to gauge acceptance between data sources and of animal and plant use is called the informant agreement ratio (IAR) (Trotter and Logan, 1986; Heinrich et al. 1998). By using the following formula to determine IAR, this consistency demonstrates a high level of acceptance and is an excellent strategy to utilize such plants (Heinrich et al. 1998).

$$\mathrm{IAR} = \frac{N_{\mathrm{ur}} - N_t}{N_{\mathrm{ur}} - 1}$$

where the total number of animals received from all data sources is called N_{ur}. The total number of animals used in each category is N_t. IAR readings fall between 1 and 0. The animal has the likelihood of being recognized by many individuals if the IAR values are close to or equal to 1.

Cultural Important Index (CI)

We incorporated the cultural value index (CI), which may be seen as a simplification of the cultural value of Reyes Garcia et al. (2007) and Javier and Pardo-de-Santayana (2008).

$$\mathrm{CI} = \sum_{u=u1}^{uNC} \sum_{i=i1}^{iN} \mathrm{UR}_{ui}/N$$

where CI = cultural important index, UR = use report, u = use category, NC = number of total category of use and N = total number of informants.

Cultural Significance Index (CSI)

The method as proposed by Silva et al. (2006) was resorted to, using the following equation

$$\mathrm{CSI} = \sum \mathrm{CSI}\ (i \times e \times c) \times \mathrm{CF}$$

where i = management of the species, e = preference for use, c = frequency of use and CF = correction factor which considers the consensus among the informants.

Statistics

By reducing the dimensionality of such datasets, principal component analysis (PCA) that increases interpretability while minimizing information loss was used. Correlations between various biotic and abiotic factors was conducted using principal component analysis (PCA). $p < 0.05$ was accepted as the cutoff point for statistical significance.

9.3 Results

9.3.1 Demographic Characteristics of the Informants and the Area of the Study

During the survey, different areas in the four districts (Fig. 9.1), Purulia, Bankura, Burdwan and East Midnapore, were visited for three to four days per month for a period of one year. It was found that the tribal populations were initially reluctant to reveal their knowledge and hence we had to take help of known people to communicate with them. They included one male and one female candidate in our group who were familiar and well versed with the local dialect of the tribal population and hence, slowly we were able to gain their confidence. All 36 informants comprising's of 32 male and 4 female informants representing 88.8% males and 11.11% females were interviewed. As the informants were divided into various age groups, it was found that 2.7% informants belonged to the 30–39 age group, 11.11% to the 40–49 age group, 13.88% to the 50–59 age group while 44.44% informants were within the 60–69 age group, 16.66% informants were in the 70–79 age group and 11.11% within the 80–89 age group (Table 9.1). Few photographs of collecting and communicating with informants during survey are provided in Fig. 9.2.

9.3.2 Analysis of the Different Indices

As the disaster indicators were split into biotic and abiotic factors, there was heterogeneity between the two. Biotic factors depend on abiotic factors and other factors of the organism itself, and hence, biotic factors were acceptable to the scientific community while abiotic indicators though accepted by the scientific community still revealed some failures in prediction. Therefore, biotic factors in the present survey include insect species, fish, amphibian, reptilian, avian, plants and mammalian species which are excellent indicators of oncoming disasters.

Traditional knowledge use value in disaster management (TKUVDM) was 0.461 in the case of mammals, followed by avians (0.361), insects (0.305), amphibians (0.27), reptiles (0.25) and finally fish species (0.138) (Table 9.2). Use value for abiotic factors also focused on the prediction of natural disasters. The TKUVDM value for abiotic factors was highest for waves 0.83 > clouds 0.388 > heat 0.352 > winds 0.166 > flood 0.138 > earthquake 0.111 > rain 0.83, respectively (Table 9.2).

Fidelity level demonstrated the favored factors used to predict disaster. It is the percentage of informants reporting the use of factors. In the present survey, we found that the fidelity level of mammals, insects and birds was appreciably more compared to fish and other abiotic factors as represented in Table 9.2.

A quantitative analytical parameter known as the "informant consensus factor" (ICF) was used to assess the degree of agreement among informants' knowledge and was crucial in classifying information for applicability. ICF was found to be 0.9 in

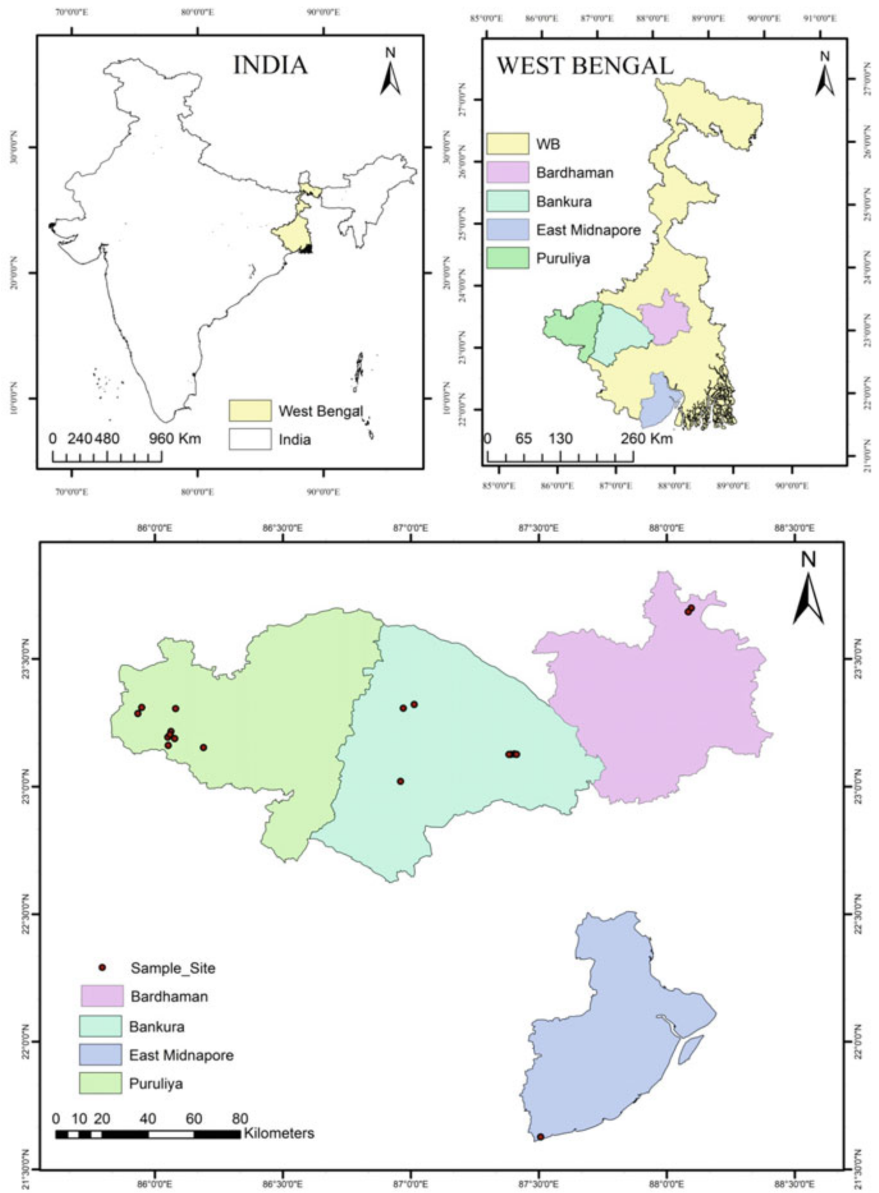


Fig. 9.1 Figure representing study area

Table 9.1 Demographic characteristics of the informants of the study area

Demographic feature	Number of people ($n = 36$)
30–39	1
40–49	4
50–59	5
60–69	16
70–79	6
80–89	4
Gender	
Men	32
Women	4
Education	
Uneducated	16
Primary school	12
Secondary school	5
High school	3
Degree	0
Occupation	
Full time	Nil
Part time practitioners	Wood collector, daily labor
Farming/agriculture	Some ($n = 6$)

the case of mammals and amphibians, followed by avian and insect species at 0.83 and in turn followed by fish and reptiles (Table 9.3).

The CI index was used as a tool to identify species which had a high level of agreement with the culture of the entire survey region and to recognize the common knowledge of these individuals. This does not necessarily imply that animals with lower indices are less fascinating. Animal knowledge was not evenly distributed among the informants. It was possible to study intracultural variances by taking into account various subgroups. The knowledge of animals in various cultures can also be compared using the CI index. In the present study, we found that the CI index for mammals and aves was 1.415 and 1.194, while that for amphibians, fish, insects and reptiles was 0.917, 0.887, 0.749 and 0.583, respectively (Table 9.3). The radar plot is presented in Fig. 9.3.

The cultural significance index varied between various groups of species (Table 9.3). It was found on analysis that CSI was the highest in the case of mammals (7.38) followed by aves (4.32), fish (2.64), insects (1.52), amphibians (1.385) and reptiles (0.25). CSI is generally used to estimate a high value to identify a class or species which are culturally important for disaster management in rural areas.

We found that the informant agreement ratio of avian and insects was 0.948 and 0.942, respectively, followed by mammals and fish with 0.925 and 0.918 (Table 9.3). The IAR value of amphibians and reptiles was 0.928 and 0.921, respectively. The

Fig. 9.2 Representative photographs of Santali informants interacting with the surveyors

data showed high agreement among the informants regarding prediction of disasters or inclement weather of the selected community even when they lived far apart.

Informants from all the districts revealed that mostly cows, dogs, goats and cats show restlessness and unusual behavior during impending disasters. These include cows mooing at night, the growling, howling and squeaking of dogs and the purring of cats at night. All these were evidences related to oncoming disasters such as floods, earthquakes or cyclones.

A few informants reported that the community could apprehend flooding or the severity of rain by watching the migration of certain birds such as black headed ibis (*Threskiornis melanocephalus*) and open billed stork (*Anastomus oscitans*). Similarly, the population of great egret (*Ardea alba*) increased during the evenings and early mornings during the dry summer months.

Further, the heat of summer could be predicted by watching the nest of small passerine weaver birds belonging to the family Ploceidae and known commonly as "Babui". There are four different species of weaver birds in the four districts. These birds construct nests that are suspended from tall trees which hang over water bodies, keeping them safe from numerous predators. They position the nest's mouth

Table 9.2 TKUVDM and fidelity levels in all biotic and abiotic factor groups

Types of biotic and abiotic factor	Traditional knowledge use value in disaster management (TKUVDM)	Fidelity level FL%
Insects	0.305	55
Fish	0.138	20
Amphibian	0.27	50
Reptilia	0.25	47
Avians	0.361	65
Mammals	0.461	71
Plants	0.277	28
Wind	0.166	60
Clouds	0.388	56
Rains	0.083	25
Earthquakes	0.111	40
Droughts	0.083	33.3
Floods	0.138	35.7
Heat	0.352	46
Wave	0.83	30

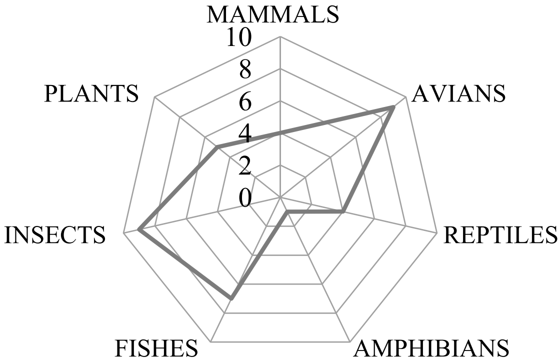
Table 9.3 Various cultural indices of different species of animals and plants are presented below

Types of species	Informant consensus factor (ICF)	Cultural important index (CI)	Cultural significance index (CSI)	Informant agreement ratio (IAR)
Insects	0.833	0.749	1.52	0.942
Fish	0.82	0.887	2.66	0.918
Amphibian	0.9	0.917	1.38	0.928
Reptilia	0.8	0.583	0.25	0.921
Avians	0.83	1.194	4.32	0.948
Mammals	0.9	1.415	7.38	0.925
Plants		1.82	4.96	0.875

in opposition (toward the east) to the hot, dry summer loo from the west that blows over the Indo-Gangetic Plain during summer months.

The use value of insects was (0.305). A few insects serve as a tool to predict natural disasters, such as Julus (a class of millipede) which emerges from the soil and moves to higher regions such as tree trunks or bark before natural calamities such as earthquakes, floods or incessant rain. Juvenile Julus huddle together when it rains continually for a few days, which allows these informants to predict whether the rain will continue or cease.

Fig. 9.3 Radar chart of different species that indicates different disaster



It was reported by other informants specially those residing in Purulia and Bankura districts that during scorching summer heat when temperatures soar for about 45 °C, dragonflies may occasionally skim over the surface of water and briefly touch it quickly and frequently. This helps them to regulate their body temperature to prevent desiccation which is a prediction that the scorching heat would continue. Further, abundance of dragonflies in a particular area represents a healthy ecosystem and chances of rain as these insects respond to subtle changes in weather. Further, it was reported by informants of Burdwan district ($n = 2$) that dragonflies may swarm in an area in response to an abundance of mosquitos as they consume mosquitoes and other flies.

A few species of Tabanids prevalent during the summer months are troublesome pests to humans and livestock because of their painful, persistent biting and blood sucking behavior (Fig. 9.4). Three informants from Purulia reported that during a long dry summer, the population of Tabanids increase and when there is persistence water crisis these flies change their feeding behavior by switching to blood sucking thereby predicting a lack of rain.

The nocturnal croaking of frogs and toads seems to be an indication of impending rain as they do it to find their mate. About 70% informants agreed that heavy rainfall is followed by the croaking of various amphibian species. About 30% informants agreed that reptiles specially snakes comes out of their holes before an earthquake or flood and take shelter on trees or roofs of thatched houses.

Most informants of Purulia, Bankura or Burdwan districts were unaware that fish could predict disaster, but to our satisfaction, two informants living in East Midnapore district shared their experience. For example, as a 10-s wave frequency becomes more important, it predicts upcoming adverse weather conditions like a possible tsunami or earthquake. In addition, shoals of small fish (which are yet to be scientifically identified) often jump out of water. The informants said that these small fish were not seen very often. Flying fish, *Exocoetus* sp., are not seen when weather conditions are good but they often glide over the surface of water and jump great distances. The informants also asserted that when such phenomena occur, it was prediction of certain disasters. *Megalaspis cordyla* glides across the water surface and

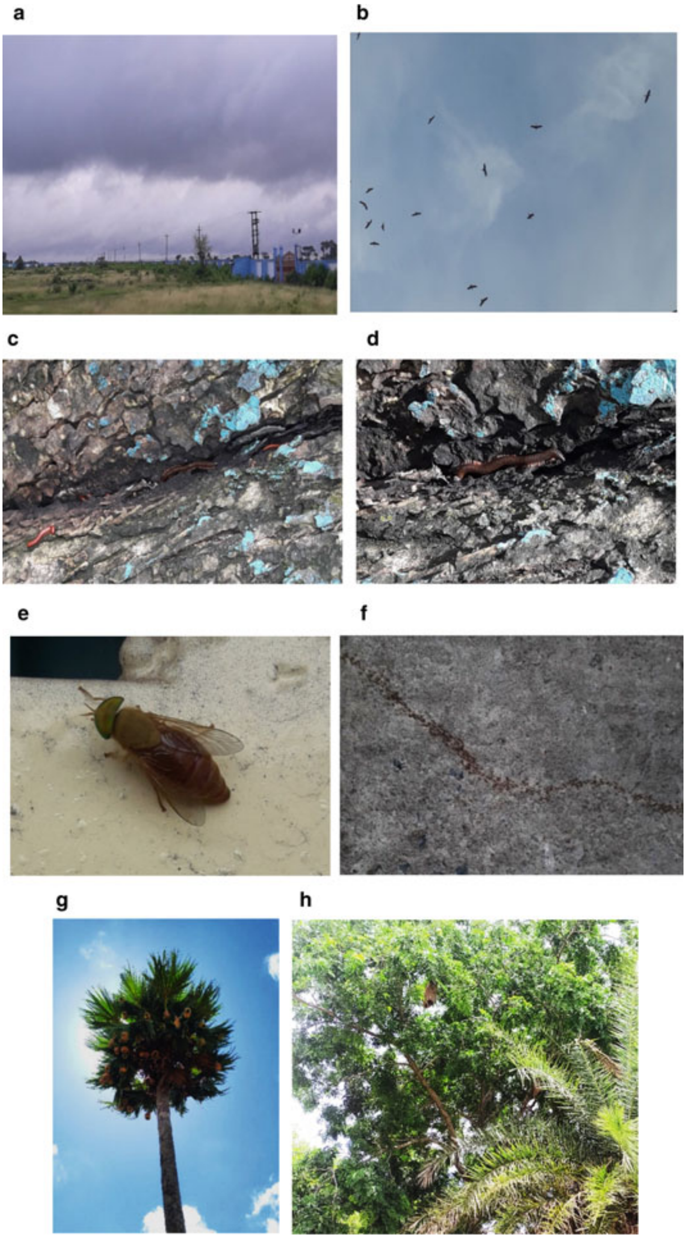


Fig. 9.4 **a–h** Photographs of some biotic and abiotic factors that assist in predicting a calamity. **a** Nimbus clouds indicate heavy rainfall. **b** Hovering of open billed stork in circles predicts rain. **c**, **d** *Julus* sp migrating and sitting on the bark of trees indicates heavy rainfall. **e** Presence of *Tabanids* indicates a hot dry summer with a heat wave for a few days. **f** Trail of ant predicts heavy rain or flood. **g** Mouth of the nest is altered by weaver birds depending on the blowing of hot summer loo. **h** Weaver birds nest hangs on *Albizia lebbeck* tree (yellow arrow)

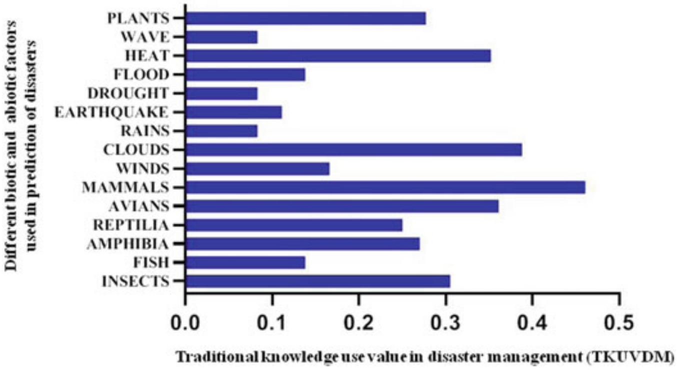


Fig. 9.5 Traditional knowledge use value in disaster management (TKUVDM), where different biotic and abiotic factors are involved in disaster prediction

often jumps, indicating a possible earthquake. Catch numbers also predict weather conditions such as high yields of *Therapon jarboa* and *Pseudorhombus arsius*, while a reduced catch of *Parastromatu niger* indicates an impending tornado or tsunami. Only seven respondents ($n = 7$) claimed that if mango production increased, heavy rain was anticipated that year. Similarly, if the production of *Tamarindus indica* increased it was possible that rain would be less. However, if an insect (Pakurchinda Poka, local name) consumed the leaf of *Shorea robusta* voraciously, it signified heavy rainfall. Some informants said that an increase in *Saccharum spontaneum* production suggested a decrease in rainfall. Additionally, they stated that weaver birds' nests on *Albizia lebbeck* trees (known locally as Shirish trees) were signs of impending heavy rain in that region (Fig. 4h). The traditional knowledge use value of different components (biotic and abiotic factors) is presented in Fig. 9.5.

Principal component analysis is a technique for dimension reduction. All the variables are positively correlated. The first two principal components have the highest eigenvalue (75.92) and percent variance (97.34) (Fig. 9.6).

9.4 Discussion

Natural disasters have frequently resulted in significant losses and disruption of human life, physical infrastructure and socioeconomic conditions. For instance, the tsunami that hit the Indian Ocean in 2004; Hurricane Katrina in New Orleans in 2005; the earthquake in Italy in 2009; and the floods in Pakistan in 2010 all caused losses and damages that interfered with the economy of the country and society's ability to progress. Additionally, these natural disasters lead to prolonged stress among people making them highly vulnerable, disempowering both people and society and thereby hindering the long-term development of people and communities. Such events are beyond the controlled of humans. Both human and animal health can be negatively

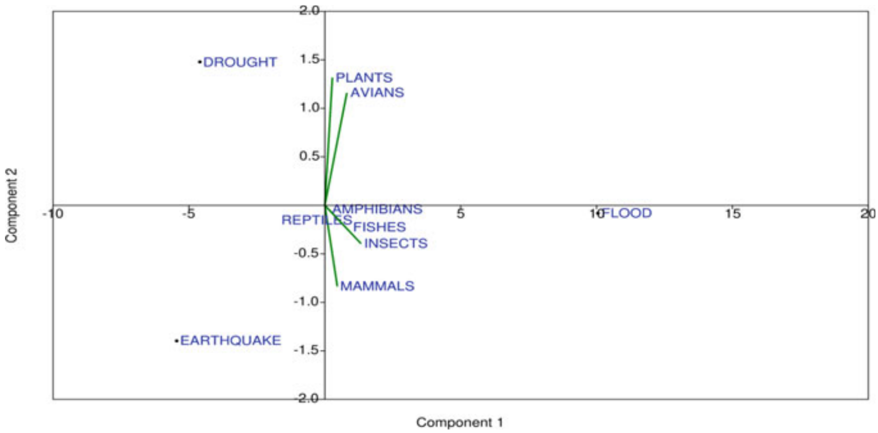


Fig. 9.6 Principal component analysis between biotic and abiotic factors

impacted by extreme heat. In hot weather, animals might overheat, become dehydrated and eventually die (Akompab et al. 2013; Appleby-Arnold et al. 2021). In such a dry scenario, the tribals communities of Purulia and Bankura consume fruits which has a high water content such as watermelon, pomelo (Batabi lebu) and depend on "Panta Bhat" (lightly fermented rice) for their morning and evening meals. In the present study, we found that tribal informants had knowledge to predict weather by observing the color and shape of the clouds and the water flow in rivers and rivulets. As residents of the targeted areas lacked communication and were illiterate, village elders who successfully understood the issue, shared the information with their community. The community built "machans" using bamboo or the stem of banana plant stitched together for use as rafts during floods. These communities' advised women and children along with their domestic livestock to move to higher ground. These communities also adopted strategies such as drying of foods (cabbage, potatoes, green peas, carrot). They depended on puffed rice (Muri) or flattened rice (Chira) during natural calamities or disasters. They also depended on colocasia, taro root, nitty grits, tapioca, smoked elephant foot yam, dried mangoes ("Amchur") and dried small fish ("Sutki"). Hard labor accompanied by a reduced food intake made them weak and vulnerable to various ailments during disasters. On such occasions, they devoted less time to cooking preferring food which was easy to prepare. During emergencies/lack of favorable cooking time, they skipped meals, which ultimately affected their health.

The problem of unsafe drinking water was usually overcome by the use of charcoal as activated charcoal adsorbs impurities on water surface including organic and inorganic substances. However, these days the use alum, zeoline is also gaining momentum.

The dried dung of cows, buffaloes, horse (made during summer months/dry period) commonly known as "Ghute" and dried wood is used as a fuel source which was in line with earlier studies conducted by other investigators (Sen and

Chander 2003; Srivastava 2009; Rahman et al. 2022). Further, they used certain species of dried grasses such as *Digitaria ciliaris*, *Echinochloa colona*, *Enteropogon dolichostachyus*, *Ergarostis pilosa*, *Heteropogon contortus*, *Iseilema laxum*, *Panicum antidotale* and *Pennisetum pedicellatu* as fuel during floods and rain. Often some of these grasses were used a fodder for farm animals. Fish were excellent disaster indicators as revealed by the tribals from east Midnapore district which also agrees with the findings of other investigators (Sethi et al. 2001).

9.5 Challenges and Recommendations

I. During the survey, we found that the tribal community had strong links with culture and livelihood. Therefore, there is a need to further assess how culture affected disaster risk reduction (DRR) activities through such activities. Large scale studies should also be carried out throughout the state. As both the overarching cultural features of these crises (biotic and abiotic factors), it was desirable to know-how communities and individuals behave during times of disasters. There are reports of government measures falling short due to local cultural aspects being ignored. We also found that both the government and the scientific community had undervalued the importance of local and indigenous knowledge. National and international organizations as well as national and regional governments have frequently disregarded local and indigenous knowledge as well as their practices. It is also challenging to develop new integrated strategies from the dynamics of the two different knowledge systems (scientific and traditional) since neither the scientific nor the local communities can fully comprehend the dynamics of each knowledge system. Inefficient integration and inadequate institutional capability of local organizations and government organizations is another factor for low disaster risk reduction. Lack of time and resources, scarcity of professional labor and the power struggle between national and local administrations are also contributing to inferior disaster risk reduction strategies. There are a few steps which can overcome such shortcomings such as

   i. Monitoring local knowledge and the inclusion of tribals and their strategies in disaster reduction for sound trust building.
   ii. Information exchange between communities affected by disasters.
   iii. Organize public awareness campaigns to make them aware of conservation of biodiversity and observe change in behavioral patterns in animals.
   iv. Encourage those tribal who are educated to co-relate their own knowledge with scientific knowledge.
   v. In the perspective of current research, evaluate the usefulness of indigenous knowledge and choose acceptable strategies after replication.

Nyong et al. (2007) opined that using indigenous knowledge in development methods is essential to their success. Natural catastrophes have continued to have a devastating impact on communities where indigenous knowledge was not frequently used. Locals have a lot of knowledge and expertise regarding their physical vicinity. To help the communities better prepare for and manage disasters and lower both the danger and damage, they have knowledge which can be trusted. Further, according to the UNISDR (2015), the Sendai Framework for Disaster Risk Reduction 2015–2030, approved by the Third United Nations World Conference, also promoted the use of indigenous peoples' knowledge and practices to supplement scientific understanding in disaster risk assessment.

9.6 Conclusion

More in-depth studies should be conducted by increasing sample sizes. We recommend that they adopt and incorporate indigenous strategies in risk reduction along with scientific methods. We also advised documentation of indigenous knowledge of the local communities for the betterment of society.

Acknowledgements The authors are thankful to the Department of Science and Technology, New Delhi for infrastructural support in the form of DST-FIST (SR/FST/LS-I/2018/173) and to DST-Govt. of West Bengal for financial support [261(Sanc./ST/P/ S&T/1G-59/2017]. The authors extend their appreciation to Mr. Pradyut Bera, UGC-JRF, Department of Geography for helping us to plot the map of the surveyed area.

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Chapter 10
Risk Perception of Landslide Among the Tribal Population: A Case Study of Kotagiri Taluk of Nilgiri District, Tamil Nadu, India

Bhagyasree Dolui, R. M. Yuvaraj, and G. Geetha

Abstract Scheduled tribe of Nilgiri district lived in unique physical, socioeconomic and cultural environmental isolation from general population. The majority of tribal population lives under the high risk of landslide zone. Therefore, it is very important to study on their perception on risk vulnerability related to landslide. This chapter focused on tribal people's risk perception on landslide. Perception of risk is a key issue when seeking to develop system, practices, and policies to protect local population; this is particularly evident when risk, mitigation strategic involves non-structural measures such as relocation and early warning system which accept the active involvement of the community in question. The research has analyzed the primary data which have been collected by using predefined questionnaire with the sample size of 170. The tribal population with ages of above 18 has been included in the study. The data were statistically analyzed by using frequency, independent sample 't' test, analysis of variance, and finally, regression model has been created. The final outcome of the study concludes that size of the family those who are staying in less member they feel more risk than those staying with more family members. The majority of respondents believes that evacuation process gets easier and safer for kids and elderly members of the family if the size of family is large. Guidance from the elderly family members, with their past experiences of landslide, helps them during disaster.

Keywords Scheduled tribe · Nilgiri district · Landslide · Risk perception · Statistical analysis

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_10

10.1 Introduction

Disaster is an unwelcome calamity brought on by forces that are mostly outside of human control, hits suddenly and without much advance notice, and seriously disrupts life and property. When large amounts of rock, dirt, or debris flow down a slope, landslides occur (Varnes 1978). Landslides occur throughout the world, and especially, in certain hotspots. Much has been written about landslide impacts on human lives and on infrastructure (Thennavan et al. 2016; Rabby and Li 2019; Yuvaraj and Dolui 2021; Chung and Li 2022). On the other hand, the effects of landslides on the ecosystem have received less attention (Schuster and Highland 2007). The part landslides play in disturbance ecology has received even less attention (Geertsema and Pojar 2007; Kumar and Annadurai 2013).

The Nilgiris district has a long history of disastrous landslide events (Thennavan and Pattukandan 2020). Landslides commonly occur in the Nilgiris from October to December. According to Khan et al. (2020), the district's strong, severe rainfall is what causes the majority of these landslides. Heavy rains in November 1891 caused numerous landslips on Coonoor Ghat and significant damage to the Kotagiri–Mettupalayam route (Ganapathy and Rajawat 2015). On November 5, 1978, numerous people died in Ooty due to house collapses, landslides, and drownings. There was continuous heavy rainfall during November 12–19, 1979, and there were heavy rain of 102.2 mm at Coonoor and a heavy landslide at Selas in which a house was completely buried in the debris along with two women and three children. Climate change and extreme rainfall events trigger landslides more frequently, causing considerable losses to the society, particularly in areas with a large settlement (Lee et al. 2017; Sangelantoni et al. 2018).

Scheduled tribe of Nilgiri district lived in distinctive physical, socioeconomic, and cultural environmental isolation from civilized population. The majority of tribal inhabitants lives under the high risk of landslide zone. For that reason, it is exceptionally important to study on their perception on risk related to landslide. Tribal groups have a close attachment with their natural environment, unique from other cultural groups, which often result in cultural variations and perceptions. This difference in the way people recognize, interpret, identify, access, and handle risk within the existing environment is further attributed to a cultural global view. These are generally derived from mixtures of traditional beliefs and values, knowledge, custom, religion, social structure, length of time in coexistence with, or livelihood of a particular geographical location, and historical and modern experiences.

The Nilgiri district is situated in Tamil Nadu, and it is the home for six distinctive tribal communities. Most of the settlements' areas of these tribes are exposed to landslides as it receives heavy rainfall from both Southwest and Northeast monsoons. This has made a significant negative impact on the environment (fauna and flora) and tribal settlements in this region. So, it is imperative to know their anxiety level on the risk of landslide. The major goal of this study is to determine whether gender differences in tribal people's perceptions of landslides, their concern about them, and their beliefs about them influence their adoption of mitigation. Over and above demographic variables, this study pinpoints on psychological variables such as perceived vulnerability, risk perception, and social trust. These psychological variables are not constrained to a theoretical framework, which typically includes perceived likelihood of the hazards and severity of the impacts. Rather, they reflect attitudes (Ajzen 1991) to natural hazards, such as fatalism belief and trust (cognitive component), worry and dread (affective component). According to attitude theory, the behavior of people can be predicted from relevant beliefs, effects, and values. Thus, to know how these attitude components can be changed to increase the implementation of mitigation is essential to communication regarding risk and in proposing effective intervention strategy. However, a better perceptive of the psychological processes associated with aging may provide insight into behavior that can be changed.

10.2 Study Area

The Nilgiri district is one amid the district of Tamil Nadu, India, which is mostly a rugged elevated area, sited at an elevation of 216–2601 m above the sea level in the Ghats which is located at western parts of South India. Kotagiri taluk is a taluk of Nilgiris district of the Indian state of Tamil Nadu with the elevation of 302–2315 m. The headquarters of the taluk is the town of Kotagiri. The total geographical area of Kotagiri taluk is 398 km^2. The latitude and longitude extension of Kotagiri taluk is 11°20′21.915″ N to 11°34′23.002″ N and 76°44′21.911″ E to 77°0′21.12″ E, respectively. The Kotagiri taluk is surrounded by the Udhagamandalam taluk of Nilgiri district in the west, Coonoor taluk of Nilgiri district on south west, Erode district in the east and north, and Coimbatore district in southeast (Fig. 10.1). Kotagiri taluk is entirely located in the Nilgiri Plateau, at the confluence of the Western and Eastern Ghats' hill ranges. Approximately 60.1% of the arable land in the study is situated under 15–36° slopes.

The Kotagiri taluk had a population of 108,684 people in 2011, with 52,668 men and 56,016 women. The total number of families residing in Kotagiri taluk in 2011 was 31,168. The average sex ratio of Kotagiri is 1064. People live in urban areas are 39.2 and 60.8% live in the rural areas. The average literacy rate in urban area is 87.4%, while rural areas is 80.3%. The sex ratio of urban areas is 1076 and rural areas is 1055. The population of children of age 0–6 years is 9125 which is 8% of the total population. The total literacy rate of the taluk is 83.05%. The male literacy rate is 83.44%, and the female literacy rate is 69.15%. The total population of scheduled tribe is 6312, out of which 3104 are male population and females are 3208. The scheduled tribes constitute 5.8% of the total population in Kotagiri taluk of Nilgiri.

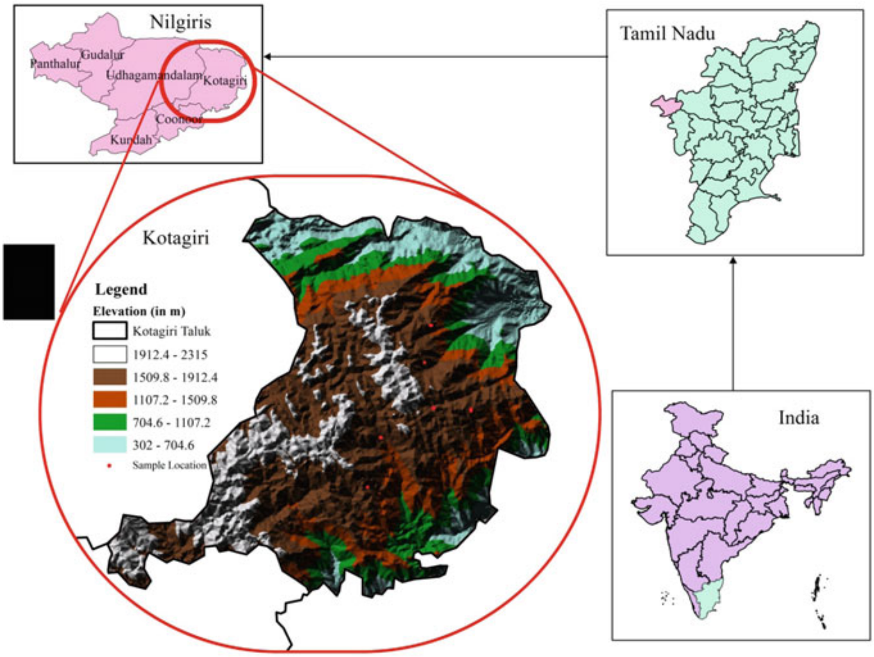

Fig. 10.1 Study area—Kotagiri taluk

10.3 Rationale of the Study

The Nilgiri district is hilly area, and the entire region is prone to landslide. The majority of the tribal people of Nilgiri district lives in Kotagiri taluk. Therefore, the tribal population residing in Kotagiri taluk is more vulnerable to landslide, so it is necessary to study their perception towards landslide risk. Tribal people are staying in one place for many generation with adoption to landslide event might have indigenous knowledge. The study has primary focus on risk perception during heavy rainfall followed by landslide event and their mitigation capacity.

10.4 Methodology

The study is mainly based on primary sources of information. The primary data were collected with the help of well-designed structured questionnaire and face-to-face interview among the tribal people living in high-risk landslide prone zone of Nilgiri district. The questionnaire was mainly based on the perception of tribal people on risk towards landslide. The questionnaire contains socioeconomic details along with risk perception, and it has nine selected variables which have been discussed further.

The questionnaire consists of total 57 open-ended questions. The study took more than 3 months between November 2021 and January 2022. The collected data have been converted into coded form in MS Excel which was transported to the Statistical Packages for Social Sciences (SPSS) for further analysis.

10.4.1 Sample Size

The focused population of this current research is tribal population of Kotagiri taluk in Nilgiri district. It had been attempted to take a sample of **260** in order to get a 6% of margin of error, but proper response was achieved only from 170 respondents, so this sample size has been taken for the study with 7.5% margin of error. The sample size was derived by using the equation given below:

$$n_{\mathrm{o}} = \frac{Z^2 pq}{e^2}$$

where

e is the desired level of precision (i.e., the margin of error),

p is the estimated proportion of the population which has the attribute in question,

q is $1 - p$.

Snowball sampling a type of non-probability sampling technique is used to gather data from the respondents who are settled in the high and moderate landslide region in Kotagiri taluk of Nilgiri district.

10.4.2 Frequency

To analysis the tribal people's perception towards landslide, statistical analysis techniques were carried out by using R-programming.

10.4.3 Independent Sample T-Test

A t-test is a statistical test that is used to compare the means of two groups (pairwise comparison). It is frequently employed in hypothesis testing to establish whether a procedure or treatment truly affects the population of interest or whether two groups differ from one another. The formula to derive independent t-test is given below:

$$t = \frac{y_1 - y_2}{s_v\sqrt{\frac{1}{m_1} + \frac{1}{m_2}}};\ S_v = \sqrt{\frac{(m_1 - 1)S_1^2 + (m_{2-1})S_2^2}{m_1 + m_2 - 2}}$$

where

T—test statistics, Y_1—mean of first sample, Y_2—mean of second sample, M_1—size of first sample, M_2—size of second sample, S_v—pooled standard deviation, S_1—standard deviation of first sample, S_2—standard deviation of second sample.

ANOVA

ANOVA is a statistical technique that helps to make multiple comparisons. This is common throughout statistic, as there are many times where we want to compare more than two groups.

$$F = \frac{\text{MST}}{\text{MSE}};\ \text{MST} = \frac{\sum_{i=1}^{k}\left(\frac{T_i^2}{n_i}\right) - \frac{G^2}{n}}{k-1};\ \text{MSE} = \frac{\sum_{i=1}^{k}\sum_{j=1}^{n_i} Y_{ij}^2 - \sum_{i=1}^{k}\frac{T_i^2}{n_i}}{n-k}$$

where Y_{ij} is an observation, T_i is a group total, G is the overall sum of all observations, n_i is the number in group I, and n is the total number of observations. F is the variance ratio for the overall test, MST is the mean square due to treatments/groups (between groups), MSE is the mean square due to error (within groups), and Y_{ij} is an observation.

10.4.4 Multiple Regressions

$$\gamma = \partial_0 + \partial_1 x_1 + \partial_2 x_2 + \cdots + \partial_t x_t + \epsilon$$

where γ—expected value of dependent variable, x_1, x_2, … x_t—predictor independent variables, ∂_0—constant, and ∂_1, ∂_2 ...—estimated regression coefficient. The methodological framework of the chapter is given in Fig. 10.2.

10.5 Result and Discussion

In this study, 4.1% of the respondents were at the age of < 25, nearly 8.2% of the respondents belongs to 25–45 age group, the majority of respondents came from the age of 45–65 which is 45.9%, and around 41.8% of the respondents were at the age of above 65. Around 58.8% males and 41.2% females actively took part in this survey.

Education plays an important responsibility in every individual's life, and it impacts the way of thinking and sets an individual perception. Education is further

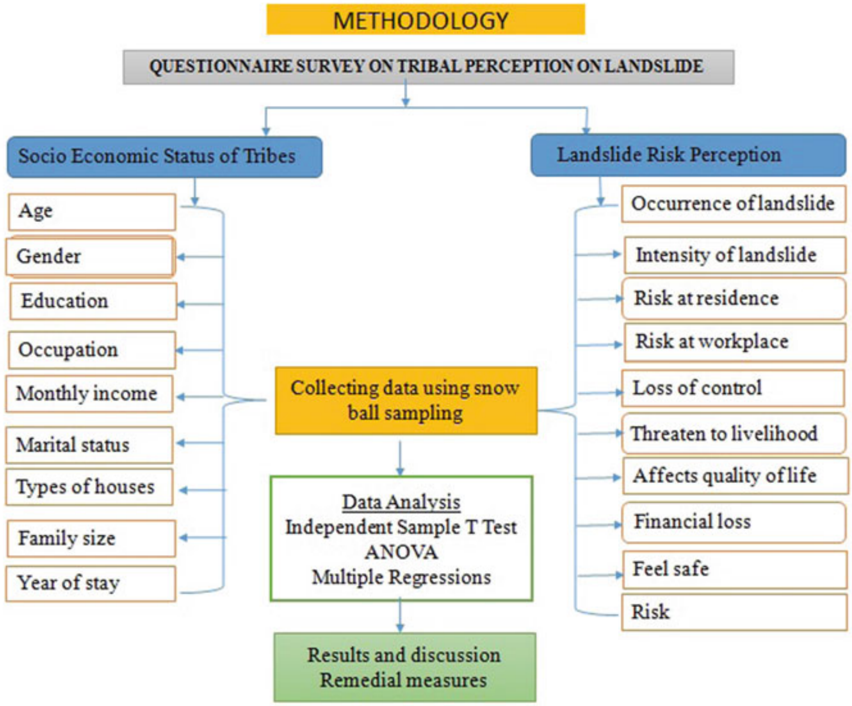

Fig. 10.2 Methodological framework

divided into four classes 24.7% of people were illiterate, 33.5% had primary education, 28.8% respondents had secondary education, and 12.9% respondents had higher education.

Occupation of these tribal respondents has been categorized into five. About 45.9% of respondents were involved in agricultural activities, 17.1% were engaged in animal husbandry, 16.5% respondents worked as agricultural labors, 4.1% of people were involved in firewood sale, and 16.5% respondents were working as government servants. The very less tribal people are going for higher education particularly in Gudalur area because of the absence of nearby higher education institution (Rao 2014) as well as they are contributing themselves for economic improvement of their family (Sinu and Mahadevan 2013).

Around 58.2% of respondent's monthly salary is < 5000, about 33.2% of people has income of 5000–15,000, 8.2% earns > 15,000. During the questionnaire survey, 70.6% respondents were married, 20.6% were unmarried, and remaining 8.8% were widower.

The houses in which the respondents live in have been divided in four types. Around 12.4% of respondents lives in kachcha houses, people living in pucca houses were 45.9%, and rest 41.8% of respondents lives in semi-pucca houses.

Here, 25.3% of respondents lives in nuclear family and 74.7% lives with join families. Family size has been divided into three classes. About 29.4% of people lives with < 4 family members, 58.2% respondents live with 4–8 members, and 12.4% stays with more than eight family members. The year of stay is one of the important factors and can help to get information of past landslide events in the location. About 8.8% have been living in their locality for < 10 years, 12.9% of respondents were living for 10–25 years, and 78.2% were living for more than 25 years (Table 10.1).

Risk Towards Landslide

Risk perception of landslide consists of nine variables which are occurrence of landslide, intensity of landslide, risk at residence, risk at workplace, loss of control, threaten to livelihood, affects the quality of life, financial loss, and feel safe. These variables under risk are taken from different literatures based on perception of landslides which have measured using three-point Likert scale with average of 1.5.

Descriptive for Risk Towards Landslide

From Table 10.2, it has been found that the risk towards landslides among the tribal people is higher in case of the variable—"Occurrence of landslide" with mean value of 2.124 and "Feel safe" with mean value of 2.11 when compared with others. Risk towards landslide is lower in case of the variable—"Affects quality of life" (M = 1.459) when compared with others. It is also inferred that the risk towards landslide is above the average level since 88% of the variables are above two out of three except the variable "Affects quality of life" as shown in Fig. 10.3 where blue dashes' line is average mean. The overall mean score of the risk towards landslide is 15.476, which is 57.33%; this points out that the respondents' risk towards landslide is above 57%.

Independent Sample 'T'-Test

Gender—Risk Towards Landslide

H_o: Male and female have no discernible differences on the risk towards landslide.

H_1: Male and female have discernible differences on the risk towards landslide.

An independent samples t-test has conducted to compare the significant difference between the male and female respondents with respect to the risk towards landslide in the Nilgiri district. Test shows that the null hypothesis has rejected due to low alpha value (< 0.05). The mean score of female respondents (mean = 15.5) is more than the male respondents (mean = 14.4) as shown in Table 10.2. This indicates that the female respondents feel more risk towards landslides than the male respondents. Hence, it is concluded that there is a statistically significant discernible between the male and female respondents with respect to the risk towards landslides.

Type of Family—Risk Towards Landslide

H_o: Between the types of family, there are no discernible differences on the risk towards landslide.

Table 10.1 Socioeconomic status of the tribes

Parameters	Category	Percent
Age	< 25	4.1
	25–45	8.2
	45–65	45.9
	> 65	41.8
Gender	Male	58.8
	Female	41.2
Education	Illiterate	24.7
	Primary	33.5
	Secondary	28.8
	Higher	12.9
Occupation	Agriculture	45.9
	Animal husbandry	17.1
	Agriculture labor	16.5
	Firewood sale	4.1
	Government servant	16.5
Monthly income	< 5000	58.2
	5000–15,000	33.5
	> 15,000	8.2
Marital status	Married	70.6
	Unmarried	20.6
	Widower	8.8
Type of house	Kachcha	12.4
	Pucca	45.9
	Semi-Pucca	41.8
Type of family	Nuclear	25.3
	Joint	74.7
Family size	< 4	29.4
	4–8	58.2
	> 8	12.4
Year of stay	< 10 years	8.8
	10–25 years	12.9
	> 25 years	78.2

$\mathbf{H_1}$: Between the types of family, there is a discernible difference on the risk towards landslide.

An independent samples t-test has performed to compare the significant difference between the types of family of the respondents with respect to risk towards landslide. As the *p*-value is lesser than significant value (0.01) which is 0.000, so our null

Table 10.2 Descriptive statistics—risk towards landslide

Variables	Mean	SD	Count
Occurrence of landslide	2.124	0.664	170
Intensity of landslide	1.747	0.662	170
Risk at residence	1.700	0.614	170
Risk at workplace	1.582	0.641	170
Loss of control	1.741	0.925	170
Threaten to livelihood	1.624	0.696	170
Affects quality of life	1.459	0.645	170
Financial loss	1.665	0.688	170
Feel safe	2.110	0.685	170
Risk	15.476	2.295	170

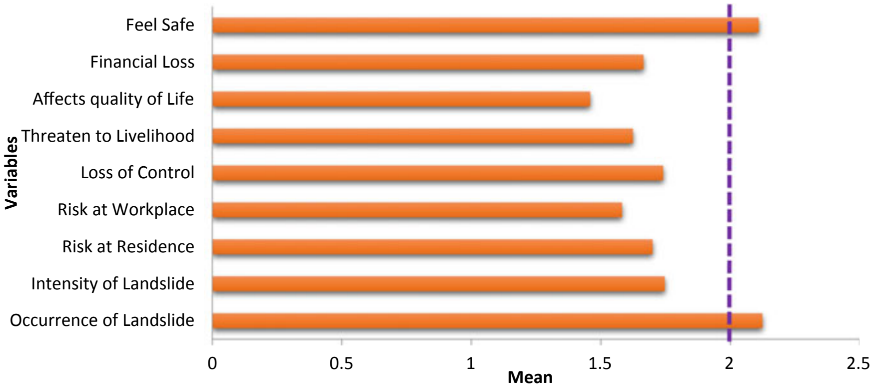

Fig. 10.3 Mean values—risk towards landslide

hypothesis has been rejected. Based on the mean value of risk towards landslide, nuclear family has 16.813 which is more than the respondents from joint family ($M = 13.039$) as shown in Table 10.3. This indicates that the nuclear family feels more risk towards landslide than the respondents from joint family. Hence, it is concluded that there is a statistically significant difference between the respondents from joint family and nuclear family with respect to the risk towards landslide. Nuclear family feels more risk due to very less people in their family as compared to joint family, with lots of people including old people who have very good knowledge on landslide.

Analysis of Variance

Education—Risk Towards Landslide

H_0: There is no discernible difference between educations on the risk towards landslide.

Table 10.3 Independent samples t-test—risk towards landslide

t	df	*p*-value	95.0% confidence interval		Estimated mean	
			Lower	Upper	Joint family	Nuclear family
6.045	168	0.000	1.498	2.952	13.039	16.813

$\mathbf{H_1}$: There is discernible difference between educations on the risk towards landslide.

A one-way between-groups analysis of variance (ANOVA) has conducted to find the significant difference among the education of the respondents with risk towards landslide.

From Table 10.4, the null hypothesis has been rejected due to the *p*-value (0.006) which is lesser than significant value (0.05). It means that there is significant difference among the education of the respondents with respect to risk towards landslide $F(3, 166) = 4.263, p < 0.05$. Tukey's HSD shows that there is no significant difference between illiterate and higher education ($p = 0.652; > 0.05$), primary and illiterate ($p = 0.412; > 0.05$), and secondary and primary ($p = 0.741; > 0.05$). It also shows that there is significant difference between primary and higher education ($p = 0.048; < 0.05$), secondary and higher education ($p = 0.009; < 0.05$), and secondary and illiterate ($p = 0.044; < 0.05$) as shown in Table 10.5. Maximum difference is between the group of respondents whose qualification is secondary and higher (difference of mean is 1.824).

Table 10.4 One-way ANOVA—risk towards landslide

	df	Sum of squares	Mean squares	*F*	Pr(> *F*)
Education	3	63.703	21.2341	4.263	0.006
Residuals	166	826.702	4.980	NA	NA

Table 10.5 One-way ANOVA–Tukey's HSD

	diff	lwr	upr	*p* adj
Illiterate–higher	0.681	− 0.842	2.206	0.652
Primary–higher	1.383	− 0.070	2.837	0.048
Secondary–higher	1.824	0.338	3.311	0.009
Primary–illiterate	0.701	− 0.475	1.879	0.412
Secondary–illiterate	1.142	− 0.075	2.360	0.044
Secondary–primary	0.441	− 0.687	1.5698	0.741

diff—difference among means of the two groups
lwr, upr—lower and upper bounds of the confidence interval at 95%
p adj—*p*-value after adjustment for the multiple comparisons

Table 10.6 One-way ANOVA—type of house and risk towards landslide

	df	Sum of squares	Mean squares	F	Pr(> F)
Type of house	2	99.736	49.868	10.533	0.000
Residuals	167	790.670	4.735	NA	NA

Type of Respondent's House—Risk Towards Landslide

H_o: There is no significant difference between respondent's type of house and their perception of risk towards landslide.

H_1: There is significant difference between respondent's type of house and their perception of risk towards landslide.

The test has been conducted to analyze the difference among the group of respondents staying in different types of houses and their perception of risk towards landslide. Table 10.6 shows that there is a significant difference between the respondent's type of house and their perception of risk towards landslide $F(2, 167) = 10.533$, $p < 0.05$.

Results of Tukey's HSD shown in Table 10.7 indicate that there is no significant difference between the respondents staying in pucca and kacha houses ($p = 0.870$, > 0.05), whereas there is significant difference of perception on risk towards landslide among the respondents staying in semi-pucca houses and pucca houses ($p = 0.004$, < 0.05); similarly, respondents staying in kacha houses and semi-pucca houses also have difference in their perception ($p = 0.000$, < 0.05). Maximum difference between the groups is those who are staying in semi-pucca and pucca houses (difference of mean is 1.756); this may be that pucca house and kacha house will not create damage during landslide, whereas respondents from semi-pucca house may think that there house will be destroyed during landslide.

Age of the Respondents—Risk Towards Landslide

H_o: There is no discernible difference between respondent's age and their perception of risk towards landslide.

H_1: There is discernible difference between respondent's age and their perception of risk towards landslide.

Table 10.7 One-way ANOVA–Tukey's HSD

	diff	lwr	upr	p adj
Pucca–kacha	– 0.269	– 1.534	0.996	0.870
Semi-pucca–pucca	1.756	– 3.034	– 0.478	0.004
Kachcha–semi-pucca	1.487	– 2.331	– 0.643	0.000

diff—difference among means of the two groups
lwr, upr—lower and upper bounds of the confidence interval at 95%
p adj—p-value after adjustment for the multiple comparisons

Table 10.8 One-way ANOVA—age and risk towards landslide

	df	Sum of squares	Mean squares	F	Pr(> F)
Age	2	55.440	27.290	5.538	0.004
Residuals	167	835.000	5.000	NA	NA

Table 10.9 One-way ANOVA–Tukey's HSD

	diff	lwr	upr	p adj
> 65–< 25	2.873	0.778	4.968	0.004
25–65–< 25	2.358	0.285	4.431	0.021
25–65–> 65	− 0.514	− 1.349	0.320	0.314

diff—difference among means of the two groups
lwr, upr—lower and upper bounds of the confidence interval at 95%
p adj—p-value after adjustment for the multiple comparisons

The result from Table 10.8 shows that the p-value is less than significant value of 0.05, which indicates that the null hypothesis has been rejected. It means that there is discernible difference between age of the respondents and the perception of risk towards landslide $F(2, 167) = 5.538, p < 0.05$. Tukey's HSD in Table 10.9 shows that there is no discernible difference of perception among the age group less than 25 years and above 65 years (p = 0.004, < 0.05); similarly, there is significant difference between the age group 25–65 and less than 25 (p = 0.021, < 0.05), but maximum difference between the age group less than 25 and greater than 65 (difference of mean is 2.873). There is no discernible difference between age group of less than 25 and 25–65 (p = 0.314, < 0.05).

Multiple Regressions—Risk Towards Landslide and Socio Economic Status

Determination of statistical relationship among two or more than variables is regression. One or more variable which is independent variable is the cause of the behavior of another one variable that is considered as dependent variable. In this regression, respondents' risk towards landslide is taken as dependent variables, whereas age, gender, education, occupation, monthly income, marital status, type of house, type of family, family size, and year of stay are taken as independent variable. Multiple regressions have conducted to identify the best linear combination of age, gender, education, occupation, monthly income, marital status, type of house, type of family, family size, and year of stay for predicting risk towards landslide.

R-squared also called coefficient of determination value is 0.67, which indicates that the present model explains large portion of variance in the output variable. The adjusted R-squared value is 0.65, which means that 65% of the variance in the measure of risk towards landslide can be predicted by the socioeconomic status of the respondents of the Nilgiri district which is large effect (Cohen 2013) (Table 10.10).

F (10.159) = 32.48, p = 0.000 which is lesser than 0.05 significant level, which shows that combination of all ten independent variables has significant relationship

Table 10.10 Multiple regression's model summary—risk towards landslides

Statistics	Values
Residual standard error	1.357
Degrees of freedom	159
Multiple R-squared	0.6714
Adjusted R-squared	0.6507
F-statistic	32.48
F-statistics with DF	10 and 159
p-value	0.000

with dependent variable, i.e., risk towards landslide. For predicting the risk towards landslide, family size (3.6) is the strongest influencing factors which is predicting dependent variable of risk towards landslide which has high size, whereas age factor influences only 0.03 with low positive effect. Marital status, type of house, and type of family have negative effect on risk towards landslide. Age (0.03), Gender (1.39), Education (0.62), Occupation (0.24), Monthly Income (1.00), Marital Status (– 0.67), Type of House (– 1.00), Type of Family (– 1.99), Family Size (3.69) and Year of Stay (1.42) shown in Table 10.11 and Fig. 10.4.

The multiple regression equation for the risk towards landslide (Y_{Risk}) is given as follows:

$$\begin{aligned} Y_{\text{Risk}} = {} & 4.59 + 0.03\,(\text{Age}) + 1.39(\text{Gender}) + 0.62(\text{Education}) \\ & + 0.24(\text{Occupation}) + 1.00(\text{Monthly Income}) - 0.67(\text{Marital Status}) \\ & - 1.00(\text{Type of House}) - 1.99(\text{Type of Family}) \\ & + 3.69(\text{Family Size}) + 1.42(\text{Year of Stay}) + \text{Error} \end{aligned}$$

Table 10.11 Multiple regression's coefficients—risk towards landslides

	Estimate	Std. error	*t* value	Pr(>|*t*|)
Intercept	4.59916	1.40595	3.271	0.001
Age	0.03148	0.01201	2.621	0.009
Gender	1.39952	0.27382	5.111	0.000
Education	0.62636	0.17039	3.676	0.000
Occupation	0.24959	0.06524	3.825	0.000
Monthly income	1.00039	0.24171	4.139	0.000
Marital status	– 0.67665	0.25134	– 2.692	0.007
Type of house	– 1.00319	0.20088	– 4.994	0.000
Type of family	– 1.99690	0.46053	– 4.336	0.000
Family size	3.69235	0.31215	11.829	0.000
Year of stay	1.42040	0.28687	4.951	0.000

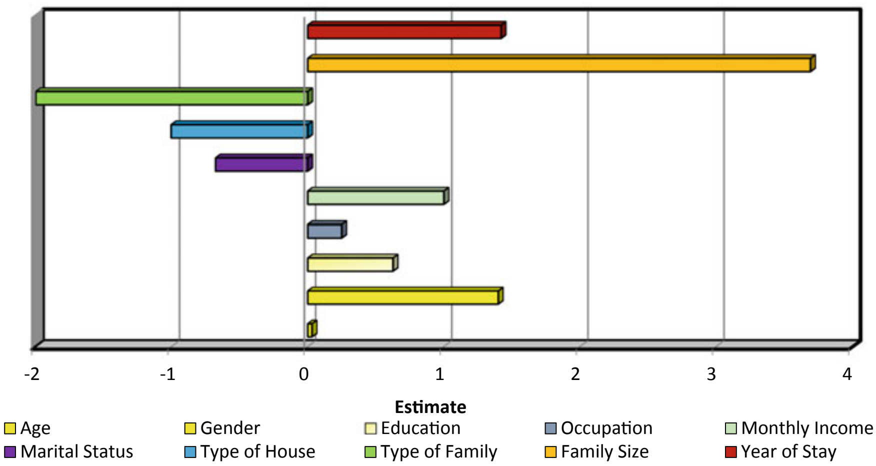

Fig. 10.4 Estimates by regression model

Limitation of the Study

The study has numerous limitation to complete the study. Foremost is accessibility, hilly region with narrow roads made a researcher to meet the tribes. Secondly, tribal people are afraid of answering the questions that we might change their living place as they are prone to landslide. Third limitation is language, where different tribes speak different indigenous languages. Fourth limitation is difficult to locate the tribe. Researcher has adopted snowball sampling to access the tribes. Another limitation of the study is that in order to protect the identity of the interviewee, photography of the tribes was not allowed while collecting data.

10.6 Suggestions

Government should ensure that tribal people have awareness on landslide. Government should give moral support to the tribes particularly female on risk towards landslides. This makes them feel more comfortable and might built great trust on government mitigation planning and policies. Government should ensure that their warning message reaches the target properly. Government along with NGOs should track the people and shift the tribal people to a safest place at the time of landslide and provide them proper food and water with hygienic.

10.7 Conclusion

It has been concluded from the descriptive that risk perception towards the occurrence of landslide is more at residence as well as their workplace. They also feel that landslide is threaten their livelihood and financial status, so they might lose their control. Female respondents feel more risk towards landslide than male respondents because of not having much contact with other people. They stay in the house for most part of their life and also thinking about past landslide which makes them more vulnerable. Nuclear family feels more risk than joint family because their family does not have experienced person, and with very less people at the time emergency, they feel it is difficult to safeguard the moveable and immovable things. Perception of risk towards landslide varies based on education among the respondents because illiterate people have high risk than higher educated people similarly primary and secondary educated people. Perception of risk towards landslide is high among the respondents who are residing in semi-pucca house because people staying in semi-pucca house have a feeling of their house get damage due to landslide. There is noticeable difference between the age groups of the respondents those who are greater than 65 years of age and between 25 and 65 are having experience, so their risk is comparatively low as contrasted to the person with lower age; this is mainly due to experience. Family size of the respondents influences more on risk towards landslide, whereas marital status, type of house, and type of family have negative effect on predicting risk towards landslide. It concludes that size of the family those who are staying in less member feel more risk than those staying with more family members. They are believing that incase of landslide, all the family members will go together to safeguard the entire family and elder in their family out of their experience they give good advice on disasters.

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Part III
Sustainability Through Indigenous Knowledge and Practice

Chapter 11
Indigenous Knowledge of Disaster Risk Reduction in Indonesia

Noorika Retno Widuri, Tupan, Ambar Yoganingrum, Rulina Rachmawati, Nana Sulaksana, and Zufialdi Zakaria

Abstract Indigenous knowledge-based disaster risk reduction is expected to be a community preventive effort before a disaster occurs. This chapter aims to explore the indigenous knowledge of disaster risk reduction in Indonesia and analyze potential fields that can be further developed. The bibliometrics approach was used to analyze Keywords from Scopus, which were then confirmed using expert interviews. The result shows that the most widely used keywords are community-based disasters, local communities, traditional architecture, traditional building, traditional house, bamboo house, disaster knowledge, disaster e-learning, cultural traditions, and disaster mitigation literacy. Meanwhile, the topics suggested by the experts to be developed include digital folklore, disaster films based on indigenous knowledge, terraces, and traditional tools as an early warning system. This chapter unveils indigenous knowledge that is taking roles in disaster risk reduction in Indonesia that has yet to be further developed for effectiveness. In addition, it shows the role of library and information sciences, especially bibliometric studies, in exploring indigenous knowledge for effective disaster management. The bibliometric approach can identify potential indigenous knowledge to be developed in the future. The development of local wisdom needs to be followed by an increase in community response based on those local wisdom to reduce disaster risk.

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_11

Keywords Indigenous knowledge · Disaster risk reduction · Bibliometrics · Co-word analysis

11.1 Introduction

Indonesia is the largest archipelagic country in the world, surrounded by oceans, having the most volcanoes, located between two continents, crossed by the equator, and has the most ethnic groups with different religions, customs, traditions, cultures, and many more. Therefore, undoubtedly Indonesia has many and varied sources of indigenous knowledge (Samson et al. 2021). Many sources of knowledge related to disaster mitigation are also found in Indonesia (Samson et al. 2021). Indonesian Cultural Statistics notes that there have been 1,239 intangible cultural heritages in Indonesia since 2013–2020 (Pusdatin. Kemendikbud 2021).

Atta's 2019 research results reveal that a cross-sectoral approach is needed to use local knowledge and practices to complement scientific knowledge in disaster risk assessment and to develop and implement policies, strategies, plans, and programs for specific sectors. In addition, there is a need to strengthen technical and scientific capacities to utilize and consolidate existing knowledge and apply methodologies and models to assess disaster risk, vulnerability, and exposure to all hazards (Rahman and Fang 2019).

In 2020, the Skala Indonesian Association researched to document indigenous knowledge and collective memories of the community regarding the earthquake and tsunami disasters and local wisdom based on disaster mitigation in the Banten region. This research uses the ethnographic method and is conducted to encourage access to risk information that can be considered in development policies and other risk reduction actions (Perkumpulan Skala Indonesia 2020). Research conducted by Hiwasaki in 2014 identified local knowledge that can be integrated with science which is then disseminated to be used by scientists, practitioners, and policymakers. The research used the action research method, and in the next stage, the findings were validated by the community through FGDs and workshops (Hiwasaki et al. 2014). In policy context, bibliometric visualization is one of the tools that can be used in knowledge policy (Noyons et al. 2002). Identifying the identified subdomains plays a vital role in mapping as a policy support tool, as there must be some reference to the "real" situation. We need field experts for this kind of validation (Noyons et al. 1999).

Suarmika et al. (2022) conducted research to determine the pattern of traditional knowledge in disaster mitigation in Indonesia and forms of disaster learning in Indonesian elementary schools using the qualitative meta-analysis method (Suarmika et al. 2022). Dekens (2007) provided an overview and framework of local knowledge in disaster preparedness using a cross-disciplinary literature review method (Dekens 2007). A bibliometric study is a network that shows the relationship between two nodes and the strength of the relationship. Network analysis can also be keyword-based (van Eck and Waltman 2014), so that it is possible to see the relationship between the units to be analyzed.

Bibliometric analysis, with the help of applications, is easy to use to examine an unlimited number of publications, both micro (institutional) to macro (world) scale (Wallin 2005). Syahputra (2019) identifies indigenous knowledge by using qualitative descriptive research. The data search used field observations and in-depth interviews. This method explores indigenous knowledge that is limited to one area. Meanwhile, Djalante (2018) conveyed the need for an agenda to review the latest publications related to disaster risk reduction, especially in the Indonesian language, and carried out by Indonesian experts' collaborations, thus enabling the identification of research progress and future research needs. However, the systematical review method used is quite time-consuming; if carried out by several researchers to speed up the process, it has the potential to cause bias because the book chapter evaluation technique must be consistent throughout all stages. The bibliometric method can fulfill this need. The method turns something intangible (scientific quality) into a manageable entity (Wallin 2005). Thus, this book chapter attempts to fill this gap.

This book chapter provides an overview of indigenous knowledge research in disaster risk reduction in Indonesia using a bibliometric study. Exploring the finding keywords to see the contribution and potential of indigenous knowledge research in the future disaster risk reduction, especially in Indonesia.

11.2 Material and Methods

11.2.1 Data Source

The book chapter data was retrieved from the Scopus database. Scopus is a multidisciplinary bibliographic database with the most extensive scope, which focuses on the completeness of indexed scientific contents (Caputo and Kargina 2021).

11.2.2 Methodology

This chapter utilizes a bibliometric method. Co-word/ co-occurrence was used in the unit of analysis. Co-occurrence displays a network visualization between keywords (co-words). These words can be selected from the title, abstract, body of the document, or a combination of fields. For this research, the keywords analyzed were the original keywords available from the document (author keywords) and the indexing keywords provided by Scopus (Widuri 2022).

The stages for bibliometric analysis can be seen in Fig. 11.1.

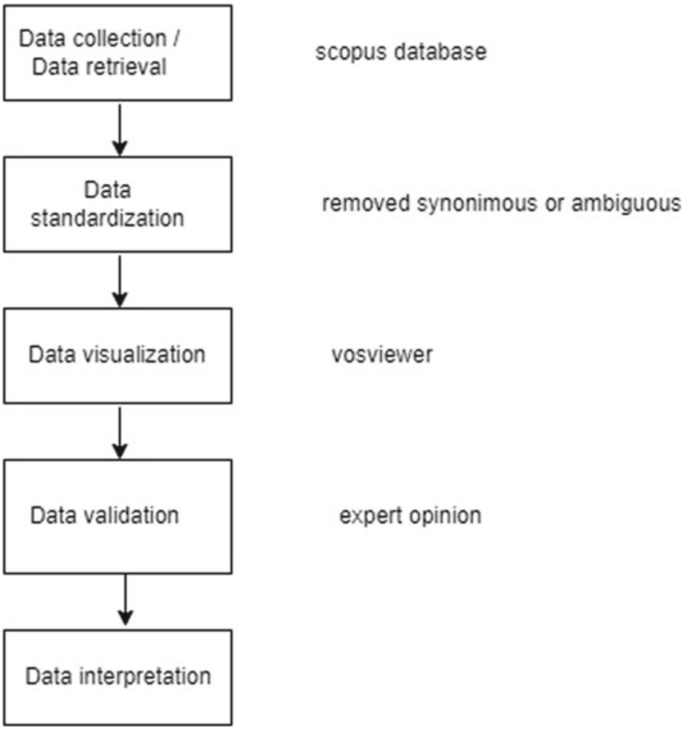

Fig. 11.1 Stages of bibliometric analysis

Data Collection/Data Retrieval

Data was obtained from the Scopus database using the following search strings:

TITLE-ABS-KEY("indigenous knowledge") OR TITLE-ABS-KEY("local knowledge") OR TITLE-ABS-KEY("local wisdom") OR TITLE-ABS-KEY("traditional knowledge") AND TITLE-ABS-KEY(disaster) AND AFFIL-COUNTRY(Indonesia)). The search found 110 documents, which were then saved in a CSV format.

Vocabulary Standardization or Keyword Standardization

In this step, synonymous, ambiguous, and general term keywords were removed (Ravikumar et al. 2015), which included keywords such as disaster, *disaster management, disaster prevention, disaster mitigation, disaster risk management, questionnaire survey, natural disaster, and surveys.*

Data Analysis and Visualization

VOSviewer software was used for data analysis and visualization. VOSviewer is a valuable software for mapping based on network data as well as for visualization and exploration of the map (Cobo et al. 2011) by using a co-occurrence unit of analysis (Galvagno 2017). All keywords were analyzed to find keywords related to local knowledge (indigenous knowledge) in disaster risk reduction.

Keywords Validation by Experts' Opinion

Experts from academics and researchers validate keywords that have been found. Then, experts provide keyword suggestions related to indigenous knowledge research on disaster risk reduction.

Interpretation

Visualization results are interpreted based on the analysts' expertise. Analysts have to explain and critically interpret the results and maps using their experience and knowledge. In this step, the analysts seek to find and extract valuable knowledge that can be used to make decisions about which policies to apply (Galvagno 2017).

11.2.3 Result and Discussion

Trends in Disaster Risk Reduction Research in Indonesia Based on Publications

Publications of indigenous knowledge research related to disasters in Indonesia first appeared in 2011. Figure 11.2 shows three periods of publications. In the first period (2011–2014), publications appear inconsistent. Then, the number of publications fluctuated with an increasing trend from 2016 to 2018. Furthermore, the number of publications increased sharply from 2017 to 2020. The number of disasters in Indonesia experienced an increasing trend between 2016 and 2019 (Puspasari 2020). The increase in the number of publications is indicated by the increase in research, presumably due to the many disasters that occurred during that period.

Distribution of Indigenous Knowledge Publications Based on Affiliation

The analysis using the Scopus database shows that most publications on indigenous knowledge are produced by the University of Indonesia, followed by Syah Kuala University and Yogyakarta State University. Based on Fig. 11.3, it can be seen that the

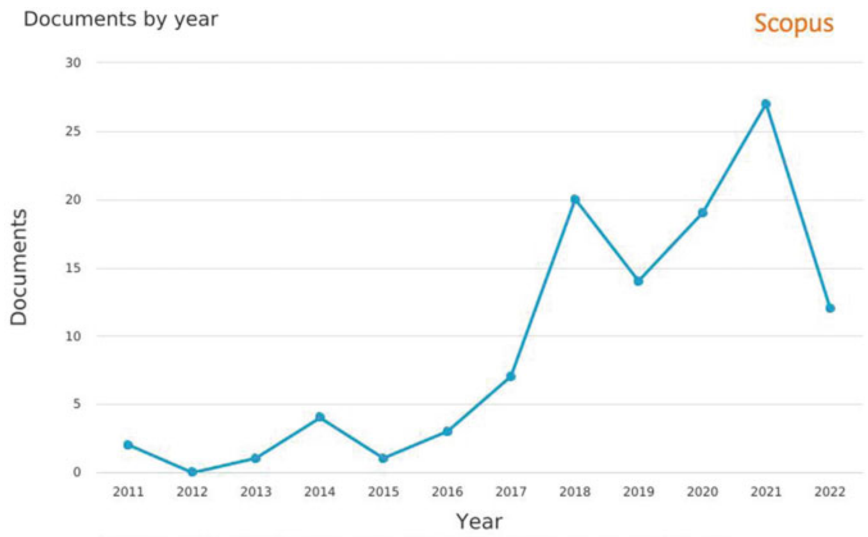

Fig. 11.2 Indigenous knowledge application in disaster risk reduction during 2017–2022

affiliations with the most indigenous knowledge publications are earthquake-prone areas.

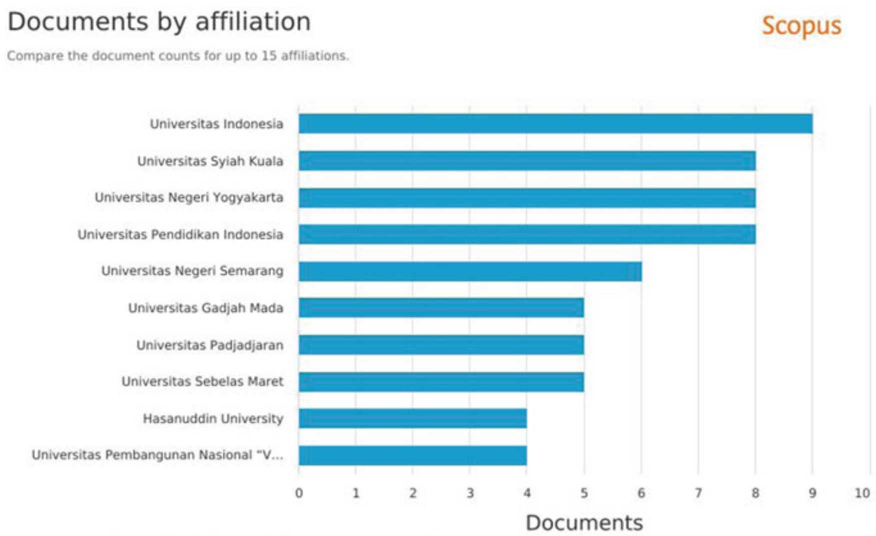

Fig. 11.3 Distribution of indigenous knowledge research in disaster risk reduction based on affiliations

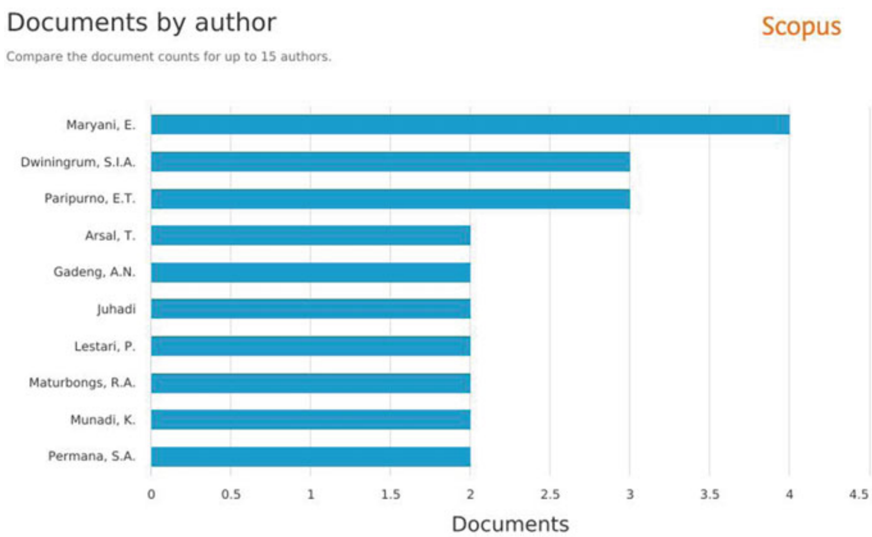

Fig. 11.4 Distribution of indigenous knowledge research in disaster risk reduction based on authors

Distribution of Indigenous Knowledge Publications Based on Authors

Based on the distribution of the authors as shown in Fig. 11.4, Maryani, a writer from the University of Indonesia Education, is the most productive author in publishing indigenous knowledge research with a total of 62 citations and an *h*-index 5, followed by Dwiningrum from Yogyakarta State University as the second most productive author with a total of 47 citations and an *h*-index 4. The third most productive author is Paripurno, E.T from Pembangunan Veteran University, East Java, Surabaya, Indonesia, with 66 citations and an *h*-index 4.

Distribution of Indigenous Knowledge Publications Based on Subjects

Based on Fig. 11.5, it can be seen that indigenous knowledge research is mainly carried out on the subject of environmental science (22.8%), followed by the social subject field as much as 17%, engineering as 10.3%, and computer science as 4.9%.

Co-occurrence Analysis

Based on the keyword visualization, there are five clusters of keywords related to indigenous knowledge, as shown in the following Table 11.1 (Fig. 11.6).

In cluster 1, keywords related to community-based disasters and local communities were found. These keywords were confirmed by an expert from the social welfare field. Based on the expert opinion, community-based disaster risk reduction

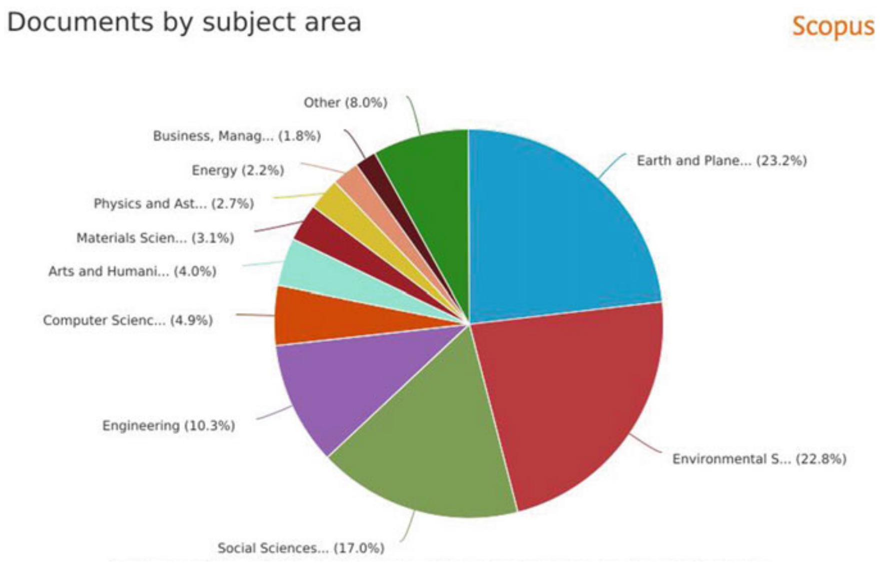

Fig. 11.5 Distribution of indigenous knowledge research in disaster risk reduction based on subjects

efforts in Indonesia are very diverse, following the conditions and culture of the community. Hence, the naming of the programs is adjusted to the regional name. The formation of *Taruna siaga bencana* (TAGANA), initiated by the Ministry of Social Affairs for volunteering in disaster management, is a corps that only exists in Indonesia. In fact, the existence of TAGANA has attracted researchers from outside Indonesia to monitor TAGANA's progress in disaster management. In addition to TAGANA, there is also *Desa tangguh bencana* (Disaster resilient village), a National Disaster Management Agency brand. There is also *Kampung siaga bencana* (disaster preparedness village), which was expanded to become a disaster preparedness area, a Ministry of Social Affairs brand. In principle, all of these are part of community-based disaster management (CBDM).

keywords found in clusters 1 and 2 include keywords such as traditional architecture, traditional building, traditional house, house building, house concept, house construction, architectural building, architectural design, and bamboo house. These keywords were confirmed by an expert in the field of civil engineering and architecture that those traditional houses are pretty good; for example, the Sundanese traditional houses are good enough for an earthquake disaster. The traditional houses can be combined with a touch of current civil engineering tools, such as equipped with an early warning system using sensors and simple tools, so that it will sound when there is a shock.

keywords found in clusters 3 and 4 consist of disaster knowledge, disaster e-learning, child protection, child protective services, and child welfare. In cluster 5, keywords such as cultural traditions and disaster mitigation literacy were found.

Table 11.1 Clusters of keywords related to indigenous knowledge in Indonesia

Cluster	Keywords
Cluster 1 (Red 142 items)	Active volcanoes, adaptive capacity, adaptive management, area of vulnerability, autoethnography, community base disaster, cultural landscape, conservation management, decision making, deforestation, disaster monitoring, disaster resilient child, early warning system, economic and social eff, economic sector, educational process, educational strategy, environmental adaptation, environmental change, environmental condition, environmental damage, environmental condition, environmental engineering, environmental function, environmental planning, environmental policy, environmental technology, environmental friendly, erosion, farming activities, fire hazard, flood disaster, flood hazards, flood production, geospatial data, geographical positions, geological conditions, geological hazards, indigenous people, knowledge and experience, knowledge level, local capacity building, local community, local knowledge, religious, science and technology, scientific knowledge, social engineering, traditional architecture, traditional building, traditional ecological knowledge, traditional house
Cluster 2 (Green 137 items)	Action community, adaptation strategy, adaptive mechanism, agricultural management, agricultural robots, architectural building, architectural design, bamboo house, breakwater, climate change adaptation, climate change resilience, coastal community, cultural diversity, cultural study, data collection tool, developing strategy, development plant, development process, disaster preparedness, disaster resilience, disaster vulnerability, distance e-learning, economic activities, emergency response, emergency services, environmental characteristic, environmental conservation, environmental disaster, environmental problem, environmental quality, environmental value, extreme conditions, fire suppression, flood early warning system, geographical condition, geography learning, geomorphology, global climate change, green open space, group consensus, historic preservation, house building, house concept, house construction, learning media, learning models, learning process, learning system, local institutions, maritime community, traditional values, tsunami disaster, tsunami early warning system

(continued)

Table 11.1 (continued)

Cluster	Keywords
Cluster 3 (Dark Blue 98 items)	Alternative livelihood, appropriate technology, building back better, community empowerment, community resilience, concept development, cost effectiveness, developing community, disaster history, disaster information system, disaster knowledge, disaster e-learning, disaster mitigation, disaster prevention, disaster risk reductions, disaster simulation, disaster warning, earthquake and tsunamis, ecological conditions, economic recovery, emergency planning, geographic information, geotechnical investigation, GIS, historical events, hybrid sociotechnical system, indigenous knowledge, indigenous people, indigenous technology, information management, knowledge accumulation, knowledge management, local and indigenous knowledge, management model, preparedness management, remote sensing, remote sensing application, social interactions, society environment, sociotechnical approach, sociotechnical system, specialized knowledge
Cluster 4 (Yellow 77 items)	Areca catechu, Central Sulawesi, child protection, child protective services, child welfare, community character, community response, cultural tourism, disaster communicator, disaster model, disaster policy, educational development, environmental communication model, heritage tourism, indigenous community, indigenous population, inheritance, knowledge management, land management, local government, local values, local wisdom, multicultural society, multiethnic society, natural science module, nature society relations, science literacy, social disaster, social integration, *tebat*/ canal blocking
Cluster 5 (Purple 77 items)	Action, Banda Aceh, coastal area, coastal settlement, coastal zone, conservation area, cultural traditional, disaster earthquake, disaster mitigation literacy, earthquake event, float settlement, humanitarian aid, indigenous, integration model, interpersonal communication, landscape development, local participation, natural resources, preparedness, Sasak's local wisdom, social justice, social system, tacit knowledge, Tenggerese people, thematic learning, traditional knowledge

Table 11.2 Indigenous knowledge categories

Number	Categories	Indigenous knowledge	Definitions	**Regions**
1.	Science and technology	*Pengataa*	Environmental management guidelines, such as determining the location of residential areas by considering environmental hazards and balance (Siradjuddin et al. 2022)	Central Sulawesi
2.	Science and technology	Earthquake-resistant houses made of bamboo	Low-cost disaster-resistant houses, utilizing indigenous knowledge, can flexibly accommodate the needs of residents by following the growth of the residents (Kusuma 2022; Triastari et al. 2021)	Banten
3.	Belief	*Gending* Java	Javanese traditional music is used for mental and physical health (Lestari et al. 2021)	Central Java
4.	Science and technology	Grogol tourism village	One of the entrepreneurial opportunities, environmental management, and social disaster prevention. Grogol tourism village is an independent tourism village (Saliman et al. 2021)	Sleman, DIY
5.	Science and technology	*Tananam multi strata*	Conservation efforts by planting multi-strata plants of woody plants and horticultural plants on every part of the slopes in Taji Village (Indouw et al. 2022)	Malang, East Java
6.	Belief	*Sasi*	Environmental management based on indigenous knowledge, which is the custom and habit of a group of customary law communities from generation to generation (Indouw et al. 2022)	West Papua

(continued)

Table 11.2 (continued)

Number	Categories	Indigenous knowledge	Definitions	**Regions**
7.	Belief	*Siri' na pacce*	Views/philosophy of life. *Siri'* is a shameful feeling when doing a disgraceful act, *pacce* is a feeling that arises as a form of solidarity toward relatives who befall distress which is manifested in the form of providing help (Ekawati et al. 2022)	Gowa, Makassar
8.	Science and technology	*Lamban langgakh*	House on stilts, a traditional house from Lampung (Juhadi et al. 2021)	Lampung
9.	Science and technology	*Jogo Tonggo*	At the community or household level (RW/RT level) to take care of neighbors and the environment from the spread of Covid-19 and the impact caused during the pandemic (Triastari et al. 2021)	Central Java
10.	Belief	*Karampuang* community	Traditional forest management (Triastari et al. 2021)	South Sulawesi
11.	Belief	*Pikukuh*	Custom law (Triastari et al. 2021)	Banten
12.	Belief	*Smong*	The concept of simple indigenous knowledge that serves as an information tool when a tsunami occurs (Triastari et al. 2021; Onrizal et al. 2020; Syahputra 2019; Gadeng et al. 2019; Rahman et al. 2018; Suciani et al. 2018; Rahman et al. 2017)	Aceh
13.	Belief	*Cattur guru bhakti*	The concept of public trust and respect for who is considered a guru, has been lasted for generations (Yuanjaya and Meiwanda 2021)	Tengger, Bromo

(continued)

Table 11.2 (continued)

Number	Categories	Indigenous knowledge	Definitions	**Regions**
14.	Belief	*Pujan Mubeng (Nrundhung)*	A ritual aims to ask for the safety of the village and cleanse the village from disturbances and disasters (Yuanjaya and Meiwanda 2021)	Tengger, Bromo
15.	Science and technology	*Nyabuk gunung* (mountain belt)	Move soils that have the potential for landslides to other places to reduce slope loads change the way of horticultural crops cultivation (Cahyono et al. 2021)	Beruk Village, Karanganyar
16.	Science and technology	PASMINA (abbreviation of *Paket Kesenian untuk Mitigasi Bencana* or Disaster mitigation art package)	An adaptation of *Nandong Smong*, an effort to maintain traditional knowledge for disaster risk reduction and tsunami hazard preparedness (Maulana et al. 2021)	Simeulue, Banda Aceh
17.	Science and technology	*Sibat Sewu*	Efforts to increase the community's capacity building (Suryanto et al. 2021)	Kampung sewu, Surakarta
18.	Science and technology	Kuta's indigenous house	Green development concept in traditional houses signifies harmony with nature to support the needs of future generations (Dede et al. 2021)	Ciamis, Jawa Barat
19.	Belief	*Pantang* (taboo) areas	Custom law aims to maintain rigorous conservation areas (Sulaiman et al. 2021)	Aceh Besar
20.	Science and technology	*Tebat*	Building canal blockings to keep the peat area wet all year round, thus protecting it from the threat of fire hazards (Utami and Nazir Salim 2021)	Riau Province

(continued)

Table 11.2 (continued)

Number	Categories	Indigenous knowledge	Definitions	**Regions**
21.	Belief	*Babarit* ritual	A ceremony that includes conditions in the form of food, drink, and fruit, as an effort to prevent disaster and gratitude to God (Bakti et al. 2021)	Pangandaran, West Java
22.	Science and technology	*Sadu* traditional house; *Falagaku; Falakanci; Hibualamo*	A traditional house with the basic concept of "spiritual-human-nature", the character of the building is different in each region but still in harmony with nature (Rahim et al. 2021)	Maluku Islands: West Halmahera; Tidore; Ternate; North Halmahera
23.	Science and technology	*Pranata mangsa*	Disaster risk reduction management by farmers using climate change predictions (Rozaki et al. 2021)	Central Java
24.	Belief	*Monda'u* Tolaki's community activities	Educational activities as an effort to avoid natural disasters from generation to generation (Hos et al. 2021)	Southeast Sulawesi Province
25.	Science and technology	*Lakkang residence*	The *Lakkang* community's residences that have an open space configuration, integrated (Syarif et al. 2020)	Makassar, South Sulawesi
26.	Science and technology	*Kampung Urug*	Indigenous people housing with several characteristics such as green open spaces, building architecture, rituals and customs, and events based on indigenous knowledge (Sato et al. 2020)	Bogor, West Java
27.	Belief	*Bersih desa* ceremony	A ceremony that has supernatural values believed to give a sense of security for the community from all forms of disaster (Malawi and Chasanatun 2020)	Magetan, East Java

(continued)

Table 11.2 (continued)

Number	Categories	Indigenous knowledge	Definitions	**Regions**
28.	Belief	*Kasepuhan Karang*, Adat community	Indigenous peoples are highly dependent on forest resources and local wisdom practices to survive various climatic conditions (Sylviani et al. 2020)	Lebak Banten
29.	Belief	*Kul-kul*	Making the sound of the gap drum (*Kul-kul*) as an alarm to gather the community for an early evaluation (Fadli and Masnun 2020)	Lombok, NTB
30.	Science and technology	*Bale Bedeq* or *Bale Balak*	House construction made of woven bamboo, wood, or boards (Fadli and Masnun 2020)	Lombok, NTB
31.	Belief	*Tolak Bahla*	Religious rituals with the recitation of prayers carried out after the earthquake (Fadli and Masnun 2020)	Lombok, NTB
32.	Belief	*Leuit*	Customary goods, every family in the community should have a garden to plant perennials and vegetables (Sugandi and Pascawijaya 2020)	Sukabumi, West Java
33.	Science and technology	Merapi's sacred Advice	Community ideas full of wisdom and good value are embedded and followed by community members as a way of life. This knowledge is a concept of disaster education in dealing with the Merapi eruption threat (Permana 2020)	Magelang, Klaten, and Boyolali, Central Java
34.	Belief	*Kasada* ceremonial tradition	Worship rituals toward Mount Kelud guards, known by the people of Kediri as *Lembu Suro* for the sake of public safety (Erni et al. 2020)	Kediri, East Java

(continued)

Table 11.2 (continued)

Number	Categories	Indigenous knowledge	Definitions	**Regions**
35.	Science and technology	*Tumik Singgalang*	A disaster Preparedness Group with the function of community-based disaster management (Ansosry et al. 2019)	Agam, West Sumatera
36.	Science and technology	*Bahuma Batahutn*	A wise environmental management system conducted by the Kanayatn Dayak tribe (Fajarwati and Masruri 2019)	Dayak, West Kalimantan
37.	Science and technology	*Gotong-royong*	A tradition of helping each other in rural, reinforced by fundraising based on village, tribal, and region and conducted by the Minang community living outside of the region (Damsar and Indrayani 2018)	Minangkabau, West Sumatera
38.	Belief	*Sabuk janur dance*	A dance developed from a myth that is used as a tool to move the community to participate in every development, especially community participation in preserving the environment and social solidarity in overcoming natural disasters and the limitations that befall them (Lestari et al. 2018)	Karanganyar, Central Java
39.	Belief	*Awig-awig*	Forest resources management (Maturbongs et al. 2017)	Lombok, NTB

An early childhood education expert mentions the importance of knowledge about disasters for children, especially in early childhood. “I think, why do so few young children know what they can do when a disaster strikes? Children from the age of 2 are used to being sent to school, so are they aware or not, that there are situations where certain behaviors are needed. Early childhood needs to be educated, not with mitigation like adults, but at least they know about the flood, etc.”

Furthermore, the expert said, “I think fairy tales could be developed for teaching children about disasters, about what to do in very simple concepts. Fairy tales about natural disasters for early childhood are already written, but it turns out very few people talk about them. In digital folklore writing, children learn things very quickly

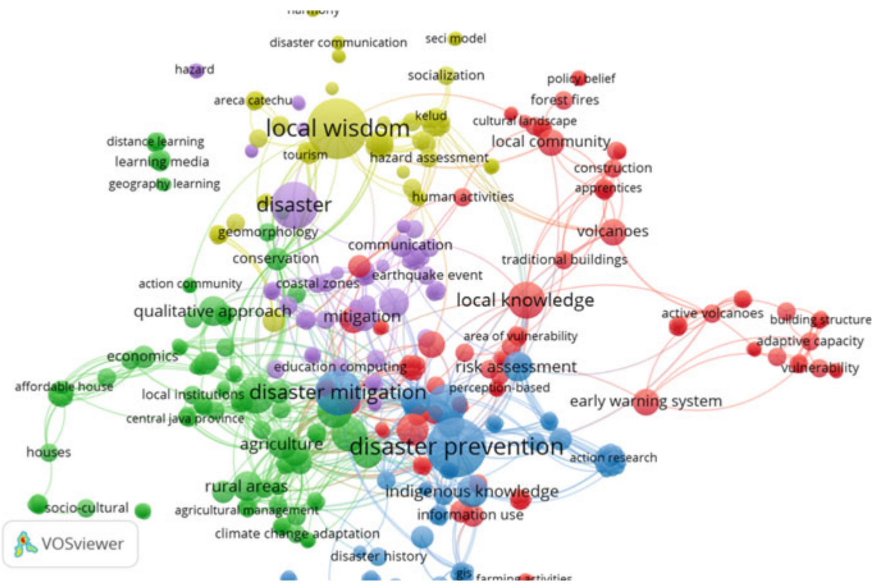

Fig. 11.6 Keyword network visualization

through digital media, but natural disaster stories in the form of short films, interactive games are still minimal".

Visualization of Indigenous Knowledge in Disaster Risk Reduction Based on Year

Figure 11.7 shows the visualization of indigenous knowledge research related to disasters per year. The figure shows that indigenous knowledge research related to disasters has been carried out from 2016 to 2021. Indigenous knowledge research conducted in 2016–2018 includes indigenous knowledge, traditional knowledge, local knowledge, traditional building, local community, and community resilience. Research on indigenous knowledge for disaster risk reduction carried out from 2019 to 2021 covers indigenous people, indigenous technology, knowledge accumulation, knowledge management, local and indigenous knowledge, indigenous people, knowledge and experience, knowledge level, local capacity building, local community, local knowledge, religious, science and technology, scientific knowledge, social engineering, traditional architecture, traditional building, traditional ecological knowledge, traditional house, heritage tourism, indigenous community, indigenous population, and inheritance.

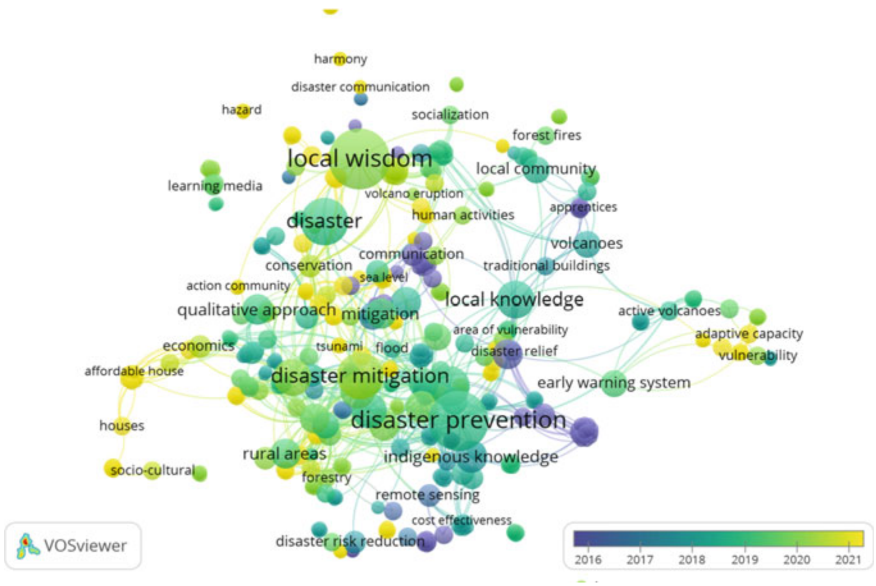

Fig. 11.7 Visualization of keyword network per year

Density Visualization of Indigenous Knowledge in Disaster Risk Reduction Research

Based on the results of density visualization in Fig. 11.8, it can be seen that the keyword density of indigenous knowledge from 531 publications from 2016 to 2021 is characterized by the number of nodes that are close to each other. The density level is indicated by the often appearing number of keywords marked in yellow, which include local wisdom, traditional knowledge, traditional culture, indigenous community, indigenous knowledge, and disaster mitigation literacy. Some dark keywords might indicate research areas that could potentially be developed. Some keywords that the research could potentially develop based on density visualization include local knowledge, traditional building, local community, active community, disaster communication, socio-cultural, and geography learning.

Indigenous Knowledge in Disaster Risk Reduction

Long before the development of modern science, indigenous peoples had developed ways of knowing how to survive as well as ideas about meaning, purpose, and value. This knowledge is commonly referred to as “indigenous knowledge” or “traditional knowledge”, “local knowledge”, and many more (Bank 1998).

Indigenous knowledge as a valuable resource for a community to survive and as a result of a long process of community adaptation to various changes that occur in

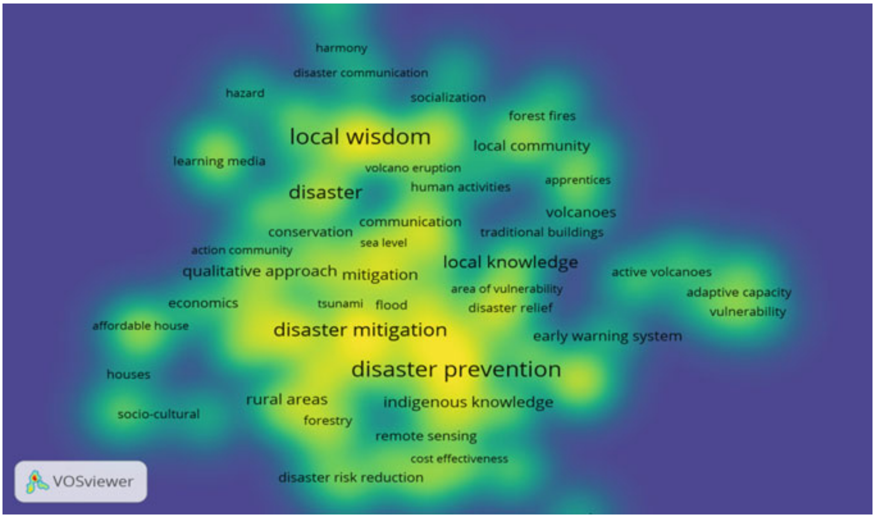

Fig. 11.8 Density visualization of indigenous knowledge in disaster risk reduction research

its surroundings is very important to be recognized and integrated into disaster risk reduction efforts. Local knowledge and the socio-cultural context of communities in disaster-prone areas must be recognized by all parties, starting from the government, policymakers, and local communities themselves. This knowledge must continue to be taught from generation to generation, legalized in the form of policies, and strengthened through integrated programs (Perkumpulan Skala Indonesia 2020).

Indigenous knowledge types can be differentiated based on:

1. How it is acquired: indigenous knowledge can be classified into two types: experiential knowledge (Dekens 2007) and transmitted knowledge (Berkes 2000). Experiential knowledge is obtained through direct experience; transmitted knowledge is passed down from one generation to the next. Along the way, experiential knowledge has a bigger legitimacy problem than transmitted knowledge because the former has been culturally internalized. Thus, indigenous knowledge is difficult to document because it is often invisible.
2. Based on their aspects: Indigenous knowledge related to physical characteristics can be said to be technical knowledge. On the other hand, invisible knowledge related to social systems, traditions, religion, and local culture is understood as a belief system. Thrupp (1989) found that indigenous knowledge is often associated with technical knowledge, the most tangible and concrete aspect of indigenous knowledge. In contrast, belief systems correspond to tacit knowledge (Mercer 2012). During the field observations, the researcher observed various strategies that could be characterized as methods for dealing with disaster events that respondents thought were not worthy of being called part of their indigenous knowledge.

3. Based on practices: Indigenous knowledge related to practice can be further divided into two types: general knowledge, which informs the daily activities of the whole community, and specialized knowledge, which is retained by members of a particular community, such as elders or shamans. This practice explains why some community members lack knowledge of their community (Dekens 2007; Zulfadrim et al. 2019)**.**

Meanwhile, Suarmika et al. (2022) simplifies the types of indigenous knowledge in disaster risk reduction into two major themes: types of disaster mitigation based on belief (belief system) and types of customary disaster mitigation based on science and technology (Suarmika et al. 2022).

11.3 Identification of Indigenous Knowledge Terms in Disaster Risk Reduction in Indonesia

Indonesia is rich in tribes spread across various islands. Residents have a way of life adapted to their environmental conditions, including how to adapt to disasters. The characteristics of disasters in each region of Indonesia vary widely, and survival requires methods derived from everyday experiences that are passed down from generation to generation (Suarmika et al. 2022).

Thirty-nine terms were found related to indigenous knowledge in disaster risk reduction in Indonesia. These terms have not appeared as keywords; therefore, the authors searched in the full-text document to find local terms related to indigenous knowledge. The most common term is *Smong*, which is mentioned in seven documents on Scopus.

According to Suarmika et al. (2022), these terms are divided into two categories: belief system and science and technology. Local belief systems are perceived here as a combination of people's beliefs (e.g., socio-cultural and religious belief systems), world views (i.e., ways of viewing the world), moral values, and principles (e.g., respect, reciprocity, sharing, and humility), and ethics (Dekens 2007).

Table 11.2 shows the categorization of indigenous knowledge. According to geologists, from 39 keyword terms related to indigenous knowledge, several terms are not only used in conditions of natural disasters but also in social disasters. These terms are Javanese *Gending, siri'na pace, Jogo Tonggo, and Cattur guru bhakti.* Likewise, at the stage of natural disasters, these terms are not all used at the stage of disaster preparedness or at the stage of reducing disaster risk but can also be implemented at the stage of disaster and post-disaster events.

The map Fig. 11.9 provides an overview of the distribution of indigenous knowledge in Indonesia based on the terms found in Table 11.2. This map shows that Java has more indigenous knowledge of disaster risk reduction than other islands. However, it does not mean that indigenous knowledge in other areas is absent or few, but it might be because there has not been much research done in other areas, or they might be uncovered in the search process for this research.

Fig. 11.9 The distribution of indigenous knowledge of disaster risk reduction in Indonesia

Figure 11.9 shows that Central Java has some indigenous disaster risk reduction knowledge; one of the areas is Karanganyar District. According to regional topography, Karanganyar District has an area dominated by hills and mountains. Indigenous knowledge from this area is *Nyabuk gunung* (mountain belt), a land preparation technique by following contour lines. This technique is passed down from generation to generation (Cahyono et al. 2021). From Papua, one of the efforts to preserve the environment is *Sasi*, which involves the younger generation. Hence, it remains an adaptation strategy for indigenous peoples in dealing with disasters (Indouw et al. 2022). Next, from Southeast Sulawesi, there is *Monda'u* indigenous knowledge, a belief and custom taught and practiced from generation to generation (Hos et al. 2021). From the above description, one of the efforts to preserve indigenous knowledge is to continue to involve the younger generation in these activities so that it is maintained for the future.

In addition, there is the *Sabuk Janur* dance*, Tumik Singgalang,* and *Sibat Sewu*, which are indigenous knowledge which, in principle, is an activity to mobilize the community to participate and increase community capacity in a disaster preparedness effort. Efforts to preserve the *Sabuk Janur* dance can be seen from the enthusiasm of the people who want to take part in preserving this culture (Lestari et al. 2018). Meanwhile, for *Tumik Singgalang*, the efforts made are through simulation activities in the community to anticipate and deal with possible disasters (Ansosry et al. 2019).

Kuta's indigenous house, *Sadu, Urug village, and Bale* Bedeg are indigenous knowledge in the form of traditional house buildings. Preserving local architecture and passing it on to future generations is essential for sustainability efforts to preserve traditional architecture (Rahim et al. 2021). In principle, indigenous knowledge in building traditional houses is a disaster mitigation effort with the concept of green open space, including the possibility of making evacuation route maps during a disaster (Dede et al. 2021; Sato et al. 2020).

11.4 Opportunities for the Development of Indigenous Knowledge Research in Disaster Risk Reduction

Indigenous knowledge is original knowledge originating from an area where disasters occur. Therefore, local residents are aware of themselves better to find a way out, both in prevention efforts before a disaster as well as when a disaster occurs (Samson et al. 2021).

Indigenous knowledge has potential to be used in research on disaster risk reduction. Several experts from various disciplines have confirmed some keywords related to indigenous knowledge in disaster risk reduction research. According to communication experts, Indigenous knowledge or cultural customs are passed down from generation to generation. Traditional knowledge is assets which can be a basis for reducing disaster risks.

The multimedia expert said that "*the content brought can be done with a cultural/indigenous knowledge approach or an approach through local customs to convey messages to the community; this method has been widely used with the aim of mitigating disasters in Indonesia. In Indonesia, there are no disaster educational games based on local games, there are quite a few abroad, such as STOP DISASTER, an example of disaster-related games. Meanwhile, in Indonesia, the disaster game has not been widely developed*".

A communication expert who has researched disasters remarks that one of the disaster mitigation efforts based on indigenous knowledge can be made through knowledge preservation. According to the expert, "*Local preservation by the community is carried out by continuing traditions and educating the next generation. The expert explains that what is being "preserved" is knowledge, and traditional leaders and elders are the ones who used to carry out the tradition Hajat laut in Pangandaran, larung, throw away everything they eat; even their clothes are stored in ships anchored to the sea. This practice is the preservation of knowledge. When being asked to traditional leaders, they did not pray towards the rulers of the sea, but to God, so that that is preserved, as a grateful that they can eat from the sea. This ordinance, this philosophy is passed down, this is what is considered the preservation of knowledge*". In line with what was conveyed by the communication expert, a documentation expert argues that one of the importance of knowledge preservation is through disaster documentation.

During the Dutch colonialization era, land provision was provided by clearing forests, cutting down trees, and pulling roots. Soil arrangement by cutting and filling the land so terracing land can be made (Nuralia 2019). The civil engineering expert said, "*terracing (terrace) is a soil conservation effort used to reduce landslides/floods.*

Better terracing can reduce the impact of landslide/flood. Terracing has been passed down from generation to generation in Indonesia. In the Southeast Asian region, terraces have been developed. In Japan, terraces are already available, but not as many as in Indonesia."

The communication expert conveyed, "*Traditional tools still play a role in helping disaster risk reduction, especially for early warning. In East Nusa Tenggara, people rely on a communication tool like a kentongan, a kind of drum that is beaten. In the west of Indonesia, easy-to-access communication tools such as mosque speakers are used or kentongan that are available in front of the house. Indonesia has a CBSO or community-based society organization, and there are already several groups in the community, such as the Pemberdayaan Kesejahteraan Keluarga PKK (Family Welfare Movement), karang taruna or youth groups, and majlis taklim or taklim councils. These groups have the resilience to absorb and convey information to the public. Through their typical activities, they can verbally inform the risks occurred in a disaster. The actors can provide understanding to the community so they can reduce their respective abilities, so the term community-based disaster risk reduction emerged"*. Furthermore, the communication expert conveyed that actors or key persons have a vital role in indigenous knowledge. "*In Indonesia, each region has different risks, so it is necessary to carefully look for actors who can translate risks into actions that can be taken as examples by colleagues around them. We need a personal or localized approach, so we need actors who can help the surrounding community understand the natural conditions they live in and how they respond to it properly so that with this information and provision if the risk becomes a disaster, they are ready. Even if a disaster does not occur, they have sufficient knowledge to take appropriate actions to reduce disaster risks.*"

11.5 Limitations of the Study

This book chapter has a limitation in the process of determining keywords. In order to get more comprehensive data, broader keyword coverage is needed. In addition, data sources that are not only Scopus but also local databases are compulsory because publications in local journals are required to identify various terms of indigenous knowledge in disaster risk reduction.

11.6 Conclusions

Indonesia has an excellent opportunity to explore research on indigenous knowledge, especially regarding disaster risk reduction in various regions. The richness of indigenous knowledge in Indonesia can be used as potential social capital to reduce disaster risks; that is, in particular, indigenous knowledge which highlights the community-based and accentuates the closeness between citizen groups, the role of actors, networks between ages, and groups that build networks and work together as social capital in disaster risk reduction.

Assets in the form of indigenous knowledge, particularly related to disaster risk reduction, need to be managed with a sound documentation system, so the next generation can still preserve that knowledge. In the context of disaster risk reduction, research exploring indigenous knowledge is required to involve all existing subjects. This book chapter contributes to developing research on disaster risk reduction, especially indigenous knowledge, which is the basis for policy-making in efforts to reduce disaster risks in regions with different characteristics.

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Chapter 12
Indigenous Knowledge in Sustainable Development: A Mao Naga Perspective

Benjamin Kodai Kaje and Kennedy Andrew Thomas

Abstract Indigenous people have depended on shifting cultivation since time immemorial. The clamour for sustainable development has, however, gained importance and much emphasis in recent years. Over a few decades, the practice of shifting/*jhum* cultivation has been abandoned among the Mao villages through the valuable inputs of scientific knowledge. They have taken recourse to terrace cultivation, where the plant waste is carefully buried and made as natural manure. This practice can be seen even in the wet paddy fields too. Though the land is limited, the people still export vegetables, fruits, and flowers to different parts of the country. Willow trees are planted in good numbers along the riverine to preserve soil erosion. Likewise, alder trees are grown amidst terrace cultivation for manure and soil retention. Besides, willow and alder trees are nurtured in plenty since the area is prone to frequent landslides and earthquakes. The authors employed a qualitative and participant observation method, which includes a semi-structured interview and the use of mass media to collect the data. This chapter attempts to conceptually analyse how indigenous knowledge and practices blended with scientific knowledge could be adopted for a sustainable future and, at the same time, better managed in the event of natural disasters.

Keywords Terrace cultivation · Willow tree · Alder tree · Indigenous knowledge · Sustainable development

12.1 Introduction

The Mao Nagas, like many other indigenous tribes of Northeast India, have been living in harmony with nature for the past decades and centuries. The issue of climate

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_12

change and other harmful effects on nature has been of recent origin to the Maos. It is obvious that globalising and commodification of nature coupled with human greed have caused great havoc to nature. In the last three to four decades, the growth of the human population has drastically increased, and so there was also development as well which led to immense pressure on natural resources, that brought great changes in terms of landscape, and the processes (Rawat and Everson 2013). Natural resources were heavily used in excess and in great demand as the global economy expanded (Pulamte 2008). The study's primary focus is on the indigenous people's perspectives on how they provide for examine and interact with nature. Thus, these naturalistic concepts strongly emphasise the value of returning to nature and convey a deep sense of unity and interdependence (Mazzocchi 2020). Indigenous knowledge (IK) may pave the path for a sustainable future in the current world, when unbridled development greed puts the welfare of future generations at risk. Indigenous agricultural and food production knowledge was employed for domestic consumption and the local market (Pulamte 2008).

Indigenous people and their knowledge are untapped resources, underutilised for ages. If indigenous knowledge, which has been handed over for centuries, could be blended with scientific knowledge, the world could be sustained, and the needs of the people fulfilled without harming mother nature. Indigenous people indeed make use of natural resources, yet this is tempered with love for nature, and there is never a moment of reckless destruction of nature at any stage of their eco-cultural interactions. The time is ticking for the world to wake up and act to save, check irresponsible developmental works, and maintain its pristine state for the most prolonged duration. This present chapter attempts to show how the Mao Nagas thrive to sustain themselves within the constrain of land and resources. The wisdom gained from their forefathers is an aid for the present generations to make maximum use of the limited natural resources.

There have been studies about willow and alder trees in different parts of the world. Wilkinson (1999) has exclusively studied the utility of willows in checking soil erosion and thus preventing other unforeseen calamities. Willows are even valuable for cold desert areas of the Himalayas (Rawat and Everson 2013). Alder-based farming has been a subject of study in Nagaland State, where it helped reduce the dependence on shifting cultivation (Rathore et al. 2010). Om Prakash dealt with soil nutrients of Nagaland, wherein the role of alder trees in improving fertility was depicted. The utility of bamboo for the Maos both for domestic consumption and for handicrafts, besides the prevention of landslides, has been highlighted (Lokho and Narasimhan 2019).

Terrace cultivation of the Mao Nagas is found in the article of Daili Neli, where the author stated that interaction with nature had led people to adopt measures which help to preserve nature (Neli 2021). Tribals generally have their own way of treating different sicknesses, and for the Mao Nagas, this is enumerated in the works of Adani Lokho. There are many works on Indigenous Knowledge for Sustainable Development in different parts of the world. Some people even offered alternative perspectives on sustainability through indigenous knowledge and its methodologies (Parsons et al. 2017).

Indigenous Knowledge (IK) of Sustainable Development studies is limited to a specific area. More so, no studies have been done on Indigenous Knowledge for Sustainable Development among the Mao Nagas of Manipur. There are limited sources concerning indigenous knowledge in healthcare, terrace cultivation, and preservation of natural resources, yet a general attempt has not been made from the perspective of the Mao Nagas. So through this chapter, an attempt is made whether indigenous knowledge, if complemented with scientific knowledge, one can be assured of a sustained future and even better tackled natural disasters in the process. Do the Mao Nagas, in some way, be an example to be emulated, abandon *jhum* cultivation and adopt terrace cultivation?

12.2 The Mao Nagas

One of the largest Naga tribes in Manipur, India, the Mao Nagas have been designated as a Scheduled Tribe by the Constitution Scheduled Tribes Order of 1950. Before the introduction of Christianity in the late nineteenth century, the Nagas mostly lacked written documentation of their way of life and forebears. The Mao Naga tribe, on the other hand, has no literature or writing of their own; rather, folklore has been passed down orally from generation to generation. As a result, their vibrant culture has been preserved, along with their unique traditions and surroundings (Mao and Hynniewta 2011). Oral history and oral traditions are the main sources of information regarding the origin of the Naga people (Irene 2020). The Nagas are a Mongoloid type of human race, according to B. B. Ghosh's research. According to the Naga ancestors, the Shupfomei arrived in Makhel, also referred to as the "Womb of the Nagas," from many directions (Irene 2020). The ancestral home of the Mao Nagas is one of the most important lands for the Nagas because it is thought to be where the Nagas originated. The Nagas have found and dedicated a number of historic structures and artefacts (Neli 2021). The '*Maola*' or '*Emela*' language spoken by the Maos is a member of the Tibeto-Burman language family's Angami-Pochuri group (Burling 2003). The history, culture, and identity of the Nagas are anchored by a number of trees, including the "Sacred Wild Pear."

The Mao Naga tribe lives in the northern hills of Manipur's Senapati district in northeastern India. They have established themselves as a farming community and engage in both terrace and wet paddy field production. Agriculture was the tribe's primary employment in earlier times because they did not engage in outside trade (Mao and Hynniewta 2011). This demonstrates the significance of gardening to the tribe and the necessity of protecting nature, which is their source of food. There was no written or recorded information on what was good or harmful within the Mao tribe because they were a closely knit tribal society living nearby their land and nearby one another (Daniel 2008).

The people's labourious transformation of the steep terrain into skillfully lovely and endless terraces concealing slopes for rice farming may be seen in the excellent craftsmanship (Heshu 2018; Kapesa 2017). One of the defining characteristics of the Maos is hard work. In general, those who have interacted with the Maos would concur with this statement. And given that institutionalised beggary was unknown to the Maos, this may be the cause of the lack of beggars. In any event, if one did not work to the best of their skills, the greater community did not provide them any support or constructive criticism (Daniel 2008). One of the main areas where agricultural goods are traded in large amounts both inside and outside the state is the indigenous village of Mao.

12.3 The Rationale of the Study

Science and technological development has a very recent past. The people's level of living did rise as a result of industrialisation and the application of modern technology. However, easing seeking simpler and better ways to make a living had numerous negative consequences. Many people are cautious about the purpose of development as a result of the wanton exploitation of resources in the name of progress. After decades of "failed" development, there is now considerable interest in indigenous knowledge. Participation and locally led and informed processes were carried out in line with the interests and aspirations of indigenous populations (Parsons et al. 2017). The study's main focus is on the perspectives of the indigenous people and how they provide for assess and relate to nature through interactions and care. The need of returning to nature is thus emphasised by these concepts that have a strong sense of unity and interaction with nature (Mazzocchi 2020). Recently, scientists and researchers have developed an interest in indigenous and traditional knowledge, which has greatly increased global awareness. Prioritising traditional knowledge while incorporating modern approaches and building a digital base for problem-solving is necessary to achieve sustainable development. The rich biodiversity and traditional knowledge of the northeastern region have drawn attention to it.

12.4 The Methodology

The majority of the data used in the current chapter is qualitative. Hence, the authors employed a qualitative and participant observation method, which includes a semi-structured interview and the use of mass media to collect the data. The first author garnered lots of valuable input, either from informal conversations with the elderly of the tribe, who are considered the rightful repository of indigenous knowledge or through years of diligent personal observations. Besides, he had telephonic conversations with many experts in the field of indigenous as well as scientific knowledge. The first author, a native of the Mao Nagas, has a direct encounter with the prevailing situation in the Mao area. He spent about one month with the people to check the veracity of the various sources gathered through interviews and other secondary sources. This chapter tries to blend indigenous wisdom with conceptual knowledge

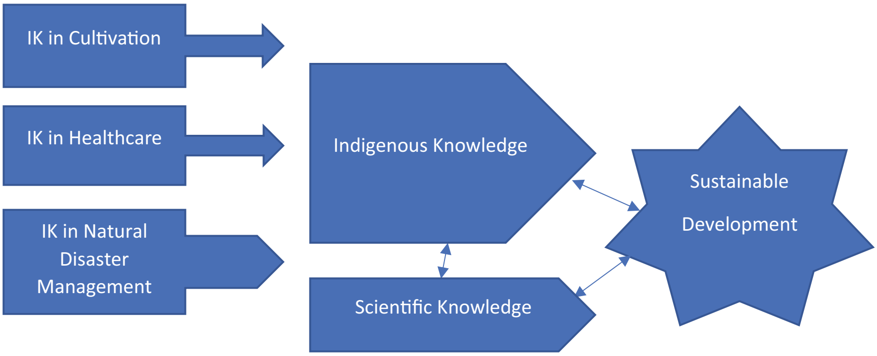

Fig. 12.1 Flow chart of how indigenous knowledge blended with scientific knowledge help in achieving sustainable development

to navigate some ways to mitigate environmental issues. The flow chart shows how Indigenous Knowledge with Scientific Knowledge could sustain the environment (Fig. 12.1).

The Mao Nagas are progressively introduced in this chapter, and it ends with a lengthy discussion on indigenous wisdom and its significance for sustainable development. For long Indigenous Knowledge has not been used to preserve and sustain environment thus natural disasters occur more frequently than it should. If the general population becomes aware of the environmental hazards caused by reckless developmental projects, then they would value the role of IK. This chapter examines environmental communication as a theoretical framework based on the idea that the construction and communication of indigenous dialogues create certain forms of knowledge that direct the meanings and perceptions that people have formed about the environment, which in turn form environmental behaviours and actions depending on the power positions of actors and the communication channels at their disposal.

12.4.1 Study Area

The state of Manipur is one of the Indo-Burma biodiversity hotspots, spans 22,325 square kilometres. The Senapati district is located between 23.8° and 25.7° North latitude and 93.5° and 94.8° East longitudes, and its elevations range from 780 m above sea level in the valley region to above 1500 m in the hilly regions (Devi et al. 2022). In the district's most northern region, there are Maos. The Angamis in the north, the Poumais in the east, the Marams and the Zemes in the west, and other tribes in the south, form their borders. Sixty-four Mao villages exist, of which 22 are federal units and 42 are revenue villages. The Council of Higher Secondary Education, Manipur, approved the teaching of the Mao language up to class 12 levels in 2016. The "Language Certificate Programme in North Eastern Language" at Namaste, Centre for Studies on North Eastern States, Nitte University, Derlakatte, Mangalore, was chosen to include Mao language as a language subject on 12 August 2016 (Kapesa 2017). Maola will be taught at the graduate level as a value-added course, and students who successfully finish it will be given a certificate. In addition, work is being done to incorporate Maola as a subject for the degree course. Figures 12.2, 12.3 and 12.4 shows the map of India, map of Manipur, map of Senapati district and area where the Maos predominantly live.

Fig. 12.2 Map of India. *Source* www.mapofIndia/Manipur.com

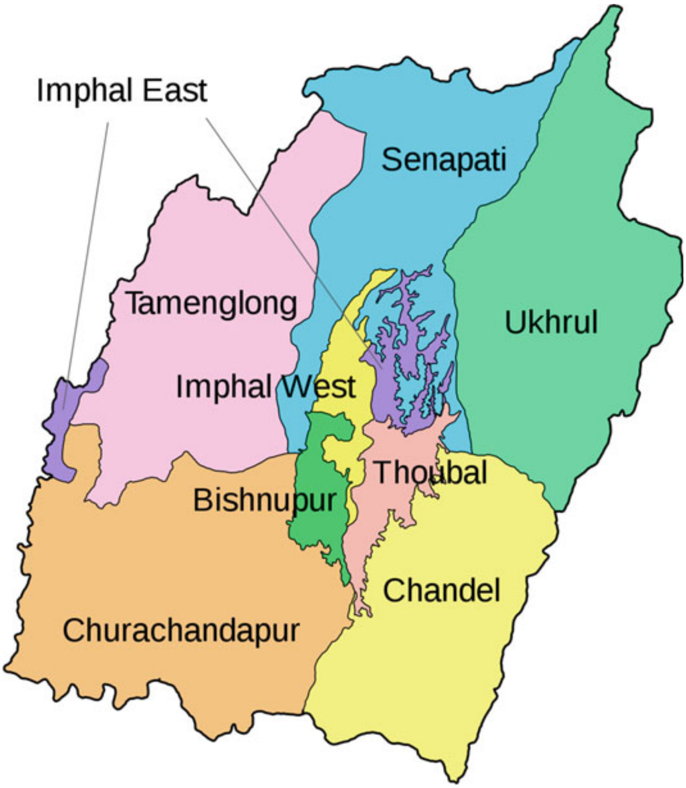

Fig. 12.3 Map of Manipur. *Source* www.mapofIndia/Manipur.com

12.5 Indigenous People

The majority of the people in places like the Caribbean islands, South and North America, and Europe reside in the nearby urban centres, even if 73.4% of the world's Indigenous population overall lives in rural areas (Brondizio et al. 2021). Native Americans and the natural world are connected. One can be confident that they understand and are knowledgeable about nature because they have lived near to it. For indigenous peoples, climate change poses problems with regard to traditional practises, knowledge systems, and adaptive measures (Adger et al. 2014). The effects of climate change where indigenous people reside have recently become the subject of inquiry. There is a knowledge deficit regarding new urban indigenous communities because the research was primarily concerned with native people and their ties to the environment, traditional settings, and rural areas (Adger et al. 2014; Cameron 2012).

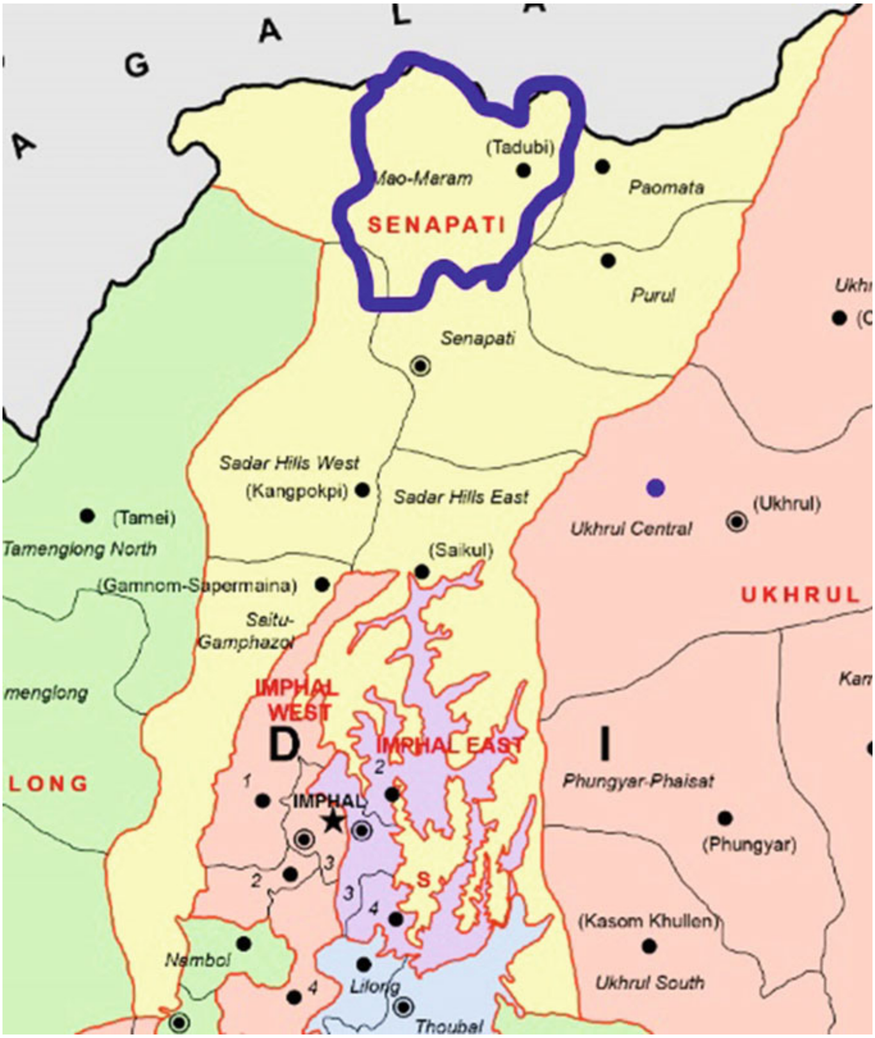

Fig. 12.4 Map of Senapati district and demarcated area showing the study site. *Source* www.mapofIndia/Manipur.com

12.6 Indigenous Knowledge (IK)

Local knowledge is social in nature and has a utilitarian value to the people; hence, there can never be knowledge that is completely independent of what others know and have known in the past. It covers the ways in which people take note of and evaluate their environment, deal with issues, regulate their way of life, and verify new information (as cited in Baybay et al.). The terms "Indigenous Knowledge," "Traditional Knowledge," "Local Knowledge (LK)," and "Local Ecological Knowledge" refer to knowledge that is specific to a particular area, has been acquired through extensive observation and interaction with the environment, and has been passed down orally through generations (Ifejika et al. 2010). The ILO estimates that there are 476.6 million indigenous people in the world, who are divided into 5000 tribes and speak 4000 different languages. They make up 6.2% of the global population. In several areas of Northeast India, there are also traditional farming methods (Pulamte 2008). According to World Bank President James D. Wolfensohn, "A local community's culture and history are fundamentally based on its indigenous knowledge. To accelerate development, we must obtain from nearby communities."

Indigenous wisdom enlightens behaviours and is passed down from generation to generation. It is regarded as part of the tradition of daily life because it is derived from experience, frequently tested through centuries of use, and tailored to regional conditions (Sillitoe 2006). Indigenous knowledge is defined as the knowledge people have acquired over time and passed down to the community as a result of experience and adaptation to the local environment and culture. The tribe's culture and biological resources are preserved with the use of this knowledge, which also helps the group remain viable (Varah and Varah 2022).There is very little ecological harm caused by adopting these native practises. They have stood the test of time and are recognised to be deeply ingrained with sustainability (Pulamte 2008). Indigenous or traditional knowledge has a significant role in reducing the effects of natural disasters, preserving domestic biodiversity, and creating sustainable adaptation and mitigation measures (Emperaire and Peroni 2007; Adger et al. 2014; Nyong et al. 2007).

12.6.1 Why Indigenous Knowledge?

The Maos likely have the least amount of land among the main Naga tribes in both Manipur and Nagaland. The fact that other tribes left Makhel and moved into the surrounding territories may have been one of the causes, as there was little room for the Maos to expand their territory. They are consequently kind of compelled to labour diligently in the field. Due to their limited land resources and lack of room for expansion, the Mao Nagas have utilised their territory very effectively (Neli 2021). Indigenous knowledge (IK) is widely acknowledged as essential for the creation of meaningful, egalitarian, and successful methods to deal with socioecological issues (Parsons et al. 2017). Since the 1980s, an escalating worldwide environmental catastrophe caused by pollution, biodiversity loss, and climate change has sparked interest in indigenous knowledge, values, and traditions as a way to comprehend and better manage local, regional, and global issues (Brondizio et al. 2021). To better understand the dynamic realities of indigenous peoples, traditional knowledge and scientific understanding are being blended in more and more ways (Adger et al. 2014; Huntington 2011). IK has been extensively credited for helping to comprehend and interpret ecological processes, as well as for use in environmental and social impact assessments, despite the fact that studies on its contribution to climate change research are still scarce (Huntington 2011; Ifejika et al. 2010).

12.6.2 Importance of IK

Northeast India is the physical "gateway" for much of India's flora and fauna, making the region one of India's biologically richest regions (Chakraborty et al. 2012). Utilising indigenous knowledge to combat this issue is especially important given how quickly growth and development are occurring. Efficiency, effectiveness, and sustainable development have all been demonstrated to be impacted by the incorporation of proper IK systems into development programmes. Like any other knowledge, IK must be used, tested, and modified to fit changing local situations (Gorjestani 2004).

When it came to nature, the Maos were cautious and made sure that the soil was treated with respect. It was always seen as a source of the sustaining agent rather than a source of the platform for producing money. Nobody ever used nature more than was necessary. Additionally, because they thought it was a kind gift from the *Ojii mashii Opfii* (mother of flat land -flat land has feminine attributes), they never hesitated to take what nature had to provide (Daniel 2008). By preserving domestic biodiversity, creating sustainable adaptation and mitigation methods, and lessening the effects of natural calamities, traditional knowledge helps reduce their effects (Adger et al. 2014; Rautela 2005).

12.6.3 Indigenous Knowledge of Fruits, Vegetables, and Flowers

Fruits, vegetables, and flowers are commonly found in the Mao region. In 1970, the Horticulture and Soil Conservation Department established the Potato Farm at *Pfukhro* (Song Song) as part of the Development of Potato and Vegetable Production Scheme. There were only 70 acres there when the farm first began. However, with support from the North Eastern Council (NEC), it was transformed into a Regional Seed Potato Production Farm after five years (NEC). The farm's size has also been increased to 300 acres in addition to the upgrades (E-Pao 2013). In 2006–2007, a new project known as Strengthening and Continuous Production of Basic Seeds in the Breeder Seed Potato Farm, Mao, was launched under NEC, and the farm's size was further enlarged to more than 1054 acres. The farm, which is situated 6300 m above sea level, was built primarily to give Northeast Indian farmers' high-quality potato seeds.

The fact that two marketplaces in the state capitals of Manipur and Nagaland are named after the Mao community is evidence of the demand for the region's agricultural products. Even in the commercial centre of Nagaland, Dimapur, it is well-liked. Since these items are organic, most people choose to buy them. These markets do well selling a variety of fruits, vegetables, and flowers. Due to the fact that National Highway 2 runs by Mao Gate, numerous travellers make it a point to buy various agricultural goods. Figures 12.5 and 12.6 are the two market places located at Imphal (Manipur) and Kohima (Nagaland) where it is named after the Mao tribe.

Fig. 12.5 Mao Market at Imphal, Manipur

Fig. 12.6 Mao Market at Kohima, Nagaland

Numerous people attend the yearly Cherry Blossom Festival at *Okhro-Ikhro* (Mao Gate), which takes place in the fourth week of November. Despite the fact that it is a Cherry Blossom festival, the primary products that are sold there include different kinds of flowers (both dry and fresh), vegetables, and fruits. Throughout the year, flowers are exported to various locations in India. The important flower-producing regions include Kohima, Dimapur (both in Nagaland), Imphal, Senapati (both in Manipur), Shillong (in Meghalaya), Arunachal Pradesh, Mizoram, Kolkata, and Bangalore.

12.6.4 Indigenous Knowledge in Healthcare

Greater than 130 significant tribal communities are located in Northeast, India. The traditional medical system is still heavily used in most native societies (Sajem Betlu 2013). Additionally, tribes have a wealth of traditional knowledge about successful herbal remedies that they have learned through experience and are typically passed down orally as a closely guarded family secret (Chakraborty et al. 2012). Each distinct tribe has its own method of an indigenous healthcare system that has been passed down from generation to generation without a written record, but with the steady development of rural areas coupled with the attraction for a more lucrative job, the interest of the younger generations in this tradition is declining. All significant illnesses have been handled by the Maos in their own unique methods. Only roughly 50 years ago, did modern medicine and healthcare become available in the region. Slowly but surely, their society is losing its innate ecological wisdom, including its healing techniques (Sajem Betlu 2013).

Depending on the sort of illness, the Maos employ the stem, bark, leaves, and fruits of the entire plant as medicine. Fever and headaches are treated using the leaves of *Momordica charantia* (*Khenavii*, local name). People utilise this herb to cure numerous other ailments because it is so widely available (A. Lokho 2012). The fruit of *Rhus semialata*, also known as *Omoshii*, is used to treat diarrhoea and stomach issues. Even dried and preserved fruit can be used in the future. The fruit and seeds of *Solanum torvum* (*Modoro shiikhokha)* are used to treat a variety of ailments, including fever, colds, stomach aches, headaches, and even high blood pressure. It is unknown and fascinating how the Mao Nagas clear their voice cords in order to make a melodic sound using *Maesa indica (Kohravii*) leaves (Lokho 2012).

12.6.5 Indigenous Knowledge of Forests and Trees

When felling a tree for the Maos, extreme caution must be exercised. In order for the shoots to emerge when the time is appropriate, one must be careful when cutting at the proper length. The primary trunk is often preserved for the sprouts to grow for around 1 to 1.5 m. Seasons for cutting trees vary, as do the methods used. The preservation of forest land among the people of Manipur and the Northeast has even been promoted by student leaders and other groups. Trees have occasionally been carelessly cut down in the name of development projects. There are a lot of villages where it is against the law to fell trees located above the village. Bamboo is planted on the river banks by the Mao Naga community to prevent soil erosion. Bamboo does not have deep roots. As a result, they permit trees like *Salix tetrasperma* to cling to the grove's edge. Combining bamboo and *Salix tetrasperma* plantation in the most sensitive bio wall is to prevent soil erosion on riverbanks (Lokho and Narasimhan 2019). Even after years and decades, the bio wall along these river banks is still strong, and the elders tell the success storey to uphold traditions.

12.7 Indigenous Knowledge in Cultivation

A closer look at the Mao Nagas' geography reveals that there is no room for them to grow their territory because the lands around them are all occupied by the other Naga tribes that split out from Makhel. Due to their limited land resources and lack of room for expansion, the Mao Nagas have effectively utilised their territory. The Mao Nagas' use of terrace gardening is one of their resiliency tactics (Neli 2021). Most homes have terraced rice fields, but some farmers work on leased property (Jajuo 2013). Even other nearby tribes frequently sought the Mao Nagas' assistance for the construction of new terraces due to their competence in this area. Terrace field construction is a labour-intensive task involving a sizable workforce. It is handled as a communal concern (Neli 2021).

The Maos was fundamentally a cultivating society. Both the rich and the poor always own paddy fields (both wet fields and terrace fields), a forest, and other properties (Saleo 2008). The idea of competing with nature was viewed as unlawful (Daniel 2008). Terraced rice fields that were formerly dry have been left uncultivated recently. In the Mao area, between 2008 and 2012, out of the 300 homes in the survey, 34.7% of the households reported keeping some of their terraced dry fields fallowed due to insufficient rainfall (Jajuo 2013).

12.7.1 Terrace Cultivation

Construction of terraces or "steps" onto such slopes is known as terrace cultivation. In order to allow soil nutrients and plant life to flow to the following terrace, this approach helps prevent rain from carrying them away down the slope. Additionally, it aids in reducing water loss and soil erosion, and it promotes the growth of crops that need irrigation (Mazzocchi 2020). It is accurate to say that the Maos once practised *jhum* farming. The Mao Nagas, in contrast to many other Naga tribes, do not, however, enjoy the luxury of shifting crops due to limited land and population increase. They were required to make the most of the available space. It is perhaps interesting to note that even names of people are given in accordance with the schedule of agricultural activity. Being an agrarian community, practising *jhum* (slash-and-burn cultivation), along with terrace and wet cultivation (swidden cultivation), and paddy being the staple diet, seasons for carrying out various stages of agricultural operations become an inspiration for a person's name (Heshu 2018).

The North Eastern Council's first funded project, the Regional Potato Farm, was established in 1970 and is situated in the Mao region near *Pfukhro* (Song Song). The state government owns this farm outright and plans to use it to provide potatoes for the entire Northeast region (Kapesa 2017). We have enormous Mao Naga villages with a vast array of beautifully terraced fields that are gorgeously watered by water transported from a great distance in conduits that are so perfectly aligned. A field may be raised and watered by arduous labour, resulting in the gigantic terraces representing the expenditure of an enormous amount of energy and farming ability, as well as a great deal of practical engineering skill (Hudson 1911). *Jhum/* shifting cultivation is a primitive style of farming that has caused major environmental issues, including desertification, erosion of topsoil, loss of forest cover, and decreases in forest productivity (Rathore et al. 2010). The images shown in Figs. 12.7 and 12.8 depicts how alder and willow trees are planted amidst the cultivated areas and besides wet fields.

The fertility of the soil is decreased by ongoing agricultural activity, but it is recovered by keeping an uncultivated period. It has been discovered that cultivating and caring for *Alnus nepalensis* D Don, more commonly known as the alder tree, accelerate the rate of reclamation from a nutrient-deficient condition to a nutrient-rich condition in the research site (Chase and Singh 2014). Worldwide, it is well known that the fertility of tropical soils is deteriorating. Since soil is a finite resource, it must be preserved, improved, or both to ensure that it continues to serve a wide range of purposes (Chase and Singh 2014). The local communities have created distinctive indigenous farming systems based on local resources, such as *Zabo*, alder, and swidden, which increase conservation and the efficient and effective use of natural resources, to get around the challenges of the mountainous terrain (Singh 2010).

Since the Maos primarily cultivate on terraces, this requires for better methods of preserving the soil's fertility. The conversion of waste land into agricultural land

Fig. 12.7 Alder trees amid the farm

Fig. 12.8 Alder and willow trees

with this approach is fairly feasible because alder does not require highly fertile soil (Kehie et al. 2017). Pollarding alder trees is a common practise. Although there is no set standard for how high the alder should be separated from the main trunk, it is usual to leave it between 1 and 1.5 m above the ground. The remaining smaller sprouts are cut during the subsequent pollarding, which allows 3–4 chosen shoots to develop. By maintaining the soil's fertility in this way, alder trees benefit the populace while also promptly supplying firewood for the home.

12.7.2 Wet Field

Two different methods of terraced rice cultivation are used by Mao farmers, depending on the availability of water in the terraces: (1) wet terraced rice cultivation (*moko do)* and (2) dry terraced rice cultivation (*dothu do*) (Jajuo 2013). The water in the "*Moko do*" is continuously supplied by a natural spring or by rivers or streams via a tiny canal. It is typically placed where the soil can hold onto water all year round, such as on the edge of a riverbank or in an area with such soil (Neli 2021). After harvest, the paddy stems are never wasted or thrown away by the farmers. The

Fig. 12.9 Willow trees beside a river and close to a wet field

Mao Nagas use mulching to improve the soil, keep the soil moist, and to some extent, reduce soil erosion. This picture Fig. 12.9 clearly depicts the fact that willow trees prevents soil erosion near the riverbank.

The region where the Maos live does not have many or any large rivers. For the purpose of preventing streambank erosion in regions where scouring was prevalent, shrub and tree willows were mostly used (Wilkinson 1999). The 1986 Plant Materials Handbook for Soil Conservation and this chapter both highlight erosion control methods in which poplars and willows play a significant role (Wilkinson 1999). Many poplars and willows can withstand occasional soil saturation as well as flooding. Poplars and tree willows have deep root systems that may stabilise vast soil masses quickly. Upslope extension happens at about half the rate of across and downslope extension, while across and downslope extension occurs at a pace similar to the yearly height increment (in metres). For preventing bank erosion and the scouring or deepening of streams and hillside waterways, willows' thin fibrous root mat has proven to be the most effective. Instead of the huge rope-like roots of some poplar species and cultivars, a soil mass with a high proportion of fine fibrous roots is stronger and more effective at preventing soil erosion (Wilkinson 1999). The ability of tree willows to dry out marshy soils is well known among farmers. During the growing season, they have significant evapotranspiration rates.

> The roots of weeping willow trees generate a network of shallow roots that spread out from the tree in all directions. The roots of the willow can spread out from the trunk up to triple the length between the edge of the tree's foliage and its trunk. Willows characteristically produce foliage that is between 45 and 70 ft wide at maturity, with roots that can spread roughly 100 ft from the centre of the trunk of large specimens (Thompson 2018).

Poplars and willows are now universally acknowledged as the best trees for intense, short-rotation forestry in temperate zones, but willow osier short-rotation coppice culture has been practised since the dawn of civilisation (Dickmann and Kuzovkina 2014).

12.8 Landslides

The Mao area falls into High Susceptible Zone and Moderate Susceptible Zone. The sector between Karong and Mao of NH-39, Senapati district, Manipur, is vulnerable to landslides. Every year, particularly during monsoon, it experiences landslides that block the road for days together (Singh et al. 2011). The major landslides of recent times in Mao areas are at Mao Gate in July 2004, where thirty-three families had to be relocated. Another major landslide was at Shajouba village in September 2007, where many families lost their houses. There was another heavy landslide at Khongnem along Imphal-Mao National Highway in October 2020. Besides, constant and perinial road depressions occur along the National Highway area of Tadubi, Chakumai and Makhan.

Landslides are unpredictable natural phenomena and cause damage to property and loss of life (Singh et al. 2011). The roles of trees and forests in rehabilitating landslide-affected areas are also crucial because of the impacts of landslides on water resources and water quality (Singh et al. 2011). Tree planting on susceptible slopes can also reduce risk, while natural regeneration and planting on failed slopes can help control the after-effects of landslides, such as sediment release into rivers (Singh et al. 2011). The Mao Naga community plants bamboo and trees on the river banks to check and protect soil erosions and other natural disasters (Lokho and Narasimhan 2019). Bamboo is used while making contour bunding in both wet fields and dry terrace farming among the Maos.

12.9 Discussions

One cannot stop or reject the existence of many developmental works in the modern world. Future security has been seriously undermined for the sake of progress. Even the sacred sites and woods, which were conserved for millennia, have not been spared by these tendencies of numerous projects and upgrades. The pressure to exploit the resources in the sacred groves has continued to increase over time as the natural area outside the groves dwindles and there is a shortage of timber outside the groves (Ormsby 2013).The Inuit Circumpolar Council (ICC) is an organisation that works to preserve the value of indigenous knowledge in Alaska. It collaborates with the people and has had success with glacial retreats and numerous other climate change-related situations. Additionally, in 2012, it intended to visit Nepal throughout the Himalayan range to spread awareness of practical solutions to numerous climate hazard challenges (Huntington 2011). The next generation can be assured of a sustainable future if the world can benefit from the useful and successful ideas of various indigenous people. To make shared indigenous knowledge accessible to a larger audience, research academics, scientists, and intellectuals from a variety of fields must work together.

Jhum agriculture is primarily perceived as an exploitative system where the land and natural resources are not maintained in the best possible way and is regarded to be a major cause of deforestation and ecological instability (Gupta 2005). Huge woods are being cleared for agriculture, habitation, and kitchen gardens, which results in the loss of naturally occurring grass and willow-covered regions (Rawat and Everson 2013). On the other hand, there are sacred beliefs held by the elders that forbid cutting down trees on land near major roadways. This practise significantly contributes to the development of many ecosystem components and maintains a long-standing coexistence (Regassa Debelo et al. 2017).

One could respond that jhum agriculture is sustainable if one adheres to indigenous knowledge and practises correctly. But, the reality is that population growth is happening right now. Why continue using methods that hurt nature if there are better, more efficient ways to solve climate change? The investigation demonstrates how indigenous Mao Nagas' conceptions of reciprocal ecological coexistence are ingrained in their traditional beliefs, ideals, and practises. Tropical deforestation is recognised to be mostly fuelled by shifting farming on a global scale (Dasgupta et al. 2021).

Humans cannot prevent natural disasters like earthquakes and landslides in hilly terrain like Senapati district of Manipur, but people can take precautions to reduce the damage. More scientific could be carried out to study in detail to reduce and mitigate the damages of landslides in the present study area. Various indigenous practices of treating different ailments could be scientifically tested to improve upon and, if proven, could be adopted by other people. From the discussion above, one can safely conclude Indigenous Knowledge played a crucial role in maintaining the ecology of the Mao area. People were able to move from *jhum* cultivation because they became aware of the harm to nature. So when Indigenous Knowledge is perfected with scientific knowledge, one can be assured of a sustained future and even better tackled natural disasters in the process.

12.10 Conclusion

This chapter makes no claims that indigenous knowledge is sufficient for achieving sustainable development, but it does suggest that it will somehow help the global effort. The scientific community would undoubtedly benefit if the wisdom of indigenous people from around the world could be combined to address a variety of climate challenges. Locals in a specific location have knowledge that has been passed down through the generations for millennia. Working with indigenous peoples is something that scientists nowadays are finding to be highly beneficial. Due to the global climate change, people are now more aware of their views and information (Huntington 2011). The impact of climate change has been felt everywhere, from the Arctic to Brazil's deep forest, from the African rainforests to the forest in northeast India. Compared to other tribes nearby, the Mao Nagas have a little amount of territory. The scant natural resources have, however, been greatly preserved as a result of the abandonment of jhum/shifting farming. The cultivation of alder trees in arid regions has contributed to the preservation of the soil's richness. The need to move cultivable land becomes unnecessary as a result, which is good news for farmers. Scientific knowledge has played a huge role in enlightening the people, the harm of shifting cultivation and adopt terrace cultivation. When people become aware of the havoc caused by defective types of farming, people are compelled to adopt changes for the better. In the process, the Mao Nagas have learned to keep up the good practice of preserving trees, planting more bamboo for domestic use as well as preventing landslides within the limited area.

The world may not care that the Mao Nagas have stopped using *jhum*/shifting agriculture, planted alder trees in the parched areas, and planted willow trees along the riverbeds. The influence on the planet would be enormous, though, if various indigenous people from various regions used their own wisdom to ensure a sustainable future. Native Americans have an environmental-friendly and productive farming method called alder-based farming. Alder leaf is frequently pruned for biomass in the soil to feed the soil with nutrients as the crops are growing alongside the alder (Rathore et al. 2010). Dr. A. A. Mao asserts that the Mao Nagas have adapted to nature and are able to read its patterns like a book since they have learned to live in harmony with it. He urged interdisciplinary study to address climate change in the future remarks (Mao and Hynniewta 2011). Studying the indigenous ways and working to scale them up or incorporate their sustainable components and knowledge into our contemporary agricultural advances or technologies would be worthwhile (Pulamte 2008). In other places of the world where there is a similar issue, the innovative and successful method of one indigenous community might be shared and imitated.

Acknowledgements My special thanks to Dr. A A Mao, Director, Botanical Survey of India, Dr. Lokho Pfoze Jerome, Ph.D. in Bio-Chemistry, Dr. Fr Nepuni William, Principal, St Xavier College, Senapati, Mr. K. Sani Alexander of Chowainu village, Mrs. S. Esther Chiswute, Member of the Mao Flower Association for all the inputs and guidance during this undertaking.

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Chapter 13
Perspectives from Indigenous Knowledge in Sustainable Development: A Study on the Rajbanshi Society in the Sub-Himalayan Region of West Bengal

Krishnendu Roy, Anindita Barman, Bipul Chandra Sarkar, and Ranjan Roy

Abstract There is an urgent need to protect our environment and to ensure resource potentiality for our future generation as an important goal of sustainable development. Sub-Himalayan West Bengal is one of the most important biodiversity hot spots in the entire world. Very few places in the world have such a variety of plants concentrated in such a limited space. In this region, the Rajbanshi society plays an important role in conservation of the regional biodiversity. The Rajbanshi society has been coexisting with the surrounding biodiverse forests from very early ages. The culture of Rajbanshi people nourish and sustain themselves with various resources from the woods. From ancient periods, the concept of sustainable development has been latent in the folk culture of the Rajbanshis. The notion of sustainable development reflects from the day-to-day lives of them—farming, food habits, rituals, etc. Rajbanshi indigenous tradition contains symbolic and ethical messages that pass on from generation to generation in order to ensure respect and compassion for other living creatures. Here, we attempt to discuss their environmental ethics and beliefs that guide their understanding of how the natural world should be viewed and treated by humans.

Keywords Ethics · Culture · Sustainability · Indigenous · Rajbanshi

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_13

13.1 Introduction

The twenty-first century demands sustainable development. It is one of the key issues in any developmental and environmental discussion. It is the primary view of every country today. With progressing modern civilization throughout the world, biodiversity is also at stake. The natural ecological structure is facing hurdles in the current times. Due to major decline in plant, animal and insect population size, plenty of species are on the verge of extinction.

Ethics are the set of moral principles that guide the behavior of individuals and groups. Religion offers moral and ethical guidance helping in the development and sustenance of proper relationships among communities and even between people and surrounding nature. Darjeeling Himalayan Region or Sub-Himalayan West Bengal is known as one of the major store houses of biological resources. Traditional knowledge and experience of the ethnic communities dwelling in this region are also rich and diverse just as the plant species (Rai and Bhujel 2012). In this connotation, Rajbanshi society is one of the most important bio-friendly communities residing in Sub-Himalayan West Bengal. From the ancient periods, the concept of sustainable development has been inherent to the folk culture of Rajbanshi society. Sustainable development not only offers to sustain the present generation but also increases the resource availability to meet the needs of the upcoming generations; that is, it is a long-term plan. Its effects are supposed to be long-lasting and can be sustained for generations. There are three modes of sustainable development—environmental, social and economic. This article is an attempt to study the indigenous notion of sustainable development in the Rajbanshi culture of Sub-Himalayan West Bengal in order to access their age-old wisdom.

Several books, articles and monographs have been published based on Sub-Himalayan West Bengal and rituals of Rajbanshi society in English and Bengali languages. In 1849, Sir Joseph Dalton Hooker, one of the best botanists in the world, found out the different species in Sub-Himalayan West Bengal and evaluated the importance of this region in 'The Himalayan Journal' (Hooker). Sunder D.H.E. focused on survey and settlement of the Western Dooars area of Jalpaiguri district. Here, a detailed description about flora and fauna in the Dooars can be found Sunder (1895). Sanyal (1965) in his book 'Rajbanshis of North Bengal' (in Bengali) focuses on the livelihood and ethnicity of Rajbanshi people. In this book, he discussed their the then occupation, economy, rituals, folk art forms, folk literature, etc. Their oral traditions, especially the folk tales collected by the author, are presented as well (Sanyal 1965). Dr. Girija Shankar Roy in his book 'Uttorbonger Rajbanshi Kshatriya Jatir Puja Parban' (in Bengali) depicts that agriculture is the major way of livelihood adopted by the Rajbanshis. In this book, it is also mentioned that the Rajbanshis were also engaged in fishing and forest resource collection. The rituals, religions and festivals belonging to the traditional Rajbanshi culture are also discussed there (Shankar Roy 1970).

To prepare this manuscript, most of the relevant books, journals and articles have been considered and reviewed. The primary objectives of this study are: (1) to find out the relationship between Rajbanshi people and surrounding natural environment of Sub-Himalayan West Bengal; (2) to focus on the indigenous ideas of sustainable development in the Rajbanshi culture.

13.2 Study Area

Geographically, the area lies between the latitude 25°58′ N to 27°13′ N and longitude of 88° E to 89°52′ E. The geographical location of the Sub-Himalayan West Bengal is shown in Fig. 13.1. The area is situated in the northern part of West Bengal and shares international borders with Bhutan and Bangladesh to the north and south, respectively. The entire study has been conducted in the Dooars of North Bengal which covers parts of Jalpaiguri, Coochbehar and Darjeeling districts. The newly formed Alipurduar and Kalimpong districts are taken as part of Jalpaiguri and Darjeeling districts, respectively.

13.3 Materials and Method

In this research, we studied different rituals of the Rajbanshi society and plant diversity of Sub-Himalayan West Bengal. We found a significant relationship between the Rajbanshis and the biodiversity of this area. Both qualitative and quantitative data and information have been collected from different primary and secondary sources. All that information is analyzed, examined and represented in this work. The prerequisite of the study is to understand the socio-economic and cultural background of these villagers.

13.4 Rajbanshi Society and Environmental Sustainability

Sub-Himalayan West Bengal is one of the most important biodiversity hot spots in the world. In a botanical survey carried out in Jalpaiguri and Darjeeling districts (including Kalimpong and Alipurduar districts), total 3151 different species of plants have been found. Very few places in the world have such a variety of plants in such a limited space (Jagannath 1987). The Himalayan state of Sikkim and Darjeeling district and northern reaches of Cooch Behar and Jalpaiguri districts of the eastern Indian state of West Bengal are ecologically contiguous with this region, and together, they represent a unique region with unparalleled natural beauty, amazing ethnic diversity and a spectacular diversity of birds (Naturenomicsy, North East India 2016). D. H. E. Sunder report 1895 states that there are several species of mammals, reptiles, birds and fish in the region (Sunder 1895). From ancient times, the rituals and cultures of most Sub-Himalayan people of West Bengal are based on agriculture, which

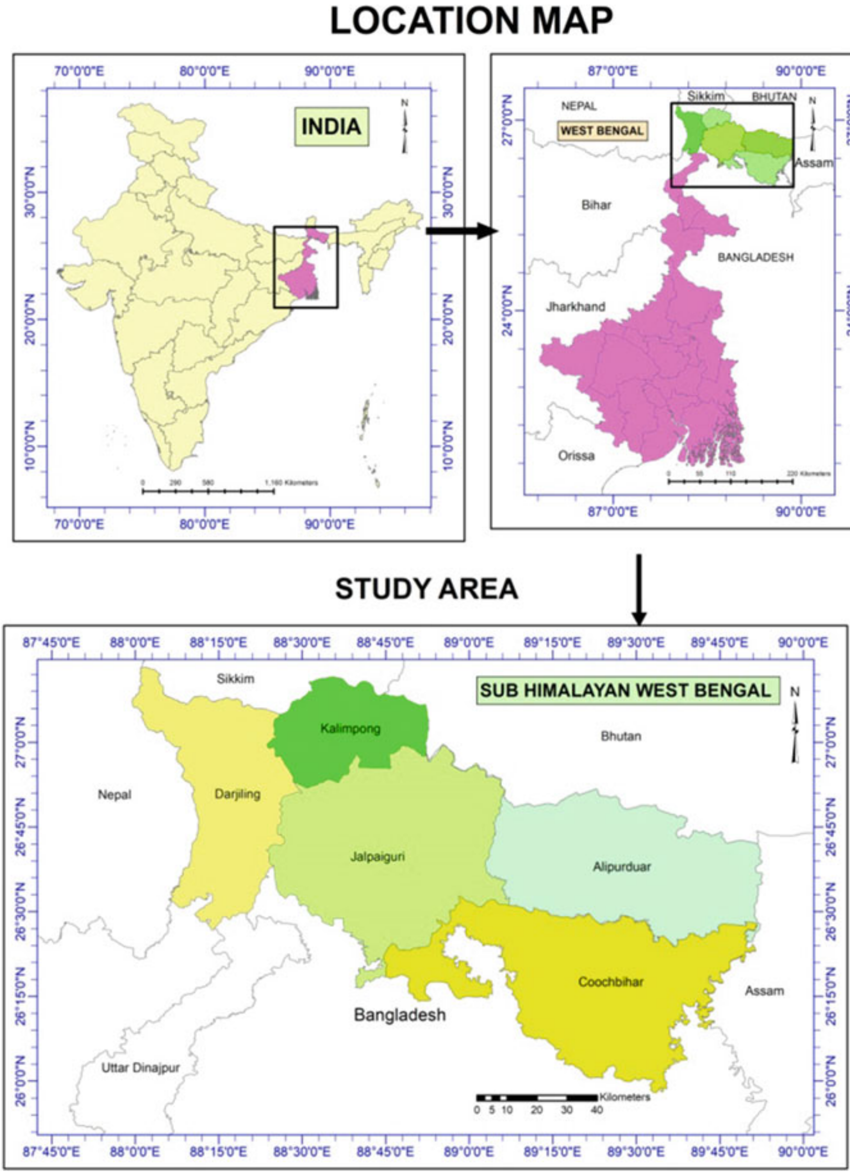

Fig. 13.1 Study area (Sub-Himalayan West Bengal)

depends largely on the annual rainfall. Various ethnic groups of North Bengal, such as Rava, Bodo, Garo, Kachari, Lalui, Dhimal and Tharur, primarily used 'Jhum' way of cultivation. Rajbanshi people used to be skilled in cultivation. They were able to cultivate in the jungle and wetlands of the vast regions of North Bengal (Roy and Roy 2014). Hence, the effects of biodiversity gradually increased in their society and culture. As crop production increased, the forest shrank in size. Destruction in biodiversity is primarily due to destruction of forest area. In this connotation, the demand for conservation of biodiversity has been increasing day by day.

13.4.1 Worshiping Plants as a Way of Diversity Conservation

Plants are worshipped almost everywhere in the world. From earlier times, the undeniable significance of plants is realized by the people in many different ways. Conservation of forest resources and preservation of biodiversity through plant worship are a remarkable phenomenon seen in the Rajbanshi society. In the Rajbanshi society, various plants are worshipped on various festive occasions. Rajbanshis used to worship Goddess Durga by planting the branches of 'mayna' (*Mayna laxiflora*) tree into the ground in Kamtapur (Sarkar 2014). Banana plant (*Musa acuminata*) is worshipped as goddess in the Rajbanshi Gachibuna festival. In this ceremony, Jute plant (*Corchorus capsularis*), 'Kachu' or Colocasia plant (*Colocasia esculenta*, schott), and 'Binna' grasses (*Juncus effuses*) are planted as a ritual of Puja. A 'Sal' tree (*Shorea robusta*) is worshipped in the form of 'Shalshiri'. In the Rajbanshi society, planting and worshipping 'Tulsi' (Ocimum Sanctum) plants in the South-East or North-East corner of the house is observed. During the 'Madanakam' worship, also referred as 'Bansh Puja', bamboo (*Bambusa stricta* and *Arundinacea*) is worshipped as god (Shankar Roy 1970). The devout couple from Rajbanshi society plant a 'Bot' or Banyan tree (*ficus benghalensis*)' and a 'Pakud' or Peepal tree (*ficus cordifolia*). Their marriage ceremony is arranged as a ritual (Roy 2019a). People from Rajbanshi society have been worshipping 'Jiga' (*Lannea coromandelica*) tree wishing long life of children and to prevent infertility of women. Rajbanshis worship 'Jurabandha Thakur' to block the 'evil eyes'. 'Tentul' tree (*Tamarindus Indica*), 'Sheoda' tree (*Streblus asper*), 'Kul' tree (*Ziziphus jujube*) and 'Jiga' tree (*Lannea coromandelica*) are worshiped as 'Jurabandha Thakur'. The pedestrians worship 'Jurabandha Thakur' with hanging bundles of dry grasses ('Jura') on these branches. These trees are also called 'Dhel Khaoya Thakur' (Shankar Roy 1970) and this is shown in Fig. 13.2e. 'Siju' plant (*Euphorbia antiquorum*) and 'phanimanasa' plant (*Euphorbia neriifolia*) are worshiped for a happy family. These trees are planted at the North-East or South-East corner of the house beside the 'Grriha Debata' (god or goddess deity on the home yard) and this is shown in Fig. 13.2f, g (Roy 2019b). In the Rajbanshi society, 'Dak Lakshmi' is worshipped as one of the agro-centric 'parbanas'. On this occasion, the paddy is worshiped as a deity. In the rice field, a special lamp or the 'Bhoga' is lit during this time. They believe the ‘Bhoga’ drives away the worms ensuring preservation of crops. The ‘Bhoga’ is shown in Fig. 13.2h. A list of few plants conserved and worshipped by the Rajbanshi society is shown in Table 13.1.

a) Gachibuna Ceremony

b) Bamboo Plant Worshipping

c) Marriage of Banyan and peepul tree

d) Worshipping Jiga tree

e) Sheoda tree worshipping

f) Siju plant worshipping

g) Phanimonasha worshipping

h) Worshipping paddy with ‘Bhoga’

Fig. 13.2 Various plants worshipped and conserved by Rajbanshi Society

Table 13.1 List of plants worshiped and conserved by Rajbanshis on account of religious belief

(Photographic and qualitative data and information have been collected from different primary and secondary sources in Sub-Himalayan West Bengal)

Deity/Festival	Vernacular name	Time and place of worship	Purpose	Regularity
Gachibuna	Paddy plant, Banana tree, Jute plants, Colocasia trees, Binna plant (vetiver)	On July–August at agricultural field	It is the occasion of first paddy plantation	Regular
Shalshiri	Sal tree	On May–June at forest	Worshipping for saving life from wild animals	Regular
Tulsi (Holy Basil)	Tulsi plant is worshiped as god	Throughout the year at North-East and South-East corner of house Worshipping for well-being		Daily
Medanakam	Bamboo tree worship	On April–May (right before a marriage or first rice ceremony)	Worshipping for happy and healthy family	Irregular
Bot-Pakur wedding	Worshipping Banyan and Peepal trees	During wedding where Banyan and Peepal trees are grown together	Worshipping for a baby	Irregular
Juraabandha Thakur	Tetul tree, Sheora tree, Kul tree and Jiga tree are worshipped as god	Any time beside the street	Worshipping for happy journey	Regular
Debir Than	Worshipping ‘Sheora’ tree	Where Sheora tree is located	Worshipping for happy family	Regular
Manasar Than	Worshipping Phanimanasa plant Daily at North-East or South-East corner of the house	At North-East or South-East corner of the house Worshipping for happy family	Worshipping for happy family	Regular
Shiber Than	Worshipping Siju tree	Daily at North-East or South-East corner of the house	Worshipping for happy family	Regular
Friendship with Jiga tree	Worshipping Jiga tree	Any auspicious day where Jiga tree is located	Worshipping for long life of children	Irregular

(continued)

Table 13.1 (continued)

(Photographic and qualitative data and information have been collected from different primary and secondary sources in Sub-Himalayan West Bengal)				
Deity/Festival	Vernacular name	Time and place of worship	Purpose	Regularity
H udum Deo	Worshipping Banana tree	Any auspicious day on June–August at agricultural field	Worshiping for Rain	Irregular
Biyao (Marriage)	Worshipping Banana tree	Any auspicious day at home	Worshipping for long life of the bride and groom	Regular
Mukhat bhat Deoya (First rice ceremony)	Worshipping Banana tree	Any auspicious day at home	Worshipping for a long life of children	Regular
Gamira	Worshipping Banana tree and Bamboo plants	Last day of Bengali year (Bisuya) at Gram dham or any ground	Worshipping for happiness of the whole society	Regular

13.4.2 Diversity of Plants Conserved as Traditional and Socio-cultural Activity

Rajbanshi society based at the Himalayan foothills is fully agriculture oriented. Forest and agriculture are the sources of almost all the worships in this community. 'Bishuya', 'Boishakhi' or 'Ashariseba', 'Amati', 'Jatra Puja', 'ksheti Laxmi Puja', 'pusuna', 'Buraburi puja, ° 'Charak' etc., can be called agriculture-originated worships. Conservation of biodiversity is rooted in the ancient Rajbanshi folk culture. There are notions of biodiversity conservation in livestock, food, farming, building houses and everything else in this society. There is a common saying, the house must have:

Uttorey gua
Dakkhiney dhua
Poobey haansh
Poccimey bansh

Translation: Areca on the north
Open on the south
Ducks (water body) on the east
Bamboo on the west

In this area, a cold wind stream blows from the north and sometimes storm rushes from the north. Hence, the Areca grove (*Areca catechu*) in the north serves as a windbreak. Refreshing wind blows from the south and this side should remain open. The sun rises on the east. The pond that serves as a source of water should get ample amount of sun, and also, the ducks kept in almost every household may swim on the water from the early morning hours. Storm comes from the western side on March–April. So bamboo groves are grown on the west (Sanyal 1965).

13.4.3 Tree Plantation, Festivals and Rituals

The last day of the month 'Chaitra' (Bengali calendar) is known as 'Bisuya' in the Rajbanshi society. That day is celebrated through various rituals. Various herbs are hung on the doors, such as 'Panimuthari' branches, 'Basak' leaves, 'Hargaji' branches, 'Bisti' branches, Gaza, neem leaves, garlic and onions. People believe that this ritual protects from airborne diseases, malicious insects and ghosts (Roy 2013). The ritual that includes consumption of different bitter leaves and vegetables is called 'Satsagi', where seven types of veggies are eaten. The number of veggies consumed may differ in different regions and it may vary from 12 to 22 types (Roy 2012). Jute, 'Helencha', Fern, 'Gandhavejal', 'Bathuya', Dholmanimuni, Pumpkin leaves, Khuriya, Bothua, Dhulpi, etc., are very popular. This ritual aims not only at the consumption of these vegetables but also at the conservation of them. Celebration of 'Bisuya' festival is shown in Fig. 13.3a. This day is a tree plantation day in Rajbanshi society. Variety of trees and vegetables like Bananas, Bamboos, Peppercorns and other plants are planted during 'Bisuya'. If there is no place for planting or if no initiative is taken about afforestation, then there is a ritual to at least put a handful of soil on the roots of plants. There is a saying 'Gorat dise maiti, Geise mathamathi' (Roy 2012) (putting soil at the base of a plant that will make a plant stronger). On that special day, Rajbanshi people start the ritual of 'Jhara'. This 'Jhara' ritual continues throughout 'Boishakh' month. 'Jhara' means a small porous earthen pot for water storage with little 'Dubbha' grass. During the whole 'Baishakh' month (Bengali month), the 'Tulsi' tree is enriched by infiltrated water from the porous mud pot (Roy 2008). This ritual is shown in Fig. 13.3b.

Different rituals of Rajbanshis like 'Paglapir Seba' (where 'Madar' flower is required), 'Jatra Seba' (where 'Jatrashi' leaves are required), 'Debi Thakurani Seba' (where 'Jaggya Dumur' is required) and Bisuya Parban (where 'Bisti' fruits and 'Panimuthari' leaves are required) are way of remembering different plants to

a) Hanging herbal branches during 'Bisua'   b) 'Jhara' ritual with Tulsi plant

Fig. 13.3 Celebration of 'Bisua'

Fig. 13.4 Worshipping Paan and Supari

conserve. Another thing is that they have been using 'Paan' (betel leaf), 'Supari' (areca nut), 'Durba' grass, 'Bael', sugar cane and mango leaves at that time of Puja or festival. In different festivals like 'Poush Parban' or 'Pusuna', they perform a ritual of putting 'Pitha Guli' (mixture of water and grinded rice) at the base of trees. Pan and Supari are worshipped as gods in plenty of other festivals as well (shown in Fig. 13.4). The root purpose of using these herbal products at the time of different festivals or rituals is to emphasize on the diversity of useful plants and conservation of biodiversity. In the different rituals, various plants that are conserved to be used by the Rajbanshis are shown in Table 13.2.

13.4.4 Folk Treatment and Biodiversity Conservation

Indigenous people have been using several plants for combating countless diseases for centuries, and they have developed a wide trust on traditional medicines. Unique medical approaches can be seen in Rajbanshi society such as remedies using plants, climbers, shrubs, insects and fish (Mandal 2011). Various plants utilized as medicinal herbs by Rajbanshi society are shown in Table 13.3.

Table 13.2 Plants conserved by Rajbanshis for rituals (Barman 2019a)

Name of the rituals	Vernacular name	Scientific name
Bisuya (Branches of herbs are hanged on the doors)	Panimuthar	*Similax rotundifoli*
	Peyaj (Onion)	*Allium ascalonicum*
	Rasun (Garlic)	*Allium sativum*
	Bisti	*Solanum violanceum*
	Basak	*Justicia adhatoda*
	Nim	*Malia azadirachta*
	Gaja	*Cannabis sativa*
	Satamuli	*Asperagus Setaceus*
	Hargaji	*Salsola longifolia*
Bisuya (for eating and drinking)	Ada	*Zingiber officivile*
	Bisti	*Solanum violanceum*
	Sukati (dry Jute leaves)	*Glinus oppositifolius*
	Chirata	*Swertia chiratia*
	Basak	*Adhatoda vasica*
Bisua (Satsagi)	Bathuya	*Chenopodium album*
	Lau sakh	*Lagenaria siceraria*
	Data sakh	*Amaranthus tricolor*
	Sajna	*Moringa oleifera*
	Ichar	*Artocarpus heterophyllus*
	Ushani	*Marsilea minuta*
	Amrul	*Oxalis corniculata*
	Grrima	*Glinus oppositifolius*
Jatra Seba	Jatrasi	*Justcia gendarussa*
Paglapir Seba	Madar ful	*Erythrina lysistemon*
Rakhal Seba	Madar ful	*Erythrina lysistemon*

According to herbal medicinal plant researchers, most of the herbal medicines of India can be found in this location. Researcher R.P. Nandi has found out 300 types of herbal medicines from his research from Indian Council of Alternative Medicine (Cheterjee). Indigenous People in different parts of the world value biodiversity for various reasons. They value biodiversity for reasons of human interest, as they believe it has material and spiritual values to human beings. As per their belief, biodiversity has immense value because it has the capacity to meet their diverse needs. Rajbanshi society has conserved the biodiversity in and around localities of their natural habitat.

Use of Organic Fencing in the Rajbanshi Society

In the Rajbanshi society, fencing with various shrubs is done to protect agricultural land, especially for the cultivation of Rabi crops and to prevent grazing. Verenda plants (*Ipomoea carnea),* white flowers (*Trachelospermum jasminoides*),

Table 13.3 Plants conserved by Rajbanshis in natural habitat and utilized as medicinal herbs (Roy 2019c)

S. No.	Vernacular name	Scientific name
1	Tulsi	*Ocimum sanctum*
2	Arjun	*Termnalia arjune*
3	Durba grass	*Cynodon dactylon*
4	Dandakalas or dhulpi	*Leucus aspera*
5	Bhado	*Cardiospermum helicacabum*
6	Akanda	*Calotropis gigantean*
7	Ulat Kambal	*Abroma angusta*
8	Bramhi	*Centella asiatica*
9	Golamarich	*Piper nigrum*
10	Kalakesarai (vrringa raj)	*Eclipta prostrate*
11	Grritakumari	*Aloe vera*
12	Thankuni Dhol manimuni	*Hydrocotyle asiatica*
13	Neem	*Tagetes erectab*
14	Gulancha	*Tinospora cordifolia*
15	Ganja	*Cannabis sativa*
16	Pudina	*Mentha spicata*
17	Sarpagandha	*Rauvolfia serpentine*
18	Dhutura	*Datura metel*

‘Siju’ plants, etc., are used to fence around the house or agricultural land. These fences are used as a long-lasting way to protect agricultural land. Bio-fencing with ‘Verenda’ plants is shown in Fig. 13.5.

Fig. 13.5 Bio-fencing with ‘Verenda’

a) Celebration of 'Verar Ghar Chuba'

b) Organic ingradients sprayed during 'Daak Laxmi Puja'

Fig. 13.6 Herbal pesticide and fertilizer usage in rituals

13.4.5 Use of Herbal Products in Everyday Life

Herbal pesticides and fertilizers are largely used in the Rajbanshi society; the house courtyard is cleared by sprinkling water mixed with cow dung. Herbal incense and 'Dhuna' (resin) made from tree gum and wood powder are used in different rituals and regular worship of Rajbanshi society. Hand-made insect killer machines and other instruments maintain ecological structure. 'Verer Ghar Chuba' is a ritual, before the 'Dol Purnima' (popular as 'Holi' Festival) in the month of March. In the agricultural field, piles of dry leaves are burnt during the festival in the evening. Ash is a good organic fertilizer. This ritual is shown in Fig. 13.5a. In the festival of 'Daak Laxmi Puja', the 'Jamuri' (sour lime, *Citrus medica*) leaf, 'khail' (paste of mustard seed, *Brassica*) and other organic ingredients, shown in Fig. 13.5b, are sprayed on the rice fields. It is said as a spell 'Aksor ha….! Poka makar dur hao! Sagare dhan tana mana. Hamar dhan kainchar sona!' (tell everyone, Insects, spiders get away! Everyone's paddy is weak! Our paddy is like pure gold) (Fig. 13.6).

They have a broad knowledge about plant diversity. The plants that are worshipped and used in rituals are mostly medicinal in quality. These plants are very valuable as per Indian Ayurveda. These medicinal plants are easily available in this region. Rajbanshi society has been conserving and worshipping these plants since ancient times. The major purpose of this effort is to mention a keen relationship between Rajbanshi people and the Sub-Himalayan West Bengal natural environment. According to indigenous belief, rituals and socio-cultural activities, the people of this society have always been compassionate to their biodiversity heritage and its value.

13.4.6 Worshiping Animals

The Rajbanshi society worships the animals as well as the plants. Respect, love and fear for the living organisms are associated with the worship of various animals. This respect, love and fear are favorable for preserving biodiversity. North Bengal once was covered with dense forest and thus was a breeding ground for wild animals. Forest animals are called 'Thakur' by rural people of Sub-Himalayan West Bengal.

'Mahakala Takur' is remembered for protection from tiger, bear or any ferocious animal. Elephant worship is another name of 'Mahakal Puja' in some regions. Incidentally, it should be noted that there is a regional custom of elephant worship in Mahakal Puja. It is assumed that Goddess Bhandani came into existence in order to abolish the fear of ferocious animal attacks from people's psyche. In any festival such as 'Nabankhai' or 'Nabanna', 'Pushuna' or 'Paush Parvan', first animals and birds along with god are offered first food ('pitha'). Animals and birds are worshiped on the day of Nabanna and Pushuna, and in a banana shell or 'dhona', food is served on the top of the shed for birds to feed on, which is called 'Mahabarik Seba'. Plus, foxes, dogs and other quadrupeds are provided with various foods outside on the roadside or near the forest. There is a custom of offering food to animals of the forest to prevent wild animal attacks during various festivals. This community worships 'Gojati' at different times of the year. Like 'Rakhal Seba' or 'Tereya Seba', 'Jatra Puja', etc. Almost every home of religious Rajbanshis has a 'thaan' of 'Hanuman Thakur'. This thakur is also worshiped as a village deity. In the worship of the regional deity 'Dang Chha Sanyasi Thakur', the tiger deity regionally known as 'Sanyasi Thakur' is worshiped along with Lord Shiva. Horses are worshiped along with thakur in the worship of regional deities of 'Deuniya Thakur' and 'Pagla Thakur'. The vehicle of various gods and goddesses of 'Sanatan' religion such as lion, elephant, snake, tiger, owl, peacock and duck have got their places on the 'bedi' (seat) of Thakur himself. A list of few animals conserved and worshipped by the Rajbanshi society is shown in Fig. 13.7. Animal worship along with various folk gods and goddesses is of particular note:

- Mahakal Puja (elephant worship)
- Bhandani (worship of wild animals)
- Tereya Seba (cow worship)
- Mahabarik Seba (worship of domestic animals and birds)
- Siyal kukurer Seba (worship of fox, dogs and other animals)
- Hanuman Thakur (worship of Hanuman)
- Dung Dhora Sanyashi Thakur (worship of tigers)
- Bhot Thakur (worship of horse).

13.4.7 Indigenous Knowledge and Waste Management in Rajbanshi Society

The Rajbanshi people are creative and disciplined by their own nature. From ancient times, the storage of various household garbage and their proper disposal methods are seen in the Rajbanshi society. Looking at a Rajbanshi household, one can observe three prominent ways of waste management—'Vira', a pit made on the ground and

a) Mahakal Thakur

b) Bhandani

c) Tereya

d) Mahabarik Seba

e) Sial Kukurer Seba

f) Hanuman Thakur

g) Dang Dhora Sanyashi Thakur

h) Bhot Thakur

Fig. 13.7 Worshiping animals

garbage dumped into it. ‘Vira’ can be used round the year. Three types of ‘veera’ are seen:

1. ‘Chhua Fela Vira’
2. ‘Jabura Fela Vira’
3. ‘Chan Fela Vira’.

Fig. 13.8 'Nakhiri' (a type of stick made of jute or bamboo sticks mixed with dung and rice bran)

Kitchen surplus food, vegetables are thrown into 'Chhua Fela Vira'. These are later used as agricultural fertilizer. Household wasted such as leaves, twigs and other wastes are put into the 'Jabura Fela Vira'. If this waste is dry and flammable, it gets used for fire in winter. Ash obtained is used as fertilizer in agricultural fields. People used to use this ash for brushing teeth as well. Domestic cow dung used to be thrown into the 'chan fela vira'. 'Nakhiri', a type of stick made of jute or bamboo sticks mixed with dung and rice bran (shown in Fig. 13.8), 'ghunte' (cow dung cake) made with these chickpeas for cooking. Cow dung was also used in agriculture. Due to the influence of time and touch of modern era, with excessive use of agricultural machinery and plastic pollution, these practices are on the verge of extinction.

13.5 Rajbanshi Society and Socio-economic Sustainability

13.5.1 Worshiping 'Gram Thakur'

The foremost objective of social sustainability is to 'build sustainable and harmonious communities'. The folk culture of the Rajbanshi society deserves special mention for maintaining social stability. If we evaluate the art and culture of them, a unique form of communal harmony emerges. The spirit of Hindu–Muslim brotherhood lies within the art and culture of the Rajbanshis. Communal harmony is woven fine into the cultural fabric of Rajbanshis. General review and investigation of folk artistry of

Fig. 13.9 Gram Thakur

the Rajbanshis sufficiently stand for a deeply rooted sense of tolerance and acceptance in their culture. Besides, 'puja-parban' are remarkable symbols of sustainable communal unity of the entire Rajbanshi society.

Economic sustainability is one of the integrated parts of sustainability. In its true essence, economic sustainability stands for optimal usage, safeguarding and sustaining resources (human and material) to create long-term sustainable value, recovery and recycling. In other words, we must conserve limited natural resources today so that future generations too can cater to their needs. Economic sustainability aims to neutralize extreme poverty and guarantee fair employment for all. Socio-economic sustainability is an integral part of the various principles of Rajbanshi society till date.

Gram Thakur is known to be a group of deities (folk gods and goddesses) placed within the village area. Among the various folk gods and goddesses of Gram Thakur, one of the special is a prominent deity called 'Pir Baba'. 'Pir Baba' was a Muslim saint. The worship of gods and goddesses of two different communities, Hindu–Muslim, in the same courtyard emerged as one of the great foundations of social stability (Shankar Roy 1970). In the 'Bansh Puja' (Bamboo worship) ceremony, each bansh (Bamboo) is considered as a symbol of a particular deity. In 'Madan Kam Puja' (bamboo play), each bamboo is worshiped as an individual deity; one bamboo is named after 'Madar Peer' who is worshiped by everyone (Fig. 13.9).

13.5.2 Mistor Dhora (To Make Friends)

The art and tradition of harmonization in Rajbanshi society are namely: 'Mistor Dhora'/ 'Sakha Hal' and 'Vadavadi'. On an auspicious day, two young Rajbanshi men establish an official friendship. This tradition is referred to as 'Mistor (friend) dhora', i.e., through a grand festival, as religious custom more than one man takes lifelong vow of friendship. People from non-Rajbanshi lineage are allowed to be included as 'Mistor' (Roy 2022). Even no caste discrimination is accepted in 'Sakhahal' festival. If two or more young men wish to be 'Sakha' or friends, facilitated by Adhikari or Rajbanshi priests, they can become friends. According to the custom, one Muslim

'Sakha' or friend is compulsory for each person to keep having more than three 'Sakhas'. Similar rituals are also seen in various other regions of Terai-Duars. For girls, the equivalent custom is 'Vadavadi'. Such a pure feeling of harmony and a rare picture of affinity among the people are precious lessons from the Rajbanshis to the rest of the world.

13.5.3 Pani Chhita Bap (To Make Son)

One of the rituals practiced in the Rajbanshi society is the practice of sprinkling water ('Pani Chhita Pratha'). At the time of marriage, the father or mother sprinkles water on the newly married couple on the stage of marriage. If a couple happens to have no parents, their relatives are supposed to perform this ritual instead. In special cases, a village well-wisher sprinkles water on the newly married couple as a father. The newly married couple respects that person for the rest of their lives and bears all his responsibilities. Even the kindhearted who sprinkled water on the couple accepts them as children (Roy 2010). Through these rituals, a pure bond of trust is established, which lasts for a lifetime.

13.5.4 Baapdaay (To Make Father)

In any troublesome situation, such as family problems, social, political or economic pressure or any major illness, if one surrenders to a respectable elderly person, and if that person accepts him / her as his offspring wishing to stand beside him/her in his/her difficult times, then birth of a relationship takes place (Roy and Roy 2014). Here, a huge room for generosity is provided within the society.

13.5.5 Pancha System

'Panch Pratha' is established to maintain social harmony and relationships in the rural areas. In social get-togethers such as marriage, feast and funeral ceremony, at least five other families from the same village must be invited. These invited families are believed to be spiritually connected to that family (Roy 2019c). Even if various family problems do exist, this 'Pancha' often attempts to resolve them.

13.5.6 Gua Khowa (Invitation for Having Betel Nut)

'Gua Khowa' ceremony is a ritual of having 'gua' or betel nut together with the neighbors as a festival. Women participation is more prominent in this event. One month after the delivery, this ceremony is usually arranged to seek blessings from the neighbors for the newborn (Barman 2019b).

13.5.7 Bahecha System

In the past times, the local Rajbanshi landholders (Jotdaar) used to possess a lot of agricultural land. Large-scale paddy production used to happen. People having no land used to work in those fields as agricultural laborers. Production and processing work was evenly distributed among them.

Generally, about 28-kg rice comes out of 40 kg (1 'mon') of paddy. The Jotdaars used to keep 22 kg of rice and rest about 6 kg was supposed to be given away to an individual laborer. Farmers could appeal for their part in advance in case of severe scarcity. This practice is called 'Bahecha System' (Roy 2019c). Through this system, Jotdaars get the rice without any hard work and are able to provide a quantity of rice to the landless agricultural laborers.

13.5.8 Baho

The land bearers used to invite the villagers to catch fishes from the wetlands or ponds on a particular day. This practice is called 'Baho' in the Rajbanshi diction. After the fishing is over, the villagers offer some fishes to the landlords (Roy 2019b).

13.5.9 Hauli

In the 'hauli system', villagers help each other in rice sowing, harvesting and any other agricultural activity. In this case, they do not charge any wages but get one lunch instead (Barman 2019b). This kind of practice helps to bring social and economic good relationships among the entire villagers.

13.5.10 *Bhanjh*

During the cultivation process, if there is a lack of bulls, landholders lend one or two cows from other farmers, this system is called ‘Bhanjh’ or ‘Panagoru’ in the Rajbanshi dictionary (Hosen).

Besides, all these above-mentioned Rajbanshis are known for other socio-economic views; that is, they have developed ways of preserving their crop and food in a scientific and sustainable manner. Various small-scale textile industries have also grown within the Rajbanshi community over decades. Additionally, in livestock farming, they have achieved notable success.

13.6 Conclusion

Indigenous rituals, ethics and practices of the Rajbanshis have remarkably contributed for sustainable development of the whole community. Today, the Rajbanshi society has been hit by modern cultural wave due to rapid industrialization and urbanization. With the advancement of technology, the socio-cultural activities of this society are mostly abolished. At the same time, the biodiversity of this region is under large crisis. With the rapid influence of mainstream culture and emergence of mechanical and chemical agricultural systems into the scene, the traditional ways are vanishing day by day. It must be really effective if both indigenous and new-age techniques coexist working synergistically. Observations and results from in-depth future researches could be useful to make effective decisions in policymaking with regard to conservation of biodiversity in India. If the folk culture of Rajbanshis is encouraged toward preserving the valuable biodiversity and establishing sustainable development of Sub-Himalayan West Bengal, the man–environment relation will become friendlier.

Acknowledgements We would like to thank Ketan Roy and Dhanajoy Barman for their valuable contributions in preparing this manuscript.

Appendix

Locations where the images of different Rajbanshi rituals are taken from

S. No.	Name of image	Location
1	Gachibuna	Paharpur, Rajganj, Jalpaiguri,
2	Madankam (Bansh Puja)	Bolbari, Mynaguri, Jalpaiguri
3	Bot-Pakur	Daker Kamat, Manikganj, Jalpaiguri

(continued)

(continued)

Locations where the images of different Rajbanshi rituals are taken from		
S. No.	Name of image	Location
4	Jurabandha Thakur	Garalbari, Rajganj, Jalpaiguri
5	Siju tree Worshipping	Uttar kalamati, Mynaguri, Jalpaiguri
6	Sheoda Tree Worshipping	Amguri, Mynaguri, Jalpaiguri
7	Phanimanasa plant worshipping	Ghegadabri, Kajaldighi, Mynaguri, Jalpaiguri
8	Verer Ghar Chuba	Changrabandha, Mekhliganj, Coochbihar
9	Bio-fencing with Verenda plants	Singimari, Mynaguri, Jalpaiguri
10	Worshiping Paan and Supari	Dinhata, Coochbehar
11	Bisuya Parbana	Pandapara, Jalpaiguri
12	Lamp or Bhogha in the paddy field	Tufanganj, Coochbehar
13	Mahakal Puja (elephant worship)	Amguri Ramsai, Mynaguri, Jalpaiguri
14	Bhandani (worship of wild animals)	Shingi Bhandani, Ramsai, Maynaguri, Jalpaiguri
15	Tereya Seba (cow worship)	Rakhalhat, Ramsai, Mynaguri, Jalpaiguri
16	Mahabarik eba (worship of domestic animals and birds)	Daker Kamat, Manikganj, Jalpaiguri
17	Siyal Kukurer Seba (worship of fox, dogs and other animals)	Daker Kamat, Manikganj, Jalpaiguri
18	Hanuman Thakur (worship of Hanuman)	Panbari, Ramsai, Mynaguri, Jalpaiguri
19	Dung Dhara Sanyashi Thakur (worship of tigers)	Amguri, Ramsai, Mynaguri, Jalpaiguri
20	Bhot Thakur (worship of horse)	Rakhalhat,Ramsai, Mynaguri, Jalpaiguri
21	Nakhuri	Daker Kamat, Manikganj, Jalpaiguri
22	Gram Thakur	Khemon hat, Ramsai, Mynaguri, Jalpaiguri

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Chapter 14
Climate Risk Management with Indigenous Knowledge and Perception—Evidence from Drought Prone Regions of India

Anindita Sarkar and Nairwita Bandyopadhyay

Abstract There are many indigenous and traditional knowledge systems that have been in practice for centuries among local communities of arid regions of India. Local communities use their traditional knowledge to predict drought and take agricultural decisions. Through evidence-based fieldwork and focus group discussions with the local communities in the villages on western Rajasthan and arid districts of Gujarat, this study tries to document all the indigenous practices and traditional knowledges that claim to predict drought and mitigate drought. The study shows that local communities can predict drought at a large extent that can be validated through meteorological and other scientific data. We argue there is no "one-size-fits-all-solution" because solutions take many shapes and forms, depending on the unique context of a community, specific challenges, and its location. While climate mitigation policies to reduce climate change are taken at the global scale and can be top-down, the climate adaptation policies need to be local and bottom up. Risk reduction and adaptation strategies need to be user-friendly in its application where local knowledge and scenarios are meaningful at the community level to help communities to manage their vulnerabilities while equipping themselves with the necessary measures to curb their future risks. If local people are made aware of and comprehend their exposure to risk and potential impacts, they can take the initiative to make decisions based on existing trade-offs. Thus, strengthening interactions among local communities, scientists and policymakers should be a key commitment to fosters effective and timely policy decision.

Keywords Climate risk management · Indigenous knowledge · Drought prediction · Climate change · Policy · Planning strategies · Local communities

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_14

14.1 Introduction

Knowledge and perceptions are intertwined and interactive components of climate risk management and adaptation. While indigenous knowledge is accumulated through understanding and learnings from past experiences, perception is a reaction to specific events or processes evolving out of culmination of subjective judgements. Though there is a broad agreement in theory that farmers' expertise and their indigenous knowledge should be integrated into discussions of climate risk management and climate change adaptation in the food systems (UNISDR 2015), much less of such indigenous knowledge has been documented or has been integrated in these recommendations.

Farming is an ancestral skill in most parts of global south. Farmers' knowledge evolves through generations of practice, multi-actor networks, and complex institutional access to formal and informal knowledge network. Farmers are also more aware of local climate conditions, their own livelihood vulnerabilities, and trade-offs which the higher-level institutions may not have access (Carolan 2006). Moreover, livelihood of farming communities is often the first to be affected by climate impacts (FAO et al. 2018), and therefore, adaptation is most often based on local knowledge and situation. Thus, it is important to value those local ecological knowledge that evolves through tacit understanding of the biological and ecological processes over the generations that is fundamentally inaccessible to anyone other than the farmers (Berkes 2009).

In the recent scholarship, there is a call to improve the integration of indigenous and local knowledges with scientific models in land management and climate adaptation (Bennett 2016; Berkes and Ross 2013) because farmers' knowledge, though often informal, is deeply informed, and therefore valuable additions to regional adaptation planning (Morton et al. 2017; Sumane et al. 2017). International organizations also have called for farmers' knowledges to be recognized as a valuable contribution to understand climate change risk and adaptation (FAO 2016). There is renewed enthusiasm among local communities from across the globe who are coordinating efforts to reclaim authority over their knowledge systems and practices.

There are many indigenous and traditional knowledge systems that have been in practice for centuries among local communities of arid regions of India. These traditional belief systems arise from their social, ecological, and institutional contexts and lead to perceptions and understanding of nature. In order to make local people more aware of the scientific concepts of climate change and engage them in action for its solution, it is necessary that scholars and policymakers have comprehensive understanding of people's beliefs and how this understanding is formulated and built on. Since India is diverse, farmers' knowledge, perceptions, and adaptations are also likely to differ spatially. Therefore, to achieve sustainability, there is a pressing need to create a constructive and comprehensive knowledge base for decision-making by identifying and integrating the heterogeneous information. This paper is an attempt to gather, document and present such local indigenous knowledge, perceptions, and understandings to the climate change literature.

14.2 Literature and Background

Perception is a cognitive process that involves receiving sensory information and interpreting it. It is believed that farmers use their indigenous knowledge to perceive the changing behaviour of climate and make possible changes in their livelihoods in general and farming practices in particular (Bwambale et al. 2021). Farmers' perception of climatic changes has been recognized as a pre-condition for local adaptation actions because farmers who perceive climate change and its detrimental effects are more likely to take proactive actions (Alam et al. 2017). The accuracy of perception is a necessary condition for a meaningful response, which eventually depends on knowledge, experience, and access to information. It is because steps taken based on wrong perception could have an adverse effect on both nature and people dependent on nature.

The term "Indigenous knowledge" has been interchangeably used as "traditional knowledge" and "local knowledge" in literature. It is defined as "a body of knowledge existing within or acquired by local people over a period of time through the accumulation of experiences, society-nature relationships, community practices and institutions, and by passing it down through generations" (Mercer et al. 2010, p. 217). It is "a body of different types of knowledge and practices of societies accumulated through a continuous interaction with their natural surroundings" (Cuaton and Su 2020, p. 2). UNESCO (2018) defines local indigenous knowledge as "the understandings, skills, and philosophies developed by societies with long histories of interaction with their natural surroundings". Indigenous knowledge is both dynamic and adaptive in nature. It is dynamic because it is formed through years of experiences of local people through generations (Sin 2017) getting continuously influenced by the users and its interaction with nature evolving over time (Flavier et al. 1995). Indigenous knowledge thus refers to the understandings, skills, and philosophies of indigenous peoples, developed through long and multigenerational histories of interactions with the natural world and adapting to highly variable and changing ecological and social conditions.

The scientific knowledge is developed through a formal evidence-based technical systematization of information supported by explanations of phenomena (Bwambale et al. 2021), local indigenous knowledge is context-specific, acquired experientially over generations, grounded in the sociocultural context and its outcomes are based on understanding of the natural realities to address issues of everyday living. Though indigenous knowledge has greater time depth and wider cultural purchase, it is often more abstract, independent of their application, and is embedded in a variety of knowledge sub-systems (Brodt 2001).

Some scholars feel that the indigenous knowledge often gets lesser value and legitimacy than knowledge derived from dominant societies and cultures. Either information on indigenous knowledge to scientists and policymakers is limited or the underlying belief systems and environmental ethics of indigenous knowledge systems are antithetical to the capitalist economic systems. (Ford et al. 2016). However, local and indigenous knowledge needs to be integrated with science before it can be used in policies, education, and actions related to disaster risk reduction and climate change impacts (Hiwasaki et al. 2014).

Local indigenous knowledge has been recognized in the global disaster risk reduction frameworks, since 1994. The Yokohama Strategy and Plan for Action in 1994 identified traditional methods to "supplement" and "reinforce" scientific knowledge for reducing disaster impacts (IDNDR 1994). The Hyogo Framework for Action in 2005 incorporated local indigenous knowledge to support and provide understandable risk information complimented by scientific and technical DRR capacity (2005) that was further presented to "complement" scientific knowledge in risk assessments and policy developments in Sendai Framework (UNISDR 2015).

There are few studies that examine ethnographic research on indigenous climate knowledge that has relevance for its application of scientific climate forecasts (Roncoli 2006). For example, Cruikshank (2005) shows how indigenous knowledge can provide information that scientists find useful for research. Several studies suggest that indigenous climate forecasting methods can offer additional insights in improving the accuracy and efficacy of scientific seasonal forecasts (Luseno et al. 2003) because indigenous forecasting methods are need driven, focus on the local weather on the timing of rains, communicated in local languages, and typically disseminated by "experts" known and trusted by local communities (Luseno et al. 2003). For such reasons linking indigenous knowledge to climate change science is one of the best ways to involve local communities for effective prediction (Berkes and Jolly 2001) and information dissemination.

Indigenous knowledge of weather forecasting and observed impacts of climate change is shaped by experiential learning and perceptions. Perception has been described as referring to a range of beliefs, judgements, and attitudes (Slegers 2008). Much research has indicated the importance of understanding how climate variability is perceived by farmers and what shapes their perception to prompt adaptive behaviours (Zampaligré et al. 2014; Weber 2010; Mertz et al. 2009; Slegers 2008; Banerjee 2014). Studies have indicated that local perceptions of changes in the climate based on local climate parameters and of extreme climatic events are similar to the observed climate data and scientific meteorological analysis (Alam et al 2017; Ayanlade et al. 2017).

The importance of farmers' perception of climate change in farm-level adaptation literature is also widely recognized (Kawadia and Tiwari 2017; Singh 2020). Studies from different parts of the world have also shown that farmers cope with climate change based on their perceptions (Li et al. 2017; Abid et al. 2015). Farmers who perceive climate change and its detrimental effects are more likely to embrace policy initiatives to address it (Alam et al. 2017). However, misleading perceptions can cause inappropriate adjustment measures (Taylor et al. 1988) and does not always guarantee adaptation measures (Gbetibouo 2009) as several factors jeopardies their ability to adapt. However, literature does not substantially confirm that farmers' adaptation measures result from their perception of climate change (Datta and Behera 2022).

Most studies that document indigenous practices of local communities and its ways to conserve environment and deal with natural disasters are located in Africa (Chang'a et al. 2010; Egeru 2012). Before the establishment of scientific weather forecasting, older generations had largely relied on indigenous knowledge to predict weather (Kadi et al. 2011) through observation and monitoring the behaviour of animals, birds, plants, and insects (Kihupi et al. 2002; Mhita 2006; Acharya 2011). A combination of plants, animals, birds, insects, meteorological, and astronomical indicators was commonly used for assessment and prediction of droughts (Galacgac and Balisacan 2009; Chang'a et al. 2010; Acharya 2011; Egeru 2012). Some studies also report the combined use of scientific and indigenous climate forecast information for farm-level decision-making (Lucio 1999; Ngugi 1999) particularly with respect to disaster prevention through early warning and preparedness (Roncoli et al. 2002) and integrating contemporary and indigenous climate forecasting for coping with drought (Shumba 1999). While some studies observed local perceptions of climate change and variability consistent with scientific data (IWFM 2012), some do not (Mulenga et al. 2016; Chen and Whalen 2016; Ochieng et al. 2016 and Panda 2016).

From the review of studies from India, it appears that the Indian farmers have perceived climate change and variability in rainfall that are in most cases consistent with the meteorological data. In this context, maximum studies reported that farmers perceived temperature warming, decreased rainfall, delayed onset of monsoon, and erratic rainfall patterns (Datta and Behera 2022; Acharya 2011; Panda 2016). Still today local communities of arid regions of India predict drought and take cropping decisions based on their perception and traditional knowledge rather than advanced scientific techniques (Banerjee 2014).

Although indigenous knowledge systems are recognized as critical resources for understanding climate change risks and adapting to climate change, no comprehensive, evidence-based analysis has been conducted. Against this background, this paper documents and analyses the indigenous knowledges which the farmers in the semi-arid areas of India (western Rajasthan and Gujarat), use. We show how they use this knowledge to perceive, monitor, mitigate, and adapt to drought, that is the most pervasive disaster in the semi-arid climates. We examine whether the farmers actively use their indigenous knowledge on indicators of drought to adapt their practices or not.

14.3 Methodology and Sampling Methods

This study is based on mixed-method approach. We selected six villages of Gujarat and five villages of Rajasthan where temperature and rainfall played a major factor, contributing to regular occurrences of drought and depleting underground water table (see Table 14.1). A structured questionnaire was used to collect farm household-level information related to their local knowledge on drought prediction, climatic variability, climate change perception, and socioeconomic attributes. Focus group discussions (FGD) were conducted to substantiate this information and to understand the villagers' drought perceptions. For assessing farmer's perception of changes in precipitation levels, farmers were asked, "Have you observed any long-term changes in the mean rainfall over the last 20 years?" Our intention was not to distinguish

Table 14.1 Location and listing of villages in the study area

District	Villages
Gujarat	
Mehsana	Kothasanamota
Sabarkantha	Nanakantharia and Laxmanpura
Banaskantha	Idata and Lodhrani
Kutch	Berdo
Rajasthan	
Jaisalmer	Hamira, Keeta, Daobla
Jodhpur	Rampura Bhatia
Barmer	Patodi

between the perception of long-term climate change and short-term variability, rather we wanted to capture farmers' perception of the changes in meteorological variables which may help them in identifying their susceptibility and to act accordingly.

14.4 Study Area

Rajasthan and Gujarat are situated on the western side of India. Parts of both the states are drought prone because of low precipitation that is received throughout the year and specially during monsoons. Both the states witness drought in every 3–4 years with severe problems of water scarcity. Climate variability is expected to increase in erratic precipitation, increasing average temperature and evapotranspiration, accelerated desertification, and land degradation. Western districts of Rajasthan experience successive years of scarcity resulting in drought. It not only results in moisture stress, that lead to agricultural losses but also impacts the social and economic life of the people. Persistent subsidence of rainfall, failure of normal onset of monsoon, and erratic behaviour of distribution lead to scarcity. Notably, Rajasthan is the largest state of India with 6.57% of the country's population and 1.15% of water resources with 66% of area designated as desert. 33% of the villages in Rajasthan is covered under safe drinking water with an average of 26.9% rural households with safe drinking water in these villages. Existing literature has documented climate variability in Rajasthan in terms of an expected increase in erratic precipitation (Singh et al. 2010a, b), increasing average temperature and evapotranspiration (Mall et al. 2006) and accelerated desertification and land degradation (Ajai Arya et al. 2009). All these factors coupled with low rainfall, increasing population and groundwater exploitation, will lead to severe problems of water scarcity in the state in future.

Gujarat is one of the most prosperous states of India. It is the fifth largest state with 5% population and 2.28% of the country's water resources. Dependence on vagaries of seasonal rainfall and climatic conditions with high diurnal temperature makes Gujarat vulnerable to climate change (Bandyopadhyay 2017). During the last three decades (1981–2010), the number of heat waves in Gujarat has been considerably high with moderate and severe heat waves affecting lives in the years 1990, 1995, 2001, 2002, 2004, and 2010. In major parts of northern Gujarat, an appreciable rise in temperature coupled with deficient rainfall has been observed in the last decade (2001–2010). It has also been observed that the frequency and intensity of droughts have increased in the state over the years, resulting in serious drinking water scarcity (Roy and Hirway 2007). Out of every 5 years, 2–3 are drought years in Gujarat, and drought becomes severe and widespread in 2–3 out of every 10 years (Vora and Parikh 1996). Occurrence of heat waves and high temperatures is also noticed in most drought years. As a result of extreme climate, fall in groundwater table has been observed over a period of last thirty years putting immense pressure on groundwater table and demand for fresh water for drinking and household.

14.5 Analysis and Discussions

This section aims to document indigenous knowledges for drought and rainfall prediction. It also discusses the various spiritual and religious practices to usher in rainfall and mitigate drought. The underlying causes and scientific explanation for such behaviour are also attempted to unravel the hidden and lost traditions with time.

14.5.1 Documenting Indigenous Knowledge for Drought Prediction

Indigenous knowledge is borne out of continuous experimentation, innovation, and adaptations, blending many knowledge systems to solve local problems. We observed that villagers used locally observed variables and experiences to assess and predict drought in Western India which they have been doing through generations. These observations are in most cases passed on through older generations to the present generations; and younger generations experience it through their own observations. This solidifies their belief in their local knowledge of drought prediction. It is amply clear that these indicators of drought or indigenous knowledge of drought prediction are informal and, in most cases, lack scientific explanation. It is also true that since this indigenous knowledge is only passed by verbal communication and lacks documentation, it never reaches the scientific community for analysis and validation. We observed a combination of plants, animals, meteorological, and astronomical indicators that were commonly used for assessment and prediction of drought in our study area.

Observing the pattern and time of arrival of monsoon[1] is the most popular way to predict drought in both western Rajasthan and Gujarat. Farmers usually count the number of rainy days during the month of May to September to understand the intensity of drought. However, it is interesting to note that the farmers of Gujarat observed delay of rainfall for 15–30 days after *Diwali*[2] as an indicator to drought while farmers in Rajasthan associated early arrival of monsoon with drought.

As a coping mechanism, the farmers of Gujarat have shifted their farming and crop calendar by a month and postponed all agricultural activities after observing the same pattern of rainfall for last five years.

Farmers in Rajasthan claimed that they could smell moisture in the soil and air to understand if rain is coming. They could sense the pattern of rainfall by associating it with the wind direction. In FGDs, they claimed that if wind blows west after *Holi,*[3] there will be no rain, and if it blows north after *Holi,* there will be more rainfall. Holi is a festival typically celebrated in the month of March in India. This indicates that the farmers have observed change in rainfall pattern in the EL-Nino and El-Nino years. Due to change in ocean circulation, El-Nino years bring droughts and La-Nina phenomenon which brings flash flood and more rainfall. During EL-Nino more wind movement happens towards the west or to the Arabian Sea. With the change in wind direction in this phase, dry winds blow over the surface water brining no rainfall. Whereas during the La-Nina phase, the heating of the ocean water happens in the Pacific and the winds blow from the east and north-east direction as these are mostly easterlies. These winds are more moisture laden and brings more rain on the land. In Gujarat, farmers observed if the wind blew haphazardly, there will be untimely rainfall.

Farmers in Rajasthan observed intensity and timing of fog to determine intensity and arrival of rainfall. In the focus group discussions, they said, during winter months if there is less fog than usual, it indicated an approaching drought year whereas if fog is observed in early morning before rainy season, then there will be more rainfall in coming year. Few respondents observed that in the month of June (when sun enters in *Rohini Nakshatra*) distance between sun and the earth is minimum and they are the hottest days in the year. If they could smell more moisture in the air, then it would raisin few days.

Farmers in Gujarat measured intensity of drought by observing water levels in their wells. One farmer remarked, "Water can be found till 115 feet, beyond which there is granite, which doesn't let water percolate". It shows that these farmers are aware of the type of rock and the kind of aquifer. Science has established that rocks such as granite and schist are generally poor aquifers because they have a very low porosity. When groundwater systems are affected by droughts, first groundwater recharge, and later groundwater levels and groundwater discharge decrease (Mishra and Singh 2011). Therefore, most often a groundwater drought is defined by the decrease of groundwater level (Chang and Teoh 1995).

In Rajasthan people predicted droughts by observing starts and moons. When *Shravan* (July and August) is at its end, and on the fifth day from the new moon in early morning if sun rises during rainfall, it is said that in the Malva region,[4] there will be good rainfall and Mewar region[5] there will be drought. Some villagers also observed shape and brightness of the moon to predict drought. Similar studies have also observed shape and light around moon and dimming starts to predict droughts (Galacgac and Balisacan 2009).

Plant behaviour like bearing of fruits and flowers, growing of shoots, and leaf characteristics are used by the local communities to predict weather and climate in Rajasthan. For example, absence of blossoming of *Tulsi* flower (Holy Basil), bearing of a smaller number of fruits in neem tree, large number of fruits in Ker plant, undergrowth of *Sangri or khejadi* trees and abundant growth of *Akara, Aankta, and Ker* plants are associated with an impending drought. Conversely, abundant blossoming of *Tulsi* flower, large number of fruits in neem and *Sangri* trees, luxurious growth of *Sangri or khejadi trees* and occurrence of prop roots from the banyan tree is associated with abundant rainfall. In both Gujarat and Rajasthan, behaviour of eucalyptus trees is used to predict rainfall. While luxuriant growth of eucalyptus indicates good rainfall, its leaves turning pale very early in winter suggests poor rainfall. A good rainfall is predicted by the villagers when they see goats starting to move towards north, sheep walking in the opposite direction of the wind, occurrence of many herds of nilgai and frequent movement and changing colour of chameleons, frequent chirping and singing of *palam* and peacock during summer months and laying of plentiful eggs by local birds. Respondents from Rajasthan also stated that sounds of certain birds like *seghul, neelkanth, sonchiriya,* and "*Palam chidi*" particularly their perching and chirping patterns provides them helpful knowledge regarding timing of rainfall and intensity of drought. From FGDs, we learnt that certain phenomenon like change of black colour of *chakli* bird (Indian Robin/sparrow) into blue, sparrows sitting on empty branches, no singing of *palam* bird, absence of migratory animals and birds in the village, laying of eggs by *titri* bird faced upward from the ground, excessive eating of grass by cows and milk by calves, cows bringing fodder in their mouth inside shades, birth of more male calves and untimely death of many livestock signifies scanty rainfall and an approaching drought.

14.5.2 Documenting Rituals to Predict and Mitigate Drought

Some studies suggest that spirituality and taboos can influence resource governance in many ways especially in encouraging collective efforts in resource utilization, protection, and nature preservation (Cutter et al. 2008 and Mowbray 2012). From our interviews with respondents and from FGDs, we also observed various rituals and religious practices that are performed to predict and mitigate the adverse effects of drought. *Akha Teej* is a Hindu festival that is celebrated during June–July to welcome the monsoon and the rains in arid parts of western India. On this occasion several, rituals are performed to predict rainfall. Five earthen lamps representing five monsoon months (June to October) are filled with water and are observed for five consecutive days. The order in which the lamps break signifies the month in which rain will come. On *Akha Teej*, in the afternoon, food and water are brought from all the neighbouring houses and are kept in small pots in one common area. It is believed that the farms of the house whose pot breaks first will receive the first rainfall of the year. Small heaps of home-harvested grains are kept on the ground. Then these grains are inhaled thrice from each heap. Odd number of grains inhaled signifies good rainfall and even number of grains inhaled signifies very low rainfall in the coming season. Sometime in April and May four small sized earthen pots are filled with water and buried underground. They are dug open after 4 months. If the pots remain as it is, it indicates drought. If the earthen pots break and water is spilled, it indicates good rain. Water is poured in small earthen pots with force. The direction of the first wall to collapse indicates the direction of clouds and intensity of rainfall. A religious practice called *Dhani Chardhna* is performed during *Akha Teej*. Two bamboo sticks, one red and one black, are held by two boys in their armpits facing each other. The priest chants religious prayers. If red stick falls on the black that means there will be a rainy season, and if black falls on the red stick, there will be drought. Though it is hard to find any scientific correlation or meteorological implication of such popular religious practices and beliefs to rainfall and droughts, they have their own local significance. This "spirituality" comprising traditional practices has far-reaching benefits in resilience building. For instance, Cutter et al (2008) and Mowbray (2012) have shown how the human spirit of resilience is often invoked by what cannot be changed. While spiritual solace may not be replaced by acts of adaptation to climate related disasters, it can definitely be a useful form of cultural capital that influence and shape the perception of risk and shock (TAF 2012).

We found that farmers' perception about drought in Rajasthan is mostly based on religious belief and weather-related factors. The older farmers perceived significant variation in temperature and precipitation, while younger farmers with less farming experience did not believe this change or were simply not sure. Most of the people who did not form expectations from indigenous knowledge mention God as the source of rain and indicate that God's actions cannot be known. Farmers generally agreed that the rain comes from God and the supernatural powers decide when and how much it will rain. When we asked about how people could predict drought, the common phrases were "it is God's will" and "Rainfall is in the hands of almighty". They believed God had to be satisfied with prayers, rituals, and sacrifices so that the farmers are not punished by low rainfall. In Gujarat, *yagna,* a ritual of sacrifices, is carried out by Brahmins to please rain God. Many perform *havan*, the fire ritual. In some communities in Gujarat, people sit on a huge cooking utensil filled with water or take out a funeral procession of a person who is still alive to please the rain God. In Rajasthan, after the *holi*, the priests in temples perform *havan to* worship the deity "*Bhaumiya*". Among Brahmins, a ritual called "*Hakra Bokra*" is performed in which balls of flour are made and thrown in four different directions to please God. In Gujarat, the frogs in the villages are married by a priest and later released in the river. The local communities believed that wedding of male and female frogs would bring rain in the area. In Rajasthan, certain omen is also associated with a good rainfall year. At the time of sowing, if a farmer sees a sack of grain or newly married women, it indicates good rainfall and a good harvest. Many people also associate a certain kind of babbles of infants during the morning to approaching rainfall.

Several other studies have also observed and documented local communities' religious beliefs and practices as an important factor in understanding and responding to natural hazards in many parts of the world (Schmuck 2000). Fara (2001) argues that traditionally natural hazards have been seen as "act of God" or as exoteric forces against which humanity had no defence. However, in our study, there is no incompatibility between belief in God and a reliance on indigenous knowledge, in local people's views. Rather, they explained that God created an orderly world with regular patterns and signs for humans to observe. Daily conversations and group discussions reflected a shared value for showing respect to God.

14.5.3 Perception of Drought and Scientific Explanations

Perception has been described as referring to a range of beliefs, judgments, and attitudes (Slegers 2008). The Cambridge Dictionary describes the meaning of perception as "a belief or opinion, often held by many people and is based on how things seem". Datta and Behera (2022) narrated perception as an act of being conscious of one's surroundings through sensory experiences, and it indicates a person's ability to understand. Our understanding of the literature suggests that four coherent elements comprising of experience, memory, expectation, and definition shape the farmers' perception on droughts and rainfall (Taylor et al. 1988). We were aware that drought has different meaning to respondents based on their physical environment, type, and degree of involvement in agricultural activities, and level of impact on their financial well-being (Dagel 1997; Ashraf and Routray 2013).

In our study, farmers were asked in their local languages about their perception of drought and its impacts on their socio-economic activities. We asked an open-ended question: "What does drought mean to you?" In Gujarat, drought is called as "*Dushkal*" or "*Dukal*" and "*Akal"* or "*Jal Akal"* in Rajasthan in their respective local languages. Both these terms literally mean time of scarcity or water scarcity. Farmers could identify drought in both Gujarat and Rajasthan. In Rajasthan, younger generation identified drought with meteorological drought whereas for older generation equated it with agricultural drought and famine. In other words, younger respondents associated lack of rainfall with drought whereas older respondents believed a drought comes when their crops have failed due to lack of rainfall, there are food shortages and livestock is dying in the village. Though more than 80% of farmers perceived drought as a natural phenomenon, few perceived it as a mismanagement of water resources by the local people and the responsible authorities. Irrespective of the location, most of the respondents believed that drought occurs when there is less or no rain over the season resulting in water scarcity for various uses mainly for drinking and agriculture, lack of water and fodder for livestock, poor cereals and food grain production, food scarcity, and less agricultural employment. Few respondents also perceived drought as increased atmospheric temperature, financial weakness, increased commodity prices, lack of electricity supply, fall in depth of water in the wells, loss of crops and livestock, unemployment, and migration.

Respondents were aware of unsustainable use of water that created water scarcity and drought. Many farmers in Gujarat associated drought with the water level in their wells. It was an inevitable observation as groundwater is the main source of irrigation and most villagers depend on agriculture for their livelihood. A typical answer from the Gujarati farmer was "*If there is water in the well, we know that there is no drought*" and "*When there is less water for drinking and irrigation in bore wells and hand pumps, drought is coming".* While in Gujarat groundwater mining for agriculture was stated as a concern for water scarcity, in Rajasthan it was the misuse of Indira Gandhi Canal (IGC) water for irrigation which was built for the purpose of drinking water in the desert. One respondent in Rajasthan said, "*IGC has solved the problems of drinking water but whenever they use too much water for irrigation there is shortage".* Another *said, "No one used to do agriculture in our lands. Now they use water for agriculture. There was no water for drinking before and now they need water for agriculture*".

Poor farmers in Gujarat opined that overextraction of water probably by rich farmers was the major cause of water shortage for agriculture and drought. Respondent in Gujarat said, "*Previously there was a well which used to have water throughout the year even in severe dry conditions. It was used for irrigating crops during drought season fearing crop losses*". In many dry and semi-arid regions, groundwater is used as a risk-reducing agency. It is only used in cases of late arrival of rainfall or less rainfall than normal years. According to assessment, Report 5 (AR5) of IPCC groundwater, due to its relative slow response to climate change impacts, can be an important tool for resilience against climate change. Some respondents felt that less rainfall was due to deforestation. Some confided that, "*though there are government initiative for planting new saplings, people are cutting trees recklessly in the village without protest*".

In drought risk perception, experience plays an important role, and it significantly affects recall and expectation of droughts. We observed experience as an important factor for constructing the perception of time and duration of rainfall. It provides them a reference to assess future expectations of drought. Previous experience regarding rainfall intensity and variability also shaped their memory and influenced their perception of droughts. Moreover, farmers' perceptions were also shaped based on how they defined favourable rainfall, that is required for optimum yield. Respondents indicated that drought is cyclic, recurring at different years of interval. We found all the farmers in Rajasthan and Gujarat have experienced drought in the past years.

In our study, respondents could remember more about the recent droughts. Studies have noted that farmers give more significance to recent climatic events as information. Most of the respondents could recall the severe droughts of 2002 and 2009 due to their severe intensity and a few older respondents could also recall the 1987 drought. It is expected because it is easier for rural people to recall more recent and/or extreme events than older or moderate ones. Scholars also report that droughts of most recent years and classic droughts are recalled, while intermediate years and droughts are lost from memory (Saarinen 1966; Ferrier and Haque 2003). Heathcote (1969) refers to the relation between actual drought occurrences and reported ones by local people as the "curve of perception".

Farmers’ perceived change in precipitation was mainly in terms of its distribution within the growing season. It is probably because the distribution of rainfall within the growing season was more important than annual values as it affected their farming decision. Such observations were also found by other scholars where the amount and distribution of rainfall within the cropping season were more important than just the total annual or total rainfall within the season (McCarthy et al. 2009). Many times, past personal experience and external sources differ significantly due to climate uncertainty (Hansen et al. 2004). Most probably that is the reason why young respondents perceived a greater number of droughts as compared to the older ones. We also observed that inter-annual variations in temperature and climate extremes were noted by the farmers over the short term and are more erratic in the recent years than in the past. For example, farmers commented that “*If there is no rainfall, there is drought and vice versa*”*;* and “*Drought is when there is heatwave*” (Fig. 14.1).

A study of the rainfall pattern from 1981 to 2010 showed that Rainfall Departure is negative from normal in 1982, 1985, 1986, 1987, 1990, 1991, 1993, 1995, 1996, 1999, 2000, 2001, 2002, 2004, and 2009, which all indicate a drought year. Out of 9 stations, almost 7 to 8 of them show negative departure in most of the cases except Porbandar, which being located in the coastal area probably has a strong maritime influence. In 1982, 1985, 1986, 1987, 1990, 1991, 1993, 1996, 1999, and 2000, the departure was more than 50%. During the drought year of 1982, values of both the indices remained negative, similar to drought years of 1985, 1986, and 1987. During drought years of 1995 and 1999, precipitation deficit and anomaly remained very high. Till the year of drought of 2000, values for both the indices showed negative

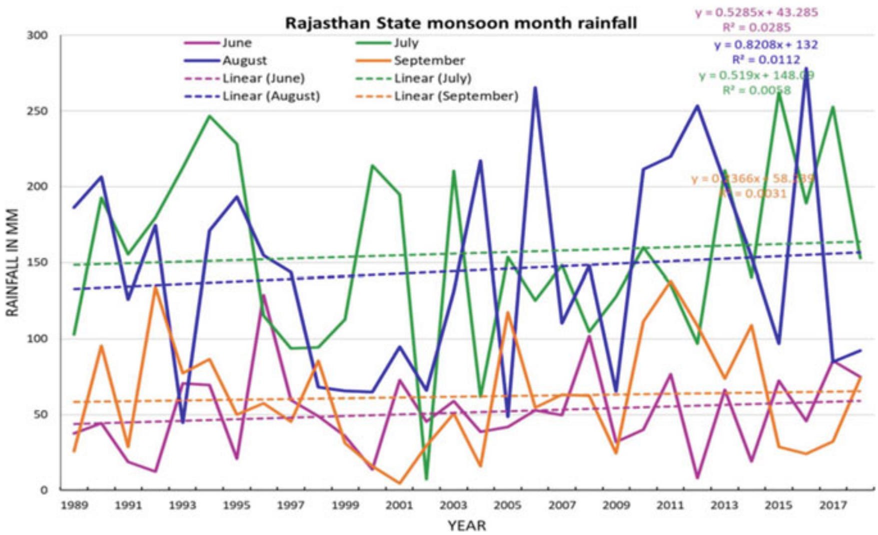

Fig. 14.1 Trend of average monthly rainfall during Monsoon in Rajasthan *Source* Calculated by Authors, *Data* from IMD, Pune

anomaly. From 2001 to 2010, in three years drought was identified with the help of two indices in 2002, 2004, and 2009.

Like drought perceptions, farmers also use past experiences in dealing with risks and uncertainties. Even though drought perceptions were substantially the same for farmers, their actual drought vulnerability and with that their drought experience and risk differed because drought vulnerability depends on both external risk of exposure and internal risk factors (Watts and Bohle 1993). However, perceived risk of drought seems to have increased over time, which was felt more strongly among households who were less endowed and had younger family member as the head of the household who inevitably has a shorter memory for droughts. They would exclaim, "the past few seasons had been dry!" which probably partially could explain the general feeling regarding the increased drought trend. Farmers were more concerned about an increased severity rather than about an increased frequency of droughts.

14.6 Discussion and Conclusion

In this chapter, we highlight the role of local indigenous knowledge, perceptions, and practices of local communities in drought prone rural areas of India and see how socio-cognitive and normative factors shape risk perception of drought at local level. Local communities to a large extent can identify drought and can understand the reasons for unsustainable use of water and water scarcity but they accept drought as a disaster caused by nature. Communities rely mostly on traditional knowledge to predict drought that they have gained through generations. Traditional knowledge mostly predicts drought by amount of rainfall, wind direction, direction and moisture of wind, state of vegetation, blossoming of flowers, bearing of fruits, and animal mannerisms. They also monitor water levels in the wells to match water utilization and recharge from rainfall**.**

From our analysis, we can say that though the people may not necessarily understand the intricate causes of drought due to climate change, they are generally aware of the problem caused by climate change and drought. We could observe that although drought had various negative impacts on the lives of rural communities in western Rajasthan, it was not their major concern. According to them, drought hits the villages every year, and it is now part of their life. The majority of respondents believe that drought is the work of nature and humans have limited influence in its occurrence. Villagers were sceptical about the power of science and early warning to prevent drought. Nevertheless, many respondents believe that government should be responsible for losses due to drought and government must provide adequate relief incentives in order to overcome the physical damage caused by droughts.

Lowe (2002) argues that many environmental problems are the result of applying narrow, specialized knowledge to complex systems. He describes modern science as "islands of understanding in oceans of ignorance" and calls for "scientists and practitioners to work together to produce trustworthy knowledge that combines scientific excellence with social relevance". Indigenous knowledge and innovations of the farming community have to be appropriately blended with modern scientific practices for addressing climate change. We argue that revisiting frameworks that seek to understand how and why perceptions of water risk differ and translate into differential behaviour is important to manage or respond to future risk. We suggest, it is important to capture farmers' perceptions of water scarcity because it helps explain investment decisions, contributes to scientifically justified adaptive behaviour, and can motivate better design of projects aimed at natural resource management and livelihood adaptation. Such inquiry has direct implications for improving our approach to climate change adaptation, which is, at its core, a behavioural change.

The findings suggest that involving local communities in disaster risk reduction techniques can surely enhance their collective capacity to cope with climatic extremes because perception-based studies are helpful in documenting the observations, experiences, and mind-set of local communities (Chapagain et al. 2009). Differences in farmer perceptions provide insights into why some farmers choose to adapt while some do not and how subjective perceptions influence decision-making to respond to external risks. Thus, initiatives to encourage adaptive behaviour must account not only for farmer perceptions of risk, but also acknowledge that these perceptions differ based on social, economic, and personal factors, and thus lead to differential behavioural outcomes. When planning for drought risk management, and climate change adaptation, it is important to understand how farmer perceptions of drought shape social vulnerability, response behaviour, and trajectories of change in drought prone areas.

We find social capital as a focus for the delivery of knowledge in local communities. Just like informal and indigenous knowledge, organized and usable climate knowledge that ensures development within the community should be also disseminated by local stakeholders. In our study villages, the farmers' networks constitute social capital that served as conduits for the flow of indigenous knowledge, helping the farmers to predict drought. Scientific climate knowledge also needs to be communicated via functional, existing communication networks of farmers and other landholders, rather than pursuing climate-specific communication programmes.

Notes

1. Monsoon is a seasonal prevailing wind in the region of South and Southeast Asia, blowing from the south-west between May and September that brings rain. It is also called as the wet monsoon.
2. Diwali is a Hindu festival with lights, held in the period October to November.
3. Holi is Hindu spring festival celebrated in February or March in honour of Krishna.
4. Malwa is a historical province and physiographic region of west-central India, comprising a large portion of western and central Madhya Pradesh state and parts of south-eastern Rajasthan and northern Maharashtra states.
5. Mewar is a region in the south-central part of Rajasthan that includes districts of Bhilwara, Chittorgarh, Pratapgarh, Rajsamand, Udaipur, Pirawa Tehsil of Jhalawar District of Rajasthan, Neemuch and Mandsaur of Madhya Pradesh, and some parts of Gujarat.

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Chapter 15
Toponym and *Kayori*: Potential Benefits of Local Wisdom *to Kaili* in Disaster Mitigation Strategies in Central Sulawesi, Indonesia

Agus Suntoro, Tri Wahyuni, Ismeti, and Nurrahman Aji Utomo

Abstract The earthquake and liquefaction in 2018 in Palu City, Central Sulawesi, Indonesia, caused thousands of casualties and property. This incident reminds us that we have forgotten the local wisdom of the Kaili Tribe, who have lived for hundreds of years in disaster-prone areas with Toponym and Kayori. We use qualitative methods with interviews and questionnaires, observation, and literature studies. One hundred Kaili people in Palu City are respondents in interviews and questionnaires, using purposive sampling taken at random. Apart from that, for supporting data, the team obtained from journals, books, and laws and regulations. The first sub-section of the book chapter discusses the existence of the Kaili Tribe in Palu City, and the second sub-chapter explores community wisdom in the form of Kayori, Toponym, and traditional houses. Discussion of the third sub-chapter is regarding recognizing the Kaili Tribe in disaster management legislation and policies. This study concludes that the Kaili people have cultural values that are adaptive to natural disasters through Kayori (oral poetry), toponymy (regional naming based on historical records), and earthquake-resistant traditional houses on stilts. In formal recognition, cultural heritage has been regulated in regional regulations related to conventional institutions. Still, it has not been comprehensively adopted as a roadmap for policy or program-making in disaster mitigation.

Keywords Toponym · *Kayori* · Disaster mitigation · Recognition · *To Kaili* local wisdom

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_15

15.1 Introduction

Central Sulawesi Province is a province in Indonesia that has dynamic and complex seismic characteristics. It resulted in the threat of natural disasters in the form of earthquakes affected by the Palu-Koro Fault, 50 km was deep (Jena et al. 2020). The Palu-Koro Fault stretches from Palu city in the west to Bone Bay which is estimated to be 250 km long. The Head of the Earthquake and Tsunami Mitigation Division of the Meteorological Climatology and Geophysics Agency (*BMKG*) of the Central Sulawesi region has a considerable record of seismicity in the past. Nine strong earthquakes have occurred since 1923, almost all six magnitudes (Zuhad 2021). The last earthquake event with significant damage and casualties occurred on 28 September 2018 with a magnitude of 7.7, which then caused a tsunami. The earthquake happened in Palu, Donggala, Sigi, and Parigi Moutong. The National Disaster Management Agency *(BNPB*) noted that the earthquake caused 4340 deaths, 4438 injuries, and 172,635 refugees. In addition, the impact of damage reached Rp. 15.58 trillion (BNPB 2019).

Natural disasters in the form of earthquakes do not just mark the existence of humanitarian activities and natural damage but become an early warning for the central and local governments to mitigate the threat of repeated disasters and as an opportunity to minimize the risk of injury. Therefore, in the macro context, it is necessary to immediately develop regulations and technocratic aspects regarding disaster mitigation and impact recovery based on the roots of local wisdom. In addition, it is also essential to explore, discover, and recognize the traditions, culture, and capabilities of local communities that have lived and are related to earthquake-prone nature for hundreds of years. One of the important things to track is the life system of the Kaili Tribe. The community has settled in Palu City and lives in the Kaili Sea area. At that time, the term "Palu" as the area's name was unknown because the Palu valley was still an ocean. Over time, the Kaili community lived in Bangga Village, Loru Village, and Bora Village bay areas. The fertility and comfort offered by nature in the Kaili valley make people interested in starting to live from the west and east. From the east, there are two phases of placement. The first phase was an area overgrown with "weeds" *bureaus*, now known as the Biromaru area. The second phase is an area for settlement now known as Palu City (Fig. 15.1).

Meanwhile, the community occupies the western region, now known as the Dolo area (Lasimpo 2019). The experience and anticipation of past disasters and earthquakes by the Kaili Tribe is beautifully conveyed through the words otherwise known as *Kayori.* One form of *Kayori* inherited is "*Goya-goya gontiro, Toko Bonga Lolio Palu, Tondo, Mamboro, Matoyomo. Kamolue melantomo*", which is translated generally as a warning that some areas such as Kabongga, Lolige, Palu, and Tondo Villages, as well as Mamboro have been submerged, only Kayumalue Village is floating. It reflects the 1938 earthquake that caused damage, loss of life, and the sinking of Palu City (Lasimpo 2019). Likewise, in the aspect of architecture, the Kaili Tribe passed down a traditional house model that is friendly to the environment and adaptive to living areas in the form of mountains and earthquake-prone areas, namely in the form

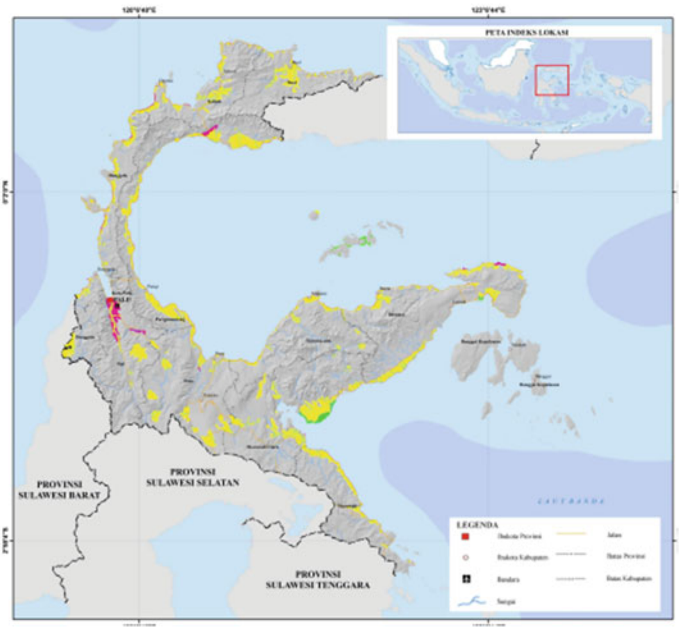

Fig. 15.1 Map of liquefaction in Palu City in 2018 and the level of vulnerability to landslide

of stilt houses called *Banua Mbaso, Banua Oge,* and *Souraja.* Tadulako University Architecture Lecturer Rifai Mardin said that the previous community in Palu City had coexisted with the earthquake. So, in addition to avoiding wild animals, the Kaili Tribe's stilt house also serves to avoid tsunami blows because it is made of wood with a more flexible and safe bending power than concrete (Haryanti 2018).

However, it is not easy to recognize the existence of language and cultural heritage as cultural rights of indigenous peoples in this context; the Kaili Tribe adopts regional policies and legislation. In addition, if the culture of indigenous peoples is used as a reference source to implement the meaning of participating in preparing a policy (political) agenda, the process is carried out gradually and sometimes even incompletely. Establishing more participatory regional policies and legislation should increase the democratic level and legitimacy of the resulting regulations. The *bottom-up approach* relates to forming regional policies and legislation initiated at the local level. It is an important phenomenon and has become a tangible manifestation of the state of law (Otto and Suzan Stoter 2012).

15.1.1 Rationale of the Study

The formulation of a problem is intended so that the substance studied in the study can be structured in direction and purpose. Two main problem formulations are the focus of this chapter, namely, (1) How the form and existence of Kaili Tribe culture related to seismicity are viewed from the aspects of the language and architecture of buildings in Central Sulawesi, and (2) How the recognition of local wisdom of the Kaili Tribe deals with local government policies or regulations related to seismicity.

Furthermore, this research will encourage the government, both central and regional, to adopt the values of local wisdom of the Kaili People in legislation products that regulate development governance, regional arrangements, and disasters in the Central Sulawesi region, including evaluation of the implementation of recovery after the 2018 earthquake. Therefore, the practice of community-based legislation (bottom-up approach) and the results of an objective evaluation of the practice are expected to provide appropriate and successful benefits for the community in the Palu City area. In addition, they can increase the legitimacy of the resulting legislation products.

15.1.2 Materials

The location of this study is the Kaili tribal community in Palu City, Central Sulawesi Province. All aspects of the Kaili people's perspective and local wisdom in Toponym and *Kayori* must be explored. The results of this exploration will later be used as the basis for the analysis of this research. Thus, the object of this study is the method, process, and implementation of the local wisdom of the Kaili tribal community in Palu City, Central Sulawesi Province. The object of this study was obtained through the role of the research subjects, namely the perpetrators of traditional rituals in the Kaili tribal community in Central Sulawesi.

The design of writing this book chapter uses an observation method involving members who live in Palu City. This argument is based on the consideration that by observing places and objects, the results are more in-depth. The location of this research is the Kaili tribal community in Palu City, Central Sulawesi Province. The selection of the research location was determined purposively or deliberately based on the consideration that the location represented each Kaili sub-ethnic. All aspects of the perspective and local wisdom of the Kaili Tribe in Toponym and Kayori need to be explored. The object of this research is the method, process, and implementation of the local wisdom of the Kaili Tribe. The object of this research can be obtained through the role of the research subject, namely the actors of traditional rituals in the Kaili tribal community.

The data collection techniques in this book chapter are grouped into several stages: document studies, interviews, observations, and questionnaires. First, document studies focus on scientific journals, research results, theses, dissertations, books, and local regulations—in-depth interviews with informants based on the prepared instruments. The following technique is in the form of observation, usually done before or after the interview. Some of the focus themes observed were related to methods, processes, media, and other matters related to the perspective of indigenous peoples and the people of Palu City on legislation and disaster mitigation.

15.1.3 Methods

To gain an adequate understanding of the knowledge of the people of Palu City, the team interviewed 100 respondents with several criteria of age, profession, ethnicity, and knowledge of the Kaili regional language. First, sampling was done randomly using the purposive sampling technique. Then, the team shares questions with the respondent from a questionnaire that focuses on three things: knowledge about the local wisdom of the Kaili Tribe, disaster, and disaster mitigation, as well as the role of government in disaster mitigation. One hundred respondents were domiciled in Palu City and its surroundings, such as Buluri City, Silae, Kayumalue, Tawaeli, Petobo, and others. Most of the respondents were from the Kaili Tribe (87 people) with sub-ethnic Ledo (45 people), Moma (2), Ray (24 people), Tara (4 people), Unde (2 people), Ija (2 people), and Doi (8 people); and 13 people, some of them immigrants from the Javanese and Bugis tribes.

The average age of respondents is dominated by the productive age between 30 and 60 years old (83%), under 30 years (13%), and above 60 years (4%). The age range is intended to determine whether age can affect people's knowledge of the culture in Palu City. Hence, the team also used in-depth interviews to gain valid data from the respondents. First, the respondent was asked about the local culture. The knowledge of the community's local culture is more influenced by the family or the surrounding environment for generations. The people of Palu City generally communicate in two languages. Kaili language is more applied in communication with prominent families, while daily practice at home tends to use Indonesian. Most of the indigenous people of the Kaili Tribe are fluent in Kaili, although they come from various sub-ethnics (Fig. 15.2).

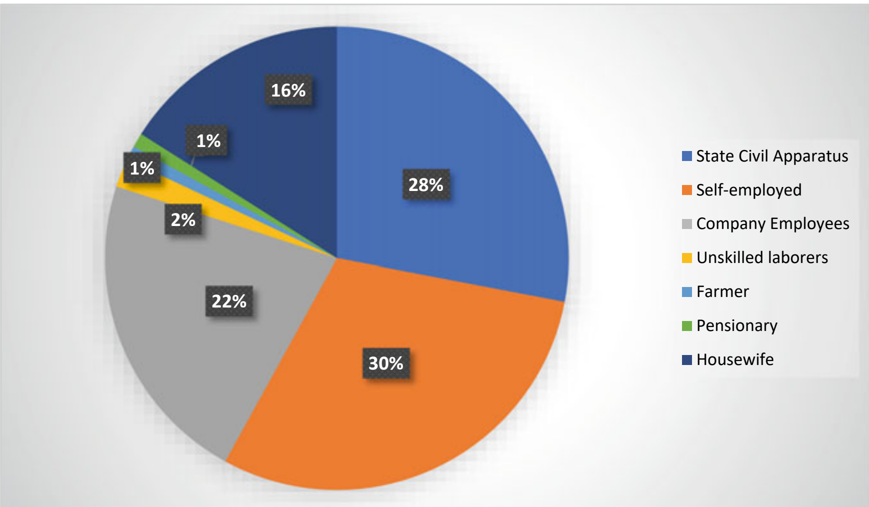

Fig. 15.2 Respondent's profession from Kaili Tribe

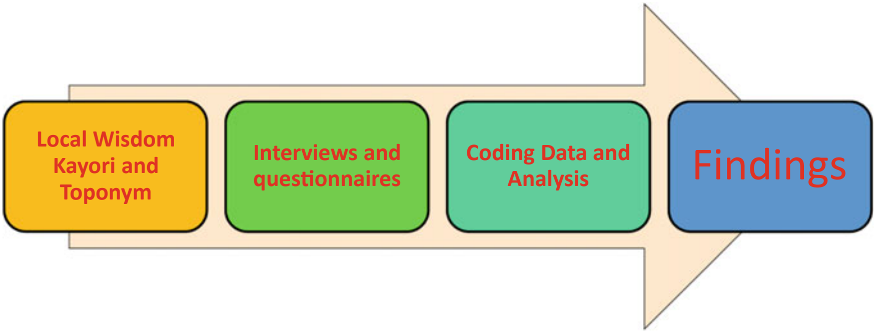

Fig. 15.3 The role of Kaili Tribe wisdom analysis in disaster recognition

The team argued that the profession of respondents in this chapter also influenced the local knowledge according to the main three things. Hence, the background of the family's knowledge is also the other criteria for deciding the respondents. The presentation of the results is the final stage of the entire series of qualitative descriptive analyses carried out in this study. Following the rules in the descriptive analysis method, the presentation of the report in this study is descriptive. Following the rules in the descriptive analysis method, the presentation of the report in the book chapter is equipped with several types of images (matrix, charts, flowcharts) or tables to facilitate understanding of explanations. This presentation method will make it easier for readers to understand the form and function of Toponym and Kayori in the Kaili tribal community in Palu City, Central Sulawesi (Fig. 15.3).

15.2 Results and Discussion

15.2.1 Kaili Tribe and Their Territory

Related to disasters, the Kaili Tribe also has a collective theory outlined in traditional rituals. That is in line with Clifford Geertz's thinking, which "defines local knowledge as knowledge held locally, by local people, a cultural system which becomes common sense for people who share a communal sensibility" (Geertz 1983). Verbal communication indicates a reaction to natural symptoms processed by their cognition space as the "main figures" of civilization in Central Sulawesi. Local knowledge and information about the disaster owned by the Kaili indigenous tribe come from the stories of ancestors or immediate family. The disaster also impacted an earthquake that lasted for three months, followed by a tsunami on the west coast.

Anthropological studies have explained that culture is a matter of great concern in the process of human civilization. Cultural inheritance and related processes can be said to be cultural material in certain groups of people. Cultural inheritance can be interpreted as a form of transformation, transition, or transition of values or social norms from the older generation to the younger generation. These norms and values must be guidelines for a person's social life. The generally abstract rules instilled in the younger generation gave the term cultural inheritance. Values and social norms are matched with learning (Siany and Atiek Catur 2009). Koentjaraningrat (2003, as cited in Nurmansyah 2019) states that cultural recognition or socialization is a process of studying culture related to social systems prevailing in a particular society. The socialization process allows an individual to know, understand, internalize, and adjust until finally being able to apply it in life in the form of actions that follow the concept of culture in society. For example, toponyms and *Kayori*, which are part of the oral tradition of the Kaili people, can be used as a foundation for implementing urban planning and legislation regarding disasters in Central Sulawesi.

The mention of *To Kaili*, meaning "Kaili people", is used as a clear customary identity. An anthropologist named Mattulada, in his book "*Sejarah Kebudayaan To Kaili*", explains the background of the mention of the Kaili people (Mattulada 1983). Mattulada's description *To Kaili socioculturally belongs to ethnic groups with the following characteristics: (1) The same sociocultural pattern in ideology, values, and customs; (2) there is a sense of togetherness with each other; (3) the tendency of exclusivity within the group; and (4) relations due to genealogical factors and territorial awareness* (Mattulada 2014).

The indigenous Kaili people do not live in areas with a naming (toponymy) based on natural events but through the oral literature (*Kayori*) according to the delivery of previous elders. *To Kaili* prefers to live in highlands, around valleys, or foothills that are considered safe from natural disasters such as earthquakes and tsunamis. That condition made the immigrant community used to call the original Kaili Tribe the "Mountain People". One of the Kaili sub-tribes in Palu City is the Ledo sub-tribe, which is the sub-tribe that occupies the most area of Palu City. The sub-tribal history of Kaili Ledo inhabited the Palu region at a time when the region began to become a landmass. It is said that the ancestors of the Kaili Ledo sub-tribe were the first residents to enter the Palu city area. Meanwhile, the western edge regions are inhabited by many sub-tribes of Unde and Daa. The region's eastern part is Sub-tribal Rai, Doi, and Tara. Then, the sub-tribes Kaili Ija, Moma, and Ledo are in the southern part of the region. The sub-tribe is believed to be the oldest, the Daa Tribe, which now lives around the mountainsides or mountains. Sub-tribes rarely settle in the city's territory, so they are called *To Po Daa.*

The Bugis Tribe dominates the migrant tribes in the region. Over time, migrants from Makasar and its surroundings arrived, who saw the area as a place to live because the land in the region was sold at low prices. The migrants then turned the Mamboro Bawah area into a settlement. They work as fishermen because the area is located on the coast. Due to the ignorance of migrants about the history and origins of the domicile area, in the end, they became victims of the Tsunami disaster of 28 September 2018.

15.2.2 Kaili's Wisdom and Disaster

The local wisdom that develops in the community, especially for *To Kaili*, was created to respond to the previous community in the face of natural disasters and environmental conditions. It was a reminder and lesson for future generations about the region's history. The mitigation awareness contained in local wisdom is expected to minimize the impact of disasters in the future. The Kaili Tribe's customs of oral literature and disaster-friendly architecture of past buildings are the collective knowledge of the previous people that they coexisted with the disaster because of the geographical location of the area they lived. From some local wisdom *To Kaili* that can be taken as lessons in carrying out disaster mitigation, including:

Local Wisdom of Building Architecture *to Kaili* (Traditional House)

In general, the architectural character of *To Kaili* has similarities with architecture in several other areas, such as Bugis, Makassar, and Toraja. Kaili tribal buildings can be divided into several classifications, including residential houses (*Banuambaso/Sapo Oge/Banua Magau, Kataba, Fecjai Kinjai*), houses of places of worship (*Masigi*), storage houses (*Gampiri)*, and deliberation houses (*Baruga*). The classification of residential houses is based on social strata in the community.

In the past, the architecture of the *To Kaili* houses was not only a protector or shelter but also had a more special meaning in terms of spirituality, namely being friendly with nature. That is why when the earthquake occurred on 28 September 2018, the traditional houses of *To Kaili* were still firmly standing. Based on information from respondents, *souraja* or *banua raja* is a form of building constructed considering the territory's condition. In the traditional Kaili building, there are supports under the foundation in the form of crosses with each other. In the event of liquefaction, this building will follow the movement of the ground without changing its shape or destroying the building. It shows that the construction of Kaili traditional buildings is aware of the disasters that can potentially hit the Kaili region. The initiator of the traditional building form was King Yodjokodi, who had no descendants (his descendants have run out) (Fig. 15.4).

Kaili's local terms in other fields of architecture are *Pamuse Nusapo* (core pole/central pole of traditional houses), *Sou-sou* (cottages that are usually built-in rice fields for shelter), *Tabaro roofs, Kataba* (traditional houses located in the highlands), *Palava* (traditional houses in the lowlands). It is necessary to know that the shape of *kataba* and *palava* houses shows the social strata in the Kaili indigenous people. It is said that the construction of traditional houses in ancient times was adapted to the situation in the region. For every traditional house, there was *a buho* "rice granary". It was done as a form of disaster mitigation at that time. If a disaster occurs, people who have architectural forms of houses such as *kataba* and *palava* will not run out of food because they have prepared them next to the house. According to Nisbah, a Palu anthropologist and a lecturer at the Faculty of Anthropology, Tadulako University,

Fig. 15.4 Kaili's traditional house (left) and a new style government building that adopts the traditional house building of the Kaili Tribe (right)

the technology of making *houses To Kaili* is also based on natural disaster mitigation actions. *To Kaili* made a stilt house with supporting poles lined with stone bases to keep the house balanced. When building a house is about to begin, the first phase is to measure the strength of the soil by sticking a stick or machete into the ground. The result will be known resistance or the potential level of soil strength to support the building.

In the past, when natural signs had signaled that a big earthquake would occur, then by *to tua nungata* which means "old man who is the head of the village", the community was ordered to make a kind of body safety device shaped like a ladder used during an earthquake occur. In this tool, each person places their head at the neck level in the hole between the steps so that the control over earthquake shaking can maintain the balance of each person's body together (Interview by the team on 6 September 2022). The architecture of the *To Kaili* houses in the past had a primary function, not only as a protector or shelter but also as a spiritual thing, namely being friendly with nature. Therefore, when the earthquake occurred on 28 September 2018, *To Kaili's* traditional houses were still strong.

Kayori **(Local Oral Literature)**

The Kaili Tribe has a rich sub-language. There are about 30 sub-languages that the *To Kaili* people still use daily. However, the Kaili have a mother tongue or lingua franca known as the Ledo language. The word "Ledo" means "no". Ledo language can be said to be a flexible language which is used to communicate with other Kaili languages. The original Ledo language (not influenced by the immigrants' language) is still found around Raranggonau and Tompu. Meanwhile, the Ledo language used in Palu, Biromaru, and its surroundings has been assimilated and contaminated with several foreign languages, especially Mandarin and Malay (Saleh 2013). The languages still used in daily conversation are Tara language, Rai language, Doi language, Unde language, Ado language, Ija language, Da'a language, Moma language, and Bare'e language.

For the Kaili Tribe, religious teachings and customs must go together and not contradict each other. The Kaili people believe earthquakes will strike when people damage or violate customs and religious teachings. The Kaili Tribe elders conveyed that to their children and grandchildren through oral literature called *Kayori*. Panambulu, the 104 years old man in Palu said, "*There are all stories (about natural disasters) in Kayori, including our parents' stories*" (Marta 2019). *Kayori* is an old way of singing something to remind the younger generation that past events are reminders of the present. *Kayori* is a way of speaking with poems conveyed as a feeling of love and worship for the majesty of *Pue Langi* "*To Manuru*". According to Nisbah (the local archaeologist), the narrative of natural disaster events is also commonly spoken through *Kayori, Dulua*, and *Dade Date*, namely types of oral literature through the process of telling stories by speaking (speech) accompanied by the use of a series of musical instruments such as *yori, harp, gimba, gong*, and the other musical instruments. To remember specific events or conditions, the Kaili Tribe uses the art of storytelling or speaking. However, it causes limitations in the distribution of knowledge only centered on parents. That is one of the challenges in maintaining local wisdom, especially Kayori.

However, for the Kaili Tribe living in the Palu valley, *Kayori* conveys an event or natural disaster. It happened because the people in the Palu valley had experienced repeated disasters, so they responded to these natural events in art or art of speech, one of which was *Kayori* (Palogai and Bohang 2021). *Kayori* is essential to this day because one of the messages contained in it is a suggestion to maintain a balance between nature, humans, and something that protects them. The following are *Kayori's* famous poems for *To Kaili.*

Manggita adana ri tana Kaili, *Ade domo ranga rapeilira,* *Radeikimo pangajari,* *Ane Mamala tana Kaili ragoya vai,* *Rapaka tala, vehia adata niuli totua*	Let us see the customs in the land of Kaili If you do not pay attention, Let's teach them If the ground of Kaili is shaken again In Sink, that is the custom that parents tell

The oral tradition of the speech has many local terms from the Kaili Tribe, including *tirotasi, batu bulava, nasio, nakatugoa, tonggolobio, narogo, nasoa, nalonjo, mapaga, nalingu, nepone ntasi, kaombo, naombo, bomba talu* (three waves), *tana rionju, bulili, naonga, kaombona, tanamodindi, tanah mambo* (ground down), *pue alusu* (ghost), *wentiro* (lost area), *tana runtu, nepogu* (explode), *nepone buse ntasi, karampe, yodjokodi*, *tolare* people who live in mountainous areas which are often known as *To Po Daa*, *balia, nalino dunia, ular menyanyi, kinta* or the old village in Petobo, *ombo* (collapse), *pesaku* (spear), *komiu nosarara, tulabala, nakapali, nalodo, nuragi ose* (like a disaster antidote), *peolanta* (hidden), *mapane, buse ntasi, neponetasi/uentasi nepone* (rising sea). "*Agina Mainga, Ne Maonga*" means "better be careful than drown" and is one of the famous *Kayori* that the elder *To Kaili* used to recite through *Kayori* oral literature.

Fig. 15.5 Interview with Mr. Abdurrahman, the community leader of Kaili Tribe and former. Head of Siranindi Village (left) and Mr. Safrudin of the local Kaili community (right)

One of the other famous *Kayori* related to the disaster event is "*goyang-goyang ganti* (*banawa*), who looks down on the *Kabonga* and *Lolioge Palu, Tondo* and *Mamboro* people have drowned. The rest of the Kayumalue floats", which can be interpreted as "There has been a ground shake "earthquake," and the community Kabonga and Lolioge saw that the replacement area in Donggala" (Fig. 15.5).

Regency had disappeared, while the Tondo and Mamboro areas had sunk. Only the Kayumalue area remained (visible). The story told in the local Kaili language is like the utterance, *ane malingu biasa nepone bomba talu* (when there is an earthquake, usually there are three waves), *nongiu* (there is natural sound), *naoti uventasi, moni nu tondji, ri tangabongi, ri tangaeo, ante dan mangaribi, asu nelolo, tangabongi uda pane eo, ne nalingu mangova ri kalangana.* According to Ibe Palogai, an Indonesian poet, in his book *Kayori: Seni Merekam Bencana*, the *To Kaili* people who live in the Palu valley make memories and experiences as "theorems" and try to pass them on to future generations so that the events that occur can be used as lessons and warnings (Palogai and Bohang 2021). In addition, related to these terms, other signs are to see clouds and animals such as cats, cows, and chickens. In the 2018 tsunami disaster, some people implemented this collective knowledge. Namely, when they saw cows coming down the mountain, they went down the mountain. However, some still need to heed these natural signs.

The *Kayori* is like a prayer that asks the ruler of the universe if at this time, the Kaili people, who live no longer see the customs in the land of Kaili, give a reprimand in the form of an earthquake. *Kayori* is then closed with the sentence "*begitulah adat kita yang sudah dijelaskan para leluhur*" that means "that is our custom that has been explained by the ancestors" (Palogai and Bohang 2021).

According to some respondents, there is no term in the Kaili language as a form of warning or a sign of disaster. However, around 53% of respondents also said there was, but many needed to remember the meaning of these terms. As for the terms known by the people of Palu City, both the Kaili indigenous people and the newcomers, among others, "*nabaitasi ane mabai motasi* or *mepenemo uentasi*", which means "if the sea water is dry, it means that the water will have a high tide or rise", *poiri limboro, nasara ininawa, buri, dandedate, tavevenalai* that means the animals go, *nalino dunia, sikatan bakau* "a group of birds singing in the sunset". According to research respondents, these terms, which were ultimately believed to be a sign of a disaster, appeared the day before the 2018 disaster occurred. The *topo daa*, aware of these natural signs, rush toward the mountains or highlands to anticipate a disaster. Even though the *Daa* tribe does not know what disaster will occur at that time, they believe these omens signal that something terrible will happen in the area.

Toponym (Territory Naming)

The world's attention to disasters and their mitigation based on local wisdom has been done a lot. Geological researchers have also mainly studied many geographic and rock structures in the Palu City area. If it is related to Toponym and *Kayori*, research on naming places has also been carried out with the synergy of several agencies to maximize disaster mitigation. However, this is like a tit-for-tat with the policies taken by the local government.

Based on the results of the Computational Linguistics research conducted by Lauder, the intensity of the appearance of self-names (anthroponyms) and place names (toponyms) in newspapers reached 33.92% (Lauder 2009). The branch of science that studies naming is called onomastics or onomasiology. According to the Online Big Indonesian Dictionary V (*Kamus Besar Bahasa Indonesia V Daring*) published by the Language Development Agency, the definition of onomastics is "the investigation of the origin, form, and meaning of self-names, especially the names of people and places". Meanwhile, onomasiology is defined as investigating the semantic relationship between language symbols and the things they mean, including, in this case, the investigation of polysemy and synonymy. Linguistically, onomastics is a branch of science within the scope of Historical Linguistics which studies anthroponymy and toponymy. Culture plays a crucial role in naming oneself and a place. Indonesia and all regions in the world have cultural diversity that shows uniqueness in reconstructing a name in terms of semantic, morphological, and phonological (Van Langendonck 2007).

Anthroponymy presents the era relationship between the study of names and various other disciplines, such as anthropology and sociology (De Stefani 2016). The analysis carried out in anthroponomics research is not only related to the origin and meaning of names but also to cultural understanding, which leads to the identity of a civilization. The world's attention is also manifested in an organization formed under the auspices of the UN ECOSOC (United Nations Economic and Social Council), which states that toponymy is indispensable for managing economic and social problems. In addition, the United Nations also formed UNGEGN (United Nations Group of Experts on Geographical Names) in 1960, which has the main task of naming the names of places worldwide. UNGEGN requires all UN members to manage and standardize names in local languages to preserve the history and culture of each country in the world. It is attempted as a concern for international communication, especially when distributing international aid to locations where natural disasters

Fig. 15.6 One of the toponyms, namely Jalan Tagari Lonjo, which means a sunset place, this area is located in Duyu Village, Tatanga sub-district, Palu City (left), and Kabonena Village, which means The Sandy Area (right)

occur. UNGEGN formed a working group on local language empowerment and using local place names in 2002. Then, in 2012, the working group was changed to deal with toponymy matters such as cultural heritage (Kerfoot 2015; Watt 2015). Three things describe the relationship between place names and cultural heritage (Helleland 2006: 121), including (1) place names provide information about natural and cultural conditions at the time the name was created that represents the memory of the place so that it functions as historical documentation, (2) place names are part of local language and history, and (3) place names reflect the relationship between local communities and their environment (Fig. 15.6).

Ikhsan Djorimi, an archaeologist of Central Sulawesi, mentions naming areas or regions by the Kaili Tribe based on several aspects, namely (a) geological aspects, for example, an area that used to be an area with lots of rocks is called the *Kawatuna* area. Areas with a lot of sand or sandy areas are called *Kabonena* areas. Then, there is an area called *Layana* because it used to be an estuary; (b) landscapes, for example, *Panau* or derived, K*aravana* or flat areas; (c) based on natural events, for example, *Kawambona* "landslides", *Duyu* "landslides", *Tana Runtuh* "collapsed lands", *Tagari Lonjo* "places to sink", *Tompe* "landscapes"; and (d) based on the name of the tree or location, certain types of plants are planted, such as *Balaroa, Siranindi, Jono Oge, Birobuli* (Interview by a team on 7 September 2022).

Regarding toponymy, which means naming a place, there is the term *petobo* which means "upside down". There is another term *tabale, tompe*, which means "to drift". It should also be noted that most of the indigenous Kaili people who live in disaster-prone areas do not know stories from their parents or ancestors regarding the area where they live. On average, the elders only told of an earthquake that had occurred for three months during the volcanic eruption, but nothing happened to their house. There is an original term, Kaili Tribe, which can be categorized as a form of warning to the public about the condition of an area, namely *nalonjo*. *Nalonjo* means "to fall; stumbled; sink". In general, *nalonjo* can be interpreted as when someone stands on a piece of wood and then falls without knowing that there is a hole in the place or something happened without us knowing. Another term for *nalonjo* is *nalodo* which means "sinking in the mud", now better known as liquefaction. Some indigenous Kaili terms refer to falling or sinking into the water, namely *naombo, naonga, napoyo* (depending on the Kaili language of a particular sub-tribe). According to Iksam, an archaeologist in Central Sulawesi, the areas most affected by the 28 September 2018 earthquake were areas that To Kaili had never inhabited. Etymologically, Balaroa was originally a *lonjo* or "muddy land". *Kaili Ledo-Indonesian-English Dictionary* (Evans 2003) contains the word *nalonjo*, which means "to sink in the mud". In the past, community members avoided areas now affected by liquefaction because of the swampy soil structure (Damayanti et al. 2021).

The description of the potential or vulnerability to natural disasters in the Palu valley is illustrated in several areas. The *To Kaili* have a vocabulary about a disaster which is part of the *To Kaili* civilization. Several terms show the connection with natural disaster events. Among others, *Lingu* means "earthquakes which are usually used for not-too-loud earthquakes". Meanwhile, if a powerful earthquake causes violent shaking, it is called *Nalingu* or *Nabanggesi*. In natural events, earthquakes that cause tsunamis or rising water waves are called Bombatalu or "three waves rolling in from the middle of the sea which then break up on land" (Abubakar 2019). However, in the 1980s, the local government started building the *Perumahan Nasional* (National Housing Center) in Balaroa and housing estates in Petobo. Since then, the area has become crowded and dominated by immigrants, while the indigenous To Kaili still live at the top or foothills of Balaroa Village.

15.2.3 The Legal Recognition of the Kaili and Contradiction

The Legal Recognition of the Kaili

In order to operationalize the recognition and guarantee of indigenous peoples, some countries provide legitimacy in the form of laws (regulations) as well as administrative procedures (Jackson 2018). In Indonesia's national context, indigenous peoples are recognized in the constitution. In the 1945 Constitution, after the amendment, indigenous peoples are regulated in several articles, namely Article 18-B paragraph (2), Article 28-I paragraph (3), and Article 32 (on culture) (Dwi Qurbani et al. 2020). Recognition of indigenous peoples is part of and implementation of human rights. Referring to Law Number 39 of 1999 concerning Human Rights, Article 6 paragraphs (1) and (2) state that the differences and needs of indigenous peoples must be considered and protected by law, society, and government, as well as the cultural identity of indigenous peoples, including the right to protected customary land, in line with the times (Buana 2021). The Indonesian constitution still applies the concept of *conditionalities* because recognition puts the state and have several prerequisites, namely: (1) as long as it still exists; (2) following the development of society; (3) under the principles of the Unitary State of the Republic of Indonesia; (4) regulated in the law (Suryasaputra 2012).

Previously, almost the entire Palu area that stretched to the Donggala region was inhabited by the Kaili Tribe. Their existence has lived for hundreds of years in the Palu valley and the surrounding mountains. Civilization and their settlements developed and expanded and have lasted several generations. The Kaili Tribe has existed and lived and has an established conventional system. It refers to the Constitution Article 18-B paragraph (2), which requires formal state recognition by regional regulations or decrees of regional heads (on customs and their devices). Local regulations are a form of legislation resulting from agreements between local governments and legislatures, both at the provincial and district/city levels. This local regulation is generally regulated as part of the national legislation system and, in substance, must not conflict with higher regulations (Atmaja 2017). In the context of the recognition of Kaili, the role of academics, civic groups, and the community is strong enough to encourage the government to form local regulations with these various dynamics and encouragement. The Palu City Government has formally recognized the Kaili customary institution through Regional Regulation Number 9 of 2016 concerning Kaili Customary Institutions. One of the considerations in forming this regulation is the potential for Kaili customary institutions to participate in regional development. This regulation also protects against an effort to preserve customary and customary assets, both movable and immovable, which have historical values and concern the survival of generations so that they remain a cultural treasure (Sari et al. 2020). Recognition of the existence of the Kaili traditional institution does not only protect and preserve its culture. It's can be seen through the provisions of Article 11 letter (a) of Palu City Regional Regulation Number 9 of 2016 concerning Kaili Traditional Institutions, they are required to assist local governments in development in all aspects.

In the legislative aspect, establishing regional regulations related to *To Kaili* customary recognition has been in line with the agenda-building theory of Cobb & Elder. Indications are based on the fact that the initiation or process of formation and its direction begins from the aspirations of society. The theory of agenda formation tries to show that the shaper of legislation is not one single actor in the main one, but rather the process of forming legislation is a complex and lengthy process of transformation influenced by a variety of actors and many different factors (Otto and Suzan Stoter 2012). Although the mechanism in legislation through the mechanism of the agenda-building theory is bottom-up, one criticism needs to be conveyed to the Palu City government to socialize to the general public about recognizing Kaili customary institutions in regional regulations. The study's results confirmed that out of 100 respondents in Palu City, most residents were unaware and hesitated to choose the regional regulations. People are more familiar with the Kaili Tribe from the mandatory clothes and *sigga* (Kaili's signature hat) worn by government officials on any given day. The table shows respondent knowledge about the local regulation regarding the recognition of the Kaile tribe. That result represents their knowledge of the local regulation (Fig. 15.7).

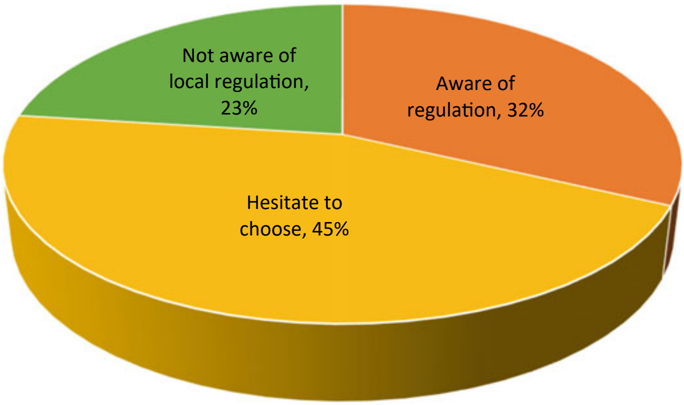

Fig. 15.7 Respondent's knowledge of local regulations regarding the recognition of The Kaili Tribe

Contradiction of Recognition

Although the norms of recognition of Kaili customary institutions have been recognized in the statutory system, in the context of disasters, it is necessary to do whether Kaili culture and customs have been formulated in local government policies as local wisdom. Interpreting the position of local knowledge, like other forms of knowledge, is most effective when multiple forms of knowledge interact to influence policy (Nugroho et al. 2018). The fundamental weakness in Indonesia's decentralization and autonomy system is that it excludes local communities with local knowledge in policymaking. Guggenheim takes the reasons that Indonesia has not developed the domestic knowledge infrastructure found in many developing countries (Reid 2012). While local knowledge production is unstoppable because it is how a community makes sense of life, these hierarchies and relationships have been a disincentive for using local knowledge to influence policy. These hierarchies shape the basis for the status and authority of local knowledge in the knowledge-to-policy realm; they have put the credibility of local knowledge in influencing policy at the lowest level. In this situation, local knowledge has little ability and credibility to legitimate power, so public policymakers have little interest in supporting a rise in the influence of local knowledge in policymaking. It also means lower interest in investing resources for policymakers' local knowledge development and application. That might be understandable, as a relationship of reciprocal legitimation connects knowledge and power. Knowledge legitimates power, and conversely, knowledge is legitimated by power (Flyvbjerg 1998).

Decentralization will incentivize local leaders to be sensitive to their constituents and local realities. Therefore, democracy will lead to transparency and accountability. A challenge to using local knowledge and sharing it with other communities, such as the policy community, is that it is often passed on through oral tradition and has yet to be codified. Codifying it becomes part of making it accessible for use and transmission to policymakers and other communities. Codifying local knowledge

Placement on hierarchy	**Types of knowledge**	**Institutional arrangements of knowledge**	**Methods in knowledge creation**	**Forms of knowledge**
High	Scientific	Prestige of organization	Experimental Quasi-experimental	Global Parchment Publication
	Professional	Local of organization	Ethnographic	Literacy
Low	Local	Hierarchy within organization	Case study	Oral knowledge

Fig. 15.8 Codifying local knowledge

also risks bureaucratizing it and freezing it in time (Fig. 15.8) (Nugroho et al. 2018). Local knowledge only sometimes interacts with bureaucracy, but in connection with other forms of professional knowledge, it can play an important role. The abstraction of this process is the recognition or cultural recognition and the identity of *To Kaili* for broader interests, namely disaster mitigation in Palu.

At least the results of this study identified three legacies of Kaili cultural values related to disasters, namely (1) *Kayori* or Kaili poetry system, which has disaster values; (2) toponymy or mention of territories by basing on the history of disasters, and (3) custom houses with a stage system design and derived from wood that is adaptive to earthquakes and tide seawater. The first cultural heritage that has a relationship with disaster is *Kayori*, which is a type of oral literature in the form of telling stories utilizing speech (t*utura*) accompanied by the use of a series of musical instruments such as *yori, harp, gimba*, gong, and other musical instruments. *Kayori* is synonymous with messages from elders about past events being a reminder for the present life to be conveyed by singing. The research team found some examples of *Kayori* in disasters, for example, "*Agina Mainga, Ne Maonga*", which means "it is better to be careful than to drown". However, to find sources of regulatory reference, especially Regional Regulation Number 9 of 2016 concerning Kaili Customary Institutions, no article or provision regulates explicitly and protects the preservation of the Kaili language, in this case, *Kayori*. The protection regulated in Article 20 is only related to values and customs. Therefore, there needs to be information that identifies the value of customs in the explanatory provisions. *Kayori*, which can be categorized as one of the models in the form of verses about disasters and is part of the language of indigenous peoples, is not used as an instrument regulated in any regulations in Palu City.

So, it is not surprising that among the respondents interviewed by the research team regarding the knowledge of *Kayori* as a narrative or verse reminder of disaster vulnerability in Palu, as many as 85% answered that they did not know. This condition was also reflected in the Kaili language teaching workshop held by the Central Sulawesi Cultural Development and Trustees Council (DPPBK) at the Central

Sulawesi Cultural Park. At the workshop, it was stated how sad it would be if the Kaili people no longer knew their language one day. In addition, a linguist from the United States, Donna Evans (as cited in Jamrin 2010: 92), who had researched the Kaili language for several years in the Palu valley, once expressed her concern about the possible extinction of the Kaili language (Taha 2015).

Although not as neat as local documents in the Aceh and West Nusa Tenggara regions (in ownership of earthquake, tsunami, and liquefaction manuscripts), the Kaili Tribe also has traces of disaster mitigation with very long traces or biographies in the Palu valley. It is characterized by the emergence of local terminology inherently attached to the events or origins of place names, such as Petobo, Jono Oge, Naombo (Abubakar 2019). Nonetheless, there is a gap and contradiction between the legacy of toponymy values as customary recognition and the administration regarding the mention of the region's name. The instructions and wisdom of the Kaili Tribe in the form of toponymy were not entirely adopted by the Palu City government in naming administrative areas or roads. In general, the naming is based only on the national hero's name. A history of disaster experience of Kaili Tribe explained by Lasimpo in "Mitigasi Bencana Berdasarkan Pengalaman Suku Kaili di Lembah Palu" (Disaster Mitigation Based on the Experience of the Kaili Tribe in the Palu Valley). Lasimpo's study used the 16 villages used as research samples, most in Donggala Regency[1] and Sigi Regency[2] have toponym, and the process of naming their areas has a history of disaster. Have toponymy, and the process of naming their areas has a history of disaster. Meanwhile, the toponymy in Palu City only found three places whose naming is related to traditional houses, and *vatu tela* stone causes sparks or mountains (Lasimpo 2019).

In addition, other problems arose from the weak literacy of the government in implementing toponymy, namely the construction of Duyu permanent housing carried out after the 2018 tsunami and liquefaction. In Kaili toponymy, *duyu* means "landslide". Unfortunately, the government's carelessness and ignorance of the Kaili language made them carry out development in a landslide-prone area in the event of a disaster. As a result, 630 new dwellings were built by the Ministry of Public Works and Public Housing. The development is based on a loan from the National Slum Upgrading Program-Contingency Emergency Response Component (NSUP-CERC) of Rp. 44.5 billion (Bahfein 2021).

Another thing that concerns the cultural heritage of the Kaili Tribe that is adaptive to earthquakes or liquefaction is the modeling of buildings or traditional houses or what is known as *Souraja*. Research conducted by *Kompas* after the tsunami and liquefaction in 2018 showed that houses with such models could also withstand

[1] Ape and Malikomean the winding hills are overgrown with rattan, also called gonjo or mud, that occurred in liquefaction earthquakes in the past, at government administrative become Amal Village, Sindue District, Donggala Regency; Taijo "Terenjes" means much water, based on the Kaili Rai dialect. At the exact location, it is known as lome or muddy ground, at government administrative become Tompe Village, Sirenja District, Donggala Regency.

[2] Pombewe, means the mention of natural events called a tobe land or landslide, and the existence of a boat mooring site called Rano Njakaya, at government administrative become Pombewe Village, Biromaru District, Sigi District.

tsunamis if the water does not carry a large discharge. The traditional houses of Central Sulawesi on the Trans Sulawesi Line toward Banawa District still stand upright. Traditional buildings of the Kaili Tribe generally use wood with better bending power than concrete materials. The use of materials affects the strength of building structures against shocks (Haryanti, 2018).

Nonetheless, the heritage of indigenous houses is not institutionalized or adopted by the government in development policies. For example, in the economic and industrial areas in Palu City, there are only a few government buildings built by adopting the Kaili tribal model. These buildings include Tadulako University, Central Sulawesi Regional Planning, Research, and Development Agency, and the Siranindi Building, the official house of the Governor of Central Sulawesi Province. The phenomenon of neglect of the concept of the Kaili Tribe's traditional houses cannot be separated from the legal politics of regulation from the government, both provincial and Palu City, which indeed does not make Kaili Tribe houses a standard for development after the tsunami and liquefaction. From the two documents studied, the traditional house of the Kaili Tribe has degraded in value because it is only placed on the material aspect. In Article 17, paragraph (1) of Regional Regulation Number 9 of 2016 concerning Kaili Customary Institutions, the government considers traditional houses only a source of wealth for traditional institutions. For this reason, Palu City Regional Regulation Number 16 of 2011 concerning the Palu City Regional Spatial Plan for 2010–2030 places the traditional houses of the Kaili Tribe only in the context of cultural preservation. The provisions of Article 56 letter (b) confirm that the Kaili or *Souraja* traditional house built by adopting a house or palace left by the Palu Kingdom became a strategic area of Palu City's importance of sociocultural functions.

The Regional Government of Palu City needs to learn from the Regional Government of Aotearoa in New Zealand. They can position themselves as partners of Maori Tribe to seek of status as mana whenua (holders of territorial authority) as equal and self-determining entities (Howard-Wagner et al., 2018). Under the Local Government Act 2002, local authorities do not have the status of a Treaty partner. Instead, they have a range of responsibilities to involve Māori in decision-making, to take account of Māori "culture and traditions with their ancestral land, water, sites, *waahi tapu*, [sacred sites] valued flora and fauna, and other taonga" and to have processes in place for consultation with Māori (Howard-Wagner et al. 2018). It demonstrates the proper position of local government in reorganizing indigenous peoples.

In a more specific context, the absence of recognition of Toponym, *Kayori*, and traditional house in policy is a form of failed recognition. More precisely, the local government's management failed partly because their policy does not base on local knowledge (Nugroho et al. 2018). Recognition through Local Regulations as a public policy, but to improve local knowledge in public policymaking, we need to work with local knowledge through its political dimensions.

15.3 Recommendations

If viewed from the point of view of *the Kayori aspect,* it is crucial to encourage the Palu City Government to do two fundamental things in the framework of protecting the noble heritage of Kaili in disasters, namely the implementation and adoption of *Kayori* values. The first effort that needs to be made is the identification and verification of all *kayori* that are still scattered among the traditional elders to be comprehensively documented as government archives. In addition, it is also necessary to carry out learning mechanisms for future generations. The second effort that needs to be made is the regulation in the regulation or regional policy for preserving the language and *Kayori* of Kaili. With a solid legal basis, interventions in implementing programs, budgets, and conservation efforts are getting more robust. It is hoped that *Kayori* will become a reference in disaster mitigation efforts in Palu City and its surroundings.

The government must comprehensively know toponyms to name territories or administrative areas. The government, through its apparatus, must recognize the origins and history of the Kaili Tribe. It is related to toponymy which will determine the formation of regional spatial regulations. The government can organize areas to realize zero settlements, namely limited areas for activities and safe zones for developing economic centers and settlements.

The cultural heritage of indigenous houses needs to be reviewed in regulations so that it is not simply interpreted as a source of natural wealth for indigenous institutions and is limited to cultural functions only. It is necessary to draft regulations to become guidelines in development throughout Palu City, especially in disaster-prone areas. In addition, the preparation of regulations or binding rules for disaster zones is difficult to reach due to access problems. The lifeblood of the local community must also be utilized to the fullest to implement the regulation.

15.4 Conclusions

In Indonesia, there is recognition of indigenous peoples in the constitution. The recognition puts the state as a filter and puts many prerequisites. The Kaili Tribe has existed and lived and has a conventional system. Recognition of the institution is not only to preserve its culture alone but to protect and preserve its existence. *Kayori* is a type of oral literature in the form of storytelling by speaking (*tutura*) accompanied by a series of musical instruments. *Kayori* is synonymous with a message from an elder about past events as a reminder of the present life delivered by singing. The Kaili Tribe also has traces of disaster mitigation with a very long-life history in the Palu valley. The position of local knowledge that is not well institutionalized and only passed down in oral tradition has a weak binding power—efforts to encourage it through Regional Regulations as a public policy. To increase local knowledge in public policymaking, we need to work with local knowledge through its political dimension. The government, through its instruments, must recognize the origin and history of the Kaili Tribe. It is related to the toponymy that will determine the formation of regional spatial regulations.

Based on the study in this book chapter, it is concluded that the Kaili Tribe has local wisdom in disaster mitigation *through Kayori in the* form of oral speech, architecture on stilt houses, and naming places based on disaster history. These three local pearls of wisdom should ideally be simultaneously adopted in every policy, urban planning, and disaster mitigation in Palu City. The involvement of *To Kaili* in implementing regional policies based on local wisdom is an important thing that must be implemented immediately in the development of governance and urban planning of Palu, Central Sulawesi. The Central Sulawesi Government's attention to the existence of *To Kaili* is quite vital to prioritize. Cultural products in the form of reading materials and guidelines based on *To Kaili* local wisdom, such as dictionaries, written forms of the oral traditions of the Kaili Tribe, and Kaili language verses need to be documented. In addition, efforts to revitalize, socialize, and document *To Kaili's* local wisdom, especially related to disaster mitigation, must be pursued immediately.

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Chapter 16
Achieving Rural Water Security Through Traditional Knowledge: A Comprehensive Appraisal of Traditional Water Harvesting Techniques Used in Dry Lands of Purulia District, West Bengal, India

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Abstract Water security concerns the sufficient availability of equitable access to water for humans and the ecosystem. Drylands are the worst geographical region affected by chronic seasonal drought and water crises due to their geo-climatic condition. Purulia district of West Bengal state in India has a long history of seasonal drought and summer water crisis which calls for some adaptive measures to sustain the water-secured future. The district has a unique identity with its significant concentration of indigenous communities who have been practicing different traditional resilient techniques to prevent the risk of water insecurity. This chapter highlights these traditional adaptive measures practiced by different indigenous communities in the district. Based on the secondary data sources and primary data collection through the focus group discussion (FGD) in different villages, we have thoroughly assessed

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_16

the traditional water harvesting technologies for different purposes. This study also attempts to present the theoretical foundation of nature-based resource conservation and multi-level policy-driven approaches for securing water in the dry land rural setup. The result shows different levels of water harvesting systems in the district for multiple usages ranging from domestic usage to irrigation purposes on one side and the multiple government policy-driven approach on another for a secure water future for dry land rural development.

Keywords Water security · Dry lands · Rural · Indigenous · Risk · Resilience

16.1 Introduction

Water is a finite resource, and its availability varies regionally based on its geophysical, climatic, and socioeconomic status. The term water security (WS) implies two different aspects, one is water for human consumption and another is water for the environment. From the anthropocentric perspective, WS relies on affordable and equitable sharing of benefits for all, where no one is far behind in water utilization. WS for the environment means water competence to sustain the ecological system. WS has four components that combine water availability within a system, accessibility of water, water risk and hazard, and water management (Holmatov et al. 2017). Among the four components of WS, water availability is the primary integer that acts as a foundation for the remaining three components. Water availability denotes how much water is physically available within a system (Srinivasan et al. 2017). If it is scarce, then it usually creates a regional water crisis. Thus, WS is an umbrella term that combines water scarcity (lack of physical water availability) and water crisis (lack of water affordability). Water availability and accessibility become more critical in some fragile ecosystems, like dry land ecology (Bradford et al. 2020), which gets the direct negative consequences of global climate change (Lian et al. 2021). Throughout the globe, drylands are the most threatened ecology due to the factors like decreasing amount of rainfall (Sintayehu 2018), increasing temperature (Lian et al. 2021), deforestation (Leite-Filho et al. 2021), land degradation (Willemen et al. 2018) with wasteland formation (Kar et al. 2020) that also provides ample amount of risk for the local livelihood. More specifically, globe dry lands in Asia and Sub-Saharan Africa are worst affected by regional marginalization (Jobbins et al., 2018). About 2.3 billion people live in water-stressed countries, of which 733 million live in highly and critically water-stressed countries (UN-water 2021). It affects more than 40% of the global population (United Nations). Almost 80% or more of wastewater returns to the environment without adequate treatment (Jones et al. 2021). Even the concentration of indigenous communities is abundant in some dry land parts of the world (Feng et al. 2020). In order to sustain the economy and livelihood generation, most indigenous communities are practicing nature-based solutions to restore water and other associated resources (Vohland and Barry 2009; Binyam and Desale 2015; Ali 2016). The rural dry land setup needs to have proper water utilization where both water for irrigation and domestic utilization and water for ecology need to integrate with an optimum equilibrium state. Rural water security (RWS) in dry land comes with four major elements: domestic water utilization, water for irrigation, water for the ecosystem, and water risk and hazard (particularly drought). Water management gets the specific notation through water harvesting techniques (WHT), where water is collected from the runoff to surmount the deficiency and utilize it in multiple ways (Beckers et al. 2013). The primary nature of WH is more interlink with the land–water nexus. However, some of the other factors within a system determine the efficiency of WHTs. These Major sub-entities include geophysical factors like rainfall, potential evapotranspiration, slope, rock structure, and catchment character. Apart from the geophysical and climatic conditions in a region, the sustainable WHT need to be assigned to environmental, economic, and social aspects. The dry lands are one of the geographical sets known for their aboriginal concentration; thus, the region-specific uniqueness of WH is also common. In this regard, the term indigenous knowledge (IK) and traditional knowledge (TK) is synonyms for each other, where both are assigned with long historical interactions between the man-environment that help to build certain knowledge (Das et al. 2022). TK is the idea, skills, and practices that are inherited from one generation to another whereas IK is the subset of TK commonly developed and practiced by a particular indigenous community considering the natural environment, which is sometimes inseparable from their traditional cultural values and spiritual beliefs (Gunara et al. 2019). The main positive features of indigenous TK are as follows: (1) cost-effectiveness, (2) providing long-term solutions, and (3) nature-based or less or no damage prone to the natural ecosystem. Among the different forms of water resources like surface water, atmospheric water, and groundwater, the traditional WHTs show different global imprints. Study shows that wide-ranging traditional WHTs are being applied in areas where annual precipitation is between 100and 1500 mm and a population density of about 10–500 per km^2 (Melkania 2008). But, another group of scholars has shown that the WHTs are predominant in those regions where the annual rainfall is between 100 and 700 mm (Tumbo et al. 2013; Lebel et al. 2009). In some cases, although the region receives adequate rainfall, the adjacent topographic characteristics cause low groundwater recharge and high surface runoff. For instance, parts of the Chota Nagpur plateau in India are composed of hard rock terrain that causes high surface runoff and shallow groundwater tables (Kar et al. 2020). In Gujarat state (particularly in the Amreli district), hard rocky terrain is not capable of rainwater harvesting. Hence, the construction of check dams and percolation tanks is acceptable with a regional geophysical setup (Soni 2006; Hardiman 1998). Among the different types of WHTs, some of the specific traditional methods adapted to dryland environments, like collecting surface runoff through rill and slope (Strohmeier et al. 2021), harvesting flood water (Prinz and Singh 2000), tank system (Bitterman et al. 2016), rainwater reservoir (Beckers et al. 2013), human-made cave system to restore water (Prinz and Singh 2000), groundwater dams (Oweis and Hachem 2006), rooftop WHT (Tamaddun et al. 2018), and inter-row WHT (Prinz 1996), are predominant within WHT. Although, each of the specific WHTs fulfills a particular aspect of water security. For example, rooftop WHT is particularly applied to fulfill household water demand (Adugna et al. 2018; Alim et al. 2020). The inter-row WHT is applied to fill the irrigational water demand for crop production (Zhang et al. 2022). The rainwater harvesting system through silt traps in Australia is applied to fulfill water demand for animals (Lakel III et al. 2010). Apart from the fulfillment of human water demand, some tools of WHT are applied for human–environment water demand. For example, a micro-catchment system to support the annual crop production will also tackle soil erosion (Kurothe et al. 2014). In some cases, rainwater reservoirs in Northern Vietnam are used for paddy cultivation and become an effective human-made tool to control soil erosion, prevent floods and recharge the groundwater. A wider set of academic literature has considered the positive and sustainable relationship between traditional practices for the conservation of the environment. However, apart from the positive relationship between traditional practices and the environment, some regional economic practices hampered environmental sustainability. Apart from the different sets of traditional WHTs applied in different geographical setups, there are few contemporary methods practiced by indigenous society. For example, restoring the 'marginal water' becomes quite well applicable in certain regions of the globe. Collecting flood water and conserving fog and dew are considered 'marginal water' (Prinz 2002). The diversion of flood water from streams bed has been recognized as a possible cropping adjustment in Middle East and North African countries. Similarly, the collection of fog drip becomes effective for agriculture in the coastal zones of Chili, Peru, and Cape Verde (Fessehaye et al. 2014). Hence, considering all these above-mentioned aspects, this chapter tries to highlight dry land rural water security by applying different traditional WHT. For that, we have taken the Purulia district of West Bengal state, India, as a case study where we have tried to incorporate different sets of traditional indigenous methods to restore water for different utilization. Simultaneously, we have undertaken different government policies and suggested methods to conserve water for this dry land drought-prone area to achieve long-term rural water security.

16.1.1 Aim and Objectives

The present study highlights different WHTs practiced by dryland communities, particularly in rural settings. More exclusively, the chapter seeks to explore multiple WHTs where traditional knowledge is being implemented in the dry semi-humid region of West Bengal state. The following objectives are as follows:

i. To address the meaning and implication of traditional knowledge (TK) to conserve environmental entities.
ii. Highlight different traditional WHTs in different dry land setup across the globe.
iii. To conserve water in the dry land of West Bengal, with particular reference to rural setup.

16.2 Methodology

The chapter aims to highlight the traditional water harvesting methods in dryland systems, which drives us to manifest two different sets of knowledge production. The *first* one is to synthesize the nature of different traditional water harvesting methods in the dry land region across the world. The *second* one is to set out the practical illustration of some of the traditional water harvesting (WH) structures that try to secure RWS in the dry land area of West Bengal in India. Hence, the chapter undergoes two approaches parallel; the first is the theoretical foundation of traditional knowledge with its implication in dry land–water security, whereas the second is the case-specific study of the practical manifestation of some traditional water harvesting technologies that involve traditional local knowledge. Based on the two different sets of study, we have obtained multipurpose approaches ranging from narrative review for providing the theoretical base of the study, to purposive random sampling and focus group discussion (FGD) for the practical implication of the study. Figure 16.1 represents the flow chart of two different study sets, along with the multi-level assessment and data collection for the study.

We have considered the narrative review approach of the study for obtaining rigorous knowledge synthesis on traditional knowledge (TK) and its implication on natural resource conservation. We have evaluated many empirical and conceptual papers on traditional knowledge, indigenous resource utilization, and the necessity to obtain traditional knowledge to conserve natural resources. The second stage of our literature review seeks to explore some examples of traditional water management systems in dryland areas of the globe. We have considered literature written

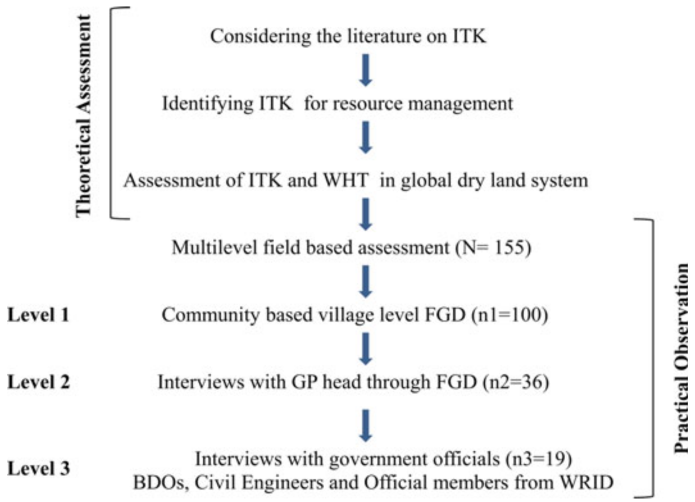


Fig. 16.1 Flowchart representing the multi-level of assessments and the data collection tools applied at each level

in English published in different years across different disciplines (mainly Anthropology, Geography, Biology, and Environment History). In this stage of our analysis, we have specified different structures of water harvesting along with their categorization based on the nature of water harvesting, like surface water (SW), atmospheric water (AW), and groundwater (GW), description of the structure and purpose of utilization.

Based on the theoretical foundation from the first section, we have tried to evaluate field-based practical examples from the study area to obtain some of the specific traditional water harvesting structures. Keeping this in mind, we have taken the Purulia district, the dry land area in West Bengal state in India. Since it is an environmental anthropocentric approach where human society makes a complex relationship with their natural environment (Salick et al. 2020), we have considered the material observation method to know the explicit uses and background of different water harvesting structures. Since the district had its socialist and tribal rebellion movements in the past, therefore before choosing the blocks and villages, we thoroughly discussed with the government officials about the present socio-political condition of the villages, the communication network connection, and the feasibility of conducting the study. Keeping all the above-mentioned aspects in mind, we have selected a total of 9 villages from 8 g Panchayat (GP) of 5 different blocks (Table 16.1 and Fig. 16.2). Villages selected by random sampling have a significant concentration of indigenous communities. However, none of the villages is explicitly tribal villages, as our focus was to obtain the traditional WHT instead of identifying the tribal clan's specific WHT.

We initiated our field visit in 2019 (January–February), and after two years of gap due to the pandemic, we resumed our field-based data collection in 2022 (June–August). Based on the pre-existing literature on traditional water harvesting methods in dryland areas in the Purulia district (Bauri et al. 2020; Oweis and Hachum 2009)

Table 16.1 Different WH structures at the village level of the Purulia district

S. No.	WH structures	Village	GP	Block
1	Open Pat Kua	Malthore	Belma	Purulia 2
2	Close Pat Kua	Benryadi	Genrua	Balrampur
3	Hallowed Geyser (Sita Kund)	Ajodhya	Ajodhya	Baghmundi
4	Dari Structure	Tamna	Chakaltor	Purulia 1
5	Dighi system	Biltora	Chharradumdumi	Purulia 2
6	Bandh system (Rani Bandh)	Keshergarh	Keshergarh	Hura
7	Pukhur	Bandhgar	Chharradumdumi	Purulia 2
8	Hapa structure	Malthore	Belma	Purulia 2
9	Goira	Chakra	Lagda	Purulia 1
10	Doba	Bela	Bela	Balarampur

Source Field observation

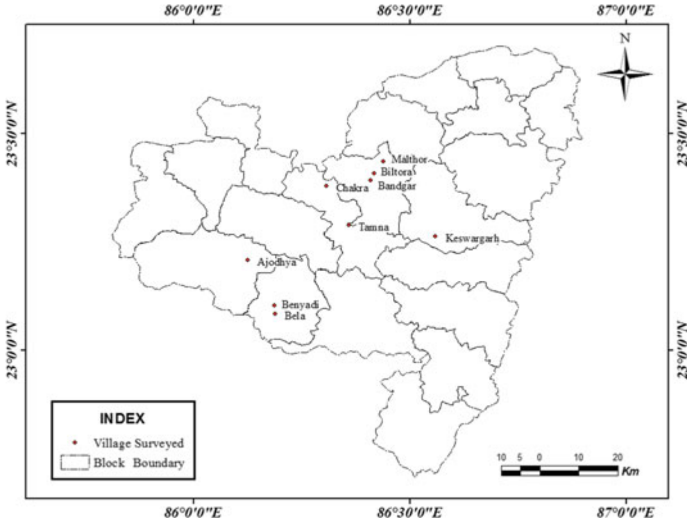


Fig. 16.2 Village surveyed in the study area

and adjoining other parts of the district, we have prepared our conceptual foundation of different water harvesting structures. More importantly, we examined different WHTs based on a location-based community survey in each village. To identify different WHTs, we made a small group of each village to explore some of the different WH structures. Each WH structure differs based on its location, uses, and construction. Therefore, we framed a set of questions for each of the WHT, like the following: (1) the background of the structure, (2) specific utilization, (3) the type of ownership, and (4) who is maintaining the structures. We have gathered our primary data based on multi-level investigation and interviews. For example, in level 1, we select ten individual respondents for each individual WHT ($n1 = 100$ as 10 individual * 10 WH structures) to get the detailed information on different WHT. In level 2 of the field-based assessment, we interact with 36 GP heads ($n2 = 36$) through semi-structured interviews. After the community-based survey, he tried to intermingle with some government officials (level 3). For that, we conduct a brief interaction with a total of 19 official members ($n3 = 19$), like Block Development officers (BDO), official members of Water Resource Investigation and Development (Agri-irrigation campus of Belgium in Purulia-2 block), and civil engineers from the corporation office. The interaction with government officials was not only for gathering knowledge against the WHT adopted by the traditional society rather obtaining in detail information on different government policies like *'Ushar Mukti,' 'Jal Dharo Jal Bharo,'* and *'Jalatirtha,'* which are based on water resource management for the district.

16.3 Results and Discussions

The chapter has two major sections of the study; one is the theoretical base which includes the narrative of traditional knowledge (TK) with its applicability for resource conservation along with case-specific WHT in global dryland setup and another one is practical inferences of different WHTs for securing dryland RWS.

16.3.1 Traditional Knowledge and Its Applications for Environmental Conservation

In this chapter, the terms indigenous knowledge (IK), traditional knowledge (TK), and local knowledge (LK) are used interchangeably. People attached to a particular environment and depended on it to sustain their livelihood also accomplished some inherent knowledge from one generation to another. The TK or IK is not only some level of skill developed over a period within a particular geographical setup, rather it is being recognized as the social capital of the home-grown community (Islam 2013) and the community-level decision-making process to secure livelihood (Charles and Berkes 2021). Indigenous knowledge is dynamic and gets matures through the trial-and-error process. Therefore, the nourishment of TK depends on how long human-environment interaction prevails within a particular geophysical environment. In this regard, Berkes has considered that it will take 200 years of continuous man-environment relation to understanding environmental entities correctly and then it may transform into a TK within a setup. The traditional knowledge of indigenous society is the overall decision-making process that is associated with man-nature interconnection (Ellis, 2005; Kuokkanen 2018), land reclamation (Sandlos and Keeling 2016), forest conservation (Sinthumule and Mashau 2020), and wildlife protection along with the protection of socio-cultural traits within a geographical setup (Lyons et al. 2020). Based on the available document and literature, it has been considered that the impulsion of traditional knowledge comes from two different streams. One group of scholars has claimed that traditional knowledge is how aboriginal communities practice sustainable living through environmental management (Moura et al. 2019). At the same time, the second group of scholars has claimed that traditional knowledge is being promoted and supported to enhance indigenous empowerment (Wilson 2004).

The application of traditional knowledge has been recognized into two separate categories: the methods of TK that have been approved by government officials, that is to increase acceptance of traditional aboriginal knowledge within government regulations and policies. Traditional aboriginal knowledge is sometimes unnecessary; instead, it can be considered the only way out for the community to detach from the leading streaming society. Sometimes, this aloofness comes from the traditional society to protect their traits, customs, and other socioeconomic practices (Hoque and Alam 2012). On the other hand, it is evident that in most cases, the locations of the aboriginal communities are being restricted in some remote inaccessible areas. Due to this remoteness and physical constraints, policies are diverted to more advantageous parts (Tonts et al. 2013). This is the reason why in the current worldview, the indigenous communities are being categorized as marginal (Robertson et al. 2012). The existence of traditional knowledge comes with two separate streams: One is intrinsic or self-induced and another one is obligatory.

In some instances, the TK becomes more integrated due to the different development approaches by government officials for the backward tribal society, which brings different environmental movements where traditional society makes agitation against the government policies and actions (Jacoby 2003). A group of scientific scholars considered the distinct nature of traditional knowledge and tried to consider it in a more specific narrative. When indigenous communities interact with their surrounding environment and build a symbiotic relationship with it, known as traditional ecological knowledge, alternately, another group of scholars has considered that TK is an overall knowledge that practices by the indigenous community (McGregor 2009). The concept of 'nature' and the 'conservation of nature' primarily originated from Euro-American societies (Stojanović et al. 2022). Compared to indigenous societies, they cannot make a difference between the human realms and the surrounding environment and pretend that the environment belongs to them (Joks et al. 2020). Based on the manifestation of indigenous communities with their environment, we could frame the development of traditional knowledge into two successive stages. In the first stage, the traditional society seeks to gather environmental knowledge through prolonged observation. In the second stage, they apply some tools and techniques to make them resilient against the dynamic change of environmental entities and sustain their economy. This sense of understanding comes from the deep-rooted interaction of indigenous society with each of the environmental entities (Morris 2010). For example, at the time of the Hudson Bay Bioregion project (2003), policymakers and researchers first time recognized and understood the environmental change through the application of TK, where the aboriginal elders were able to identify the changing nature of the climate, sea-level rise, and another dynamic status of environmental entities.

The application of indigenous knowledge is a nature-secured practice that provides long-term sustainability. Nevertheless, it is unavoidable that the way indigenous connected themselves with their surrounding environment, the same way non-indigenous could not assimilate them with nature. The embodiment of ingenious to their surrounding environment was ignored by the colonial settlers in many parts of the globe. Even in many fields of the academic context, the integration of indigenous and nature has been perceived as the magical connection between indigenous and nature (Chambers and Gillespie 2000). This typecast narrative about traditional knowledge was transformed after the globalization era when the encroachment of resources, environmental degradation, and rising population growth called for nature-based resource utilization to secure human society in the long run (Maes and Jacobs 2017). This new paradigm shift in the man-nature relationship pushed the planners and thinkers to adopt and consider more nuanced perceptive and admiration for what many call an 'Indigenous way of being' (Dumont 2002). This also brings the concept of co-existence between the indigenous perspectives with different policymakers, government officials, and academicians (Kar et al. 2020). The co-management strategies where indigenous knowledge and government policy merge are not essential tools to resolve any issue. Rather it depends on the region and perspectives of the problem.

In most cases, co-management may not apply in every policy stage. Instead, it can make the general foundation of the policy, and because of the separate culture and traits of indigenous communities, which is the foundation of their mankind, comes as a barricade on the practical application of a policy entirely within a region, as different indigenous societies may have a different set of values and customs that makes compromise from ultimate aim of the policy. For example, the connection of spiritual and religious beliefs on natural resources among the indigenous community may conserve natural resources. However, at the same time, it will obstruct government policy. For example, peoples of the Borana community obey the wells as the *Konfi* (father), consider them holy, and do not take water from wells (Behailu et al. 2016).

However, TK may inevitably act as a tool that may apply to mainstreaming civil society based on its requirement. This is because of the advancement of mainstreaming society to different tertiary activities and technologies. They are not as close to nature as the traditional society. There are two prime areas where traditional knowledge can be an essential tool that could serve a long-term healthy environment for all humankind:

(a) TK is a tool to make resilience and risk preparedness from catastrophe events.
(b) TK is a tool for resource management.

TK can be recognized as an essential tool for risk reduction and preparedness for unwanted circumstances because traditional society considers the surrounding biodiversity as a buffer against deviation, change, and disaster (Salick et al. 2020). In coping with risk due to excessive or low rainfall, drought, and crop failure, some traditional people grow many different crops and varieties with different susceptibility to drought and floods and supplement these by hunting. For example, before the tsunami outbreak in the Indian Ocean tsunami outbreak 2004, Onge tribes of India's Andaman Islands predicted the storm. They migrated to the upland areas, which made them safe and sound (Rajendran et al. 2013). Secondly, there are worldwide instances where TK has been recognized and practiced as a tool for natural resource management. For instance, traditional society cannot narrate climate change and global warming. However, they can observe seasonal rainfall changes and rising precipitation (File and Derbile 2020). Over the last 40 years of the twentieth century, the temperature in Ghana rose about 1 °C. The rainfall decreased by approximately 20–30%, which caused the drying up of several riverbeds (Gyampoh et al. 2009). With this drying environmental stipulation, local people have adopted rainwater harvesting strategies where rainwater is collected in big barrels and placed under the roofs of houses (Gyampoh et al. 2009). Another example is India's dry and semi-arid regions show some traditional water harvesting techniques, where methods like *Johads* and *Baoli* are predominant. *Johads* system is primarily practiced in the parts of Rajasthan state of India, a structural barrier that arrests the runoff of rainwater (Borthakur 2009). On the other hand, *Baoli* is a step well structure to store water in dry summer, primarily abundant in Gujarat and Rajasthan (Sivakumar et al. 2021). Based on the case studies in Rajasthan state, a group of Indian scholars has shown how traditional water harvesting methods rely on dry land ecology and are not necessarily applicable in every area. However, water harvesting is a practice that may not apply to a region all of a sudden. Instead, making it a part of life builds resilience for the future. Global climate change through increasing temperature and decreasing rainy days may transform a water-blessed region into a water-deficit region. Hence, water harvesting is essential, but it is arguable how far the modern technologies are insufficient in some regions where TK of water harvesting is recommended; also, why do some regions need modern water harvesting technology rather than TK of water harvesting? To answer this question, we could frame the discussion into three possible aspects:

a. The application of only traditional knowledge of WHTs
b. The application of modern WHTs methods
c. The hybrid knowledge of WHTs, where there is an assimilation of traditional and modern techniques for water harvesting.

The traditional WHTs are solitarily practiced in concentrated aboriginal areas, where these traditional WHTs are part of their cultural integrity. These areas are primarily abundant in the marginal backward portion of a geographical location. Still, in some cases, traditional WHTs shows better outcome than modern engineering method. For example, the *Konso* community in Ethiopia adopted the natural engineering method to conserve water. The wooden mesh filters water and the stilling basin that settles silt coming in with flood before entering the pond (Behailu et al. 2016).

In comparison, the applications of modern WHTs are principally framed in the urban sector, where water is used for the aesthetic enhancement of the artificial human-made urban structure. Also, modern WHTs are highly applied in urban hinterland and suburban to the rural sector for horticulture and crop production. The hybrid WHTs that assimilate modern and traditional techniques to manage water resources (Sharma 2017) are abundant in both rural to urban centers. In urban centers, technologies harnessing modern WHTs are applied in the beginning. However, when rising population density and environmental degradation become limitless, water harvesting through the traditional way becomes a redeemer for healthy and sustainable urban structures. On the other hand, few of the geographical regions have several rural growth centers as the leading supplier for crop production for the surrounding areas. The increasing demand for food products may call for hybrid WHTs in the rural sector so that the production of food may achieve without any environmental destruction. Some indigenous communities are practicing modern and hybrid approaches to WHTs. For example, the integrated water resource management (IWRM) approach is practiced by *the Konso* tribe of Southern Ethiopia, where they integrate a water-land conservation strategy to effectively utilize water resources. However, the surrounding of *the Konso* community has considered one of the listed heritage sites by the United Nations Educational, Scientific and Cultural Organization (UNESCO) (Behailu et al. 2016).

In this chapter, we are primarily focusing on traditional WHTs to achieve dry land–water security. The applicability of TK for water harvesting is solely considerable in those parts of the glove where water availability is substandard; therefore, dryland ecology where water is scarce requires nature-based WHTs. The reason for adopting nature-based WHTs is through the globe, dry land ecology is fragile, which responds negatively to climate change impacts. This requires the method to restore water where both humans and the environment get benefitted.

16.3.2 Water Harvesting Techniques for Drylands

Different geographical setup calls for specific patterns of WHTs where dry lands are the most difficult portion of the earth, and adopting WHTs is a big challenge (Sixt et al. 2018; Binyam and Desale 2015). Due to the limited amount of available water resources, dry lands are being recognized as an unfavorable setup to adopt WHTs (Rockström et al. 2010). Also, climate change induces temperature and rainfall anomaly (Abera et al. 2018), land degradation and restricted proportion of productive lands (Petersen et al. 2021), regional marginality (Parwada et al. 2022), and lack of capital investment with improper policy implementation (Patel et al. 2021). On the other hand, drylands are the primary hot spot where the concentration of marginalization communities (underdevelopment) is significant, and the abundance of the indigenous community is more significant than in other ecological regions (Maldonado et al. 2016). Hence, the regional underdevelopment accelerates inadequate water infrastructure in the dryland system, which leads to the overdependence on traditional WHTs to sustain the livelihood of commons. However, not all communities in dry lands are equally vulnerable, where factors like historical knowledge about the surrounding environment, participation of all, and, most importantly, coping with nature's dynamic character develop the local commons' resilience. The inception of ITK is for the solution of any problem of society, and it becomes self-motivated over time based on the maturity of the problem. Especially in the dry lands of west Asia and North Africa set out some of the explicit traditional WHTs, where the TK improved over the period by trial-and-error process (Gadgil et al. 1993). The traditional water harvesting methods have a deep-rooted association with the dry land environment. Water harvesting technology was invented in Iraq over 5000 years ago for agricultural purposes (Zakaria et al. 2012). In Jordon and Yemen, water harvesting methods were invented over 5000 years ago and 1000 BC, respectively (Prinz 1996). In Yemen, water storage of runoff water was utilized for Sorghum production. In Baluchistan, traditional water harvesting methods like *Khuskaba* and S*ailaba* have been applicable since ancient times (Khoobfekrbarabadi et al. 2020). Countries like Israeli have shown strategic outcomes through WHTs, where the association of land–water nexus is being recognized as the base of what is in dry environments. Multiple experiments have been obtained for WHTs in the Negev desert of Israel (Tepper et al. 2020). Traditional WHTs are considered 'true water harvesting' (Berking 2014), one of the prime tools to sustain dryland systems, particularly local economies. Throughout the globe, there are three dryland environments where WH systems are widely confined: arid, semi-arid regions, and sub-humid regions (Ackermann et al. 2019). The arid environments are primarily concentrated in the northern portion of Africa, where WHTs like runoff irrigation, terrace systems, micro-catchment systems, and check dams are primarily predominant (Prinz 2002; Beckers et al. 2013).

On the other hand, the semi-arid regions through the globe are primarily distributed in Mediterranean regions where rain-fed agriculture is dominant and WHTs like reservoir systems (storing of irrigation water), large sluice systems with a settling basin for the water distribution, terrace construction, and flood furrow irrigation are applied (Beckers et al. 2013). In the sub-humid environment, seasonal dry and wet phases are interchangeable in some monsoon-dominated areas where a pond ecosystem at the village level is applied in every part (Meter et al. 2014). Table 16.2 shows some region-specific water harvesting strategies in the dry land environment.

The main question is why traditional water harvesting is necessary for dry land in the contemporary world. In this regard, dry lands, particularly in the global south, experiencing uneven capital investment and areas superior to crop intensification attract the planners and government to invest first. This phenomenon is quite common in the global south due to the limitation of wealth and high land-man ratio. As a result, efforts are likely to be concentrated in suitable areas where production will be optimum with less effort to increase regional agricultural production. This brings low economic affluence in a dry land environment, which restricts technological intervention that can upgrade the agro-economic status of the region. Thus, traditional WHTs are effective where water resource is limited proportionally; this also carries viability and eco-friendly connectivity with resource utilization and natural conservation (Samuel and Mathew 2008). However, in this aspect, studies have revealed that combining traditional methods and modern technology may instigate optimum productivity with sustainable water utilization. The water harvesting strategy is essential in areas at high risk due to low precipitation and failure of crop yield. More importantly, it will enhance the vegetation cover and protect against land degradation in dry land. At least harvesting water for crop production or other uses may give more than nothing, where the region can attain self-sufficiency. This not only brings a satisfactory standard of living in dry land setup but also stabilizes the rural communities through the restriction of urban migration.

16.3.3 Purulia District and Its Water Resources and Traditional Water Harvesting Techniques

General Description of the Study Area

Purulia district is situated in the westernmost part and is the oldest site in the West Bengal state. The district is recognized as representative of the rural system and primary activities. Where about 88% area of the district comes under rural, and about

Table 16.2 Traditional and indigenous water harvesting techniques in the dry land environment of the world

S. No.	Name of the water harvesting technique	Nature of WH			Description	Region	Purpose			References
							Human need		Environmental requirement	
		SW	AW	GW			Domestic	Agriculture		
1	Minches			√	Water is moving horizontally through a least fractured rock strata and wherever it is exposed on surface, a spring or 'Minch' is formed	Ethiopia	√			Dube and Phiri (2013)
3	Typical rainwater harvest		√		Typical rainwater harvesting through catchment system	Bahi in Tanzania	√	√	√	Kibassa (2013)
4	Bandsar	√			Flood water accumulation with the help of levees along the contour lines	East and Northeast of Iran		√		Samani et al. (2014)
5	Khooshab	√			Cross-dam construction with the combination of soil and stony materials	Southeastern region of Iran Baluchistan and Pakistan		√	√	Samani et al. (2014)
6	Jessour system	√			Construction of barricade through stone walls that serves water to Fig and olive trees	Tunisia			√	Oweis et al. (2001)

(continued)

Table 16.2 (continued)

S. No.	Name of the water harvesting technique	Nature of WH			Description	Region	Purpose			References
							Human need		Environmental requirement	
		SW	AW	GW			Domestic	Agriculture		
7	Wadi bed system	√		√	Store the natural flow water by blocking system	Especially in WANA region	√	√		Oweis et al. (2001)
8	Jessour system	√			Store diverted water flow through the blocking of wall structure	Jessour system		√		Calianno et al. (2020)
9	Hafair system or Roman Ponds	√			Tank water system	Mainly confined in Sudan, Jordan, and Syria	√	√		Oweis et al. (2012)
10	Cisterns system				Small-capacity dug wells	Jordan and Syria mainly	√			Ammar et al. (2016)
11	Rhettars			√	Underground handmade tunnel that functions as a channel	Particularly in Morocco		√		Marzol and Sánchez (2008)
12	Matfia system			√	Underground rainwater storage constructed with dirt and stones	In El Jadida region of Morocco	√			Aziz et al. (2020)
13	Abar Romani	√			The narrow dug well that is being constructed below the spring on mountain slopes	Through Syria	√			De Pauw (2008)

(continued)

Table 16.2 (continued)

S. No.	Name of the water harvesting technique	Nature of WH			Description	Region	Purpose			References
							Human need		Environmental requirement	
		SW	AW	GW			Domestic	Agriculture		
14	Wadi Dams	√			Diversion of flood water into a storage	Particularly in WANA region		√	√	Omrani and Ouessar (2008)
15	Khadin		√		Runoff water collection that comes from rain through the constriction of small embankment	Hyper arid zones in Rajasthan, India		√		Goyal et al.
16	Nadis		√		Village ponds that are meant to store rainwater at rainy session	Mainly Indian villages	√	√	√	(Kumar et al. 2016)
17	Kuan		√		Small dug well that is meant to collect percolated rainwater from sandy soil	Barmer and Jaisalmer district of Rajasthan, India	√			(Machiwal et al. 2004)
18	Marab system	√			Agro-pastoral watershed system	Arid regions in Jordon		√	√	Dhehibi et al. (2020)
19	Qanats system	√		√	Consists of water production (underground part) section and water transport (surface part) section	Abundant in Syria		√		Wessels (2003)

(continued)

Table 16.2 (continued)

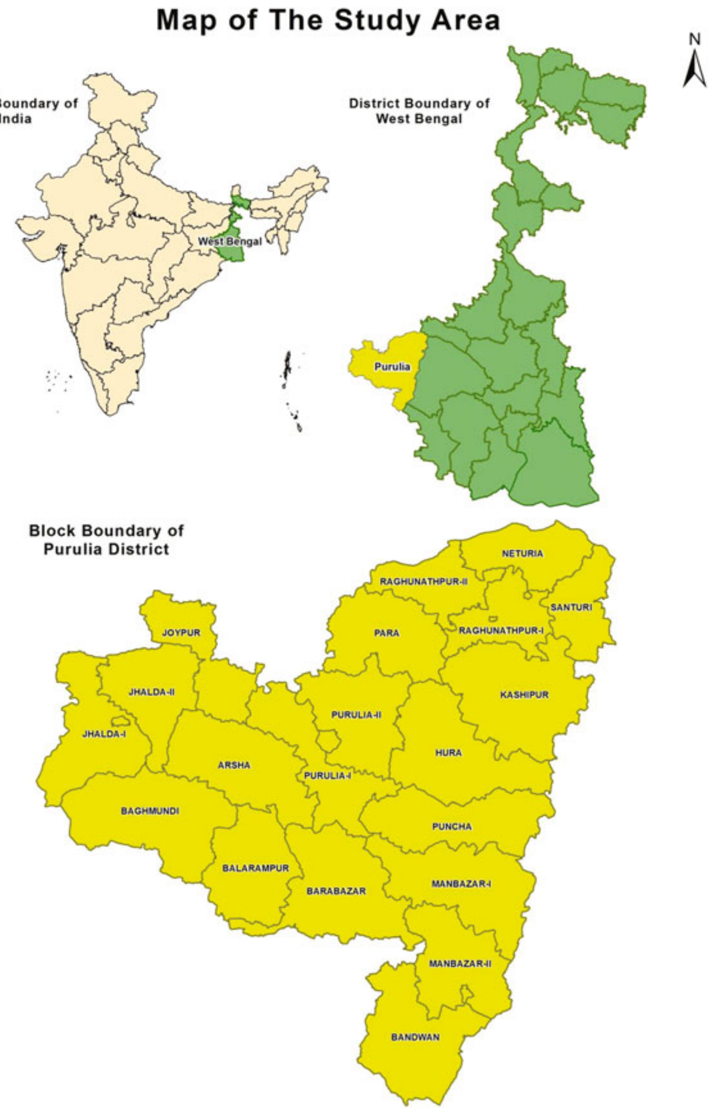
S. No.	Name of the water harvesting technique	Nature of WH			Description	Region	Purpose			References
							Human need		Environmental requirement	
		SW	AW	GW			Domestic	Agriculture		
20	Karez system	√			An irrigation system that is made up with underground-aboveground canals and reservoirs	Turpan basin region in China		√		Abudu et al. (2014)
21	Aflaz system	√			Deep water table through an underground tunnel	throughout Oman	√	√		Al-Ghafri et al. (2007)
22	Khettara			√	Large underground tunnel that acts as a porous gallery to store underground water	Southern Morocco		√		Fitzwilliam-Hall (2012)
23	Virdas	√			Small holes on dry riverbed for collecting water at summer session	Runn of Kutchs in Gujrat	√			More (2020)

73% of the main workers are from marginal primary activities. Geo-climatically, the district has ancient rock strata (primarily granite and gneiss) and falls under dry sub-humid climatic conditions. The summer temperature of the district reaches up to 48 °C, whereas the winter temperature of the district reaches near about 5 °C. The rainfall of the district is monsoon dominated. The district has an altitude of 748 feet, and the slope of the district decreases from northwest to southeast. As per demography, the district has a total population of 2,930,115, of which 51.09% are male and 48.91% are female. Cultivation-wise, the district has mono-cropped with its paddy cultivation which covers 83% of the total agricultural area. The district has its traditional cultural artefacts due to the concentration of several indigenous groups like Santhal (60%), Bhumij (18%), Sabar (7%), Munda (6%), and Bihor (1%) (Daripa 2019). A significant portion of the district comes under Jungle Mahal province, known for the dense forest coverage and concentration of several traditional aboriginal societies. Apart from the above-mentioned characteristics, the district is representative of dry land regions affected by regional drought and drought conditions.

The District and Its Water Security

Purulia district has a long history of regional water crises and drought-prone conditions (Kar et al. 2020). This westernmost part of West Bengal state in India has its cultural richness due to the significant concentration of Indigenous people. On the other hand, the primary area of the district is under *Jungle Mahal province, and the concentration of tribal society is under this jungle mahal province.* Some of the major rivers flow from this region, and the district also receives sufficient rainfall (about 1400mm/year on average); still, it is one of the water-scare regions in the state and India. Water is the fundamental input for regional growth and the local economy, and it becomes more crucial when the regional economy is exclusively reliant on primary activity. In the case of the Purulia district, out of the total agricultural holding, about 73% belongs to small and marginal farmers having scattered and fragmented smallholdings. Water stress conditions and substandard cropping yield force the cultivators to switch from crop production to other activities (Kar et al. 2020), which is the prime reason the district is considered one of the most backward parts of the state and the country (Bagli and Tewari 2019).

Water stress is one of the reasons for the significant concentration of wasteland in the district; about 60% of the total cultivated land is upland. There is a significant proportion of wasteland that comes under potential resources. However, any land reclamation strategy has been included in incorporating water-land management. In this regard, if within a geographical setup, the quantity of water is limited, then how is it possible to attain sustainable regional growth without compromising ecological balance? This requires a series of studies to understand how to attain water-secure conditions within water-stress regions. The primary task is to highlight the acting elements for water-insecure conditions in a setup. Among the four components of WS (availability, accessibility, risks, and management), the physical availability of water is determined by the region's geophysical and climatic conditions.



Purulia district has its ancient crystalline rock terrain (mainly Granite and Gneiss) that makes rapid subsurface runoff; also, hard rock creates the barricade for water percolation to recharge the groundwater. Among the 21 blocks in the district, 20 blocks are considered drought-prone. On the other hand, the slope of the district acts like a donor entity for the surrounding district due to its direction from northwest to southeast (Kar et al. 2020). Apart from the geophysical reason, the district has a positive trend of temperature growth (Dey et al. 2015), which accelerates the rate of evapo-transportation. The above-mentioned geo-climatic and physical reason is the primary input that makes the region's water deficit. The accessibility of water or other resource relies on the availability of that resource in a setup, where accessibility of water is determined through class, caste, religion, and ethnicity. In this regard, Basu et al. (2021) show how class and cast-based untouchability among the communities determines the accessibility of water from the water reservoir system. This manifestation of power relation with resource utilization is an obvious outcome when there is a resource limitation. Considering the water risk and hazard, the central portion of the district (about 16 blocks) is highly affected by Fluoride contamination of groundwater (Chowdhury et al. 2022). On the other hand, the non-perennial river system of the region accelerates the summer water crisis and drought conditions. From the water management perspective, water governance has played an effective measure through the application of multipurpose water managing projects since the last decade. For example, programs like *Ushar Mukti* and *Jal Dhoro Jal Bhoro* are considered effective measures to retain regional water sufficiency. The *Ushar Mukti* agenda is a mega watershed development program covering six state districts, including Purulia. This ridge-to-valley approach is meant to restore rivers by maintaining soil erosion and groundwater development through plantation and water harvesting. On the other hand, *Jal Dhoro Jal Bhoro* is a large-scale water harvesting method that considers the restriction and collection of runoff water with the help of minor irrigation structures.

Purulia District and Its Traditional Water Harvesting Technology

The district has multi-level water management policies, but we must not avoid the fact that '*One Size Doesn't Fit all,*' which depicts the region has multiple cultural communities with regional geophysical constraints. The district has a significant concentration of aboriginal community, who are primarily manifest with their own socioeconomic and cultural integrity. The socioeconomic development of the tribal people has been mistreated from the British phase to the present time of globalization. These aboriginals have a unique lifestyle of their own which keeps themselves away from the touch of modernity. Another reason why the aboriginal communities are untouched by modernity is the water management policies applied so far by government organizations are quite latest (onwards 2010), making the aboriginal people more reliant on nature-based water harvesting technologies. Secondly, the concentrations of semi-tribal communities are bounded in the inaccessible part of the district, where the fruit of government policy has not been reached yet. These are the prime reason why still in the modern era, aboriginal communities in many parts of the globe have their nature-based resource management strategy. For the district, local traditional knowledge of indigenous communities profoundly impacts nature-based water resource management. Several traditional WHTs have been identified in the districts and applied for different purposes. In Purulia, rural water resources are tackled through rivers, water bodies, and well (*Pat Kua*) structures. Among these three sources of water resources, manufactured structures like different water reservoirs and wells provide economic, ecological, and socio-cultural significance, particularly in the dry land. Based on the primary survey, we have identified different types of wells, water reservoirs, and added water harvesting structures where the

Fig. 16.3 Open Pat Kua structure at village Malthore of Belma GP in Purulia-2 block

WHT profoundly impacts sustaining water resources in the district. The following mentioned water harvesting structures are profound in the study area.

(a) **Pat Kua**: This system is a semi-circular underground hole primarily constructed with bricks and cement. The depth of the well varies from place to place based on the underground water table. However, the average depth of wells in this region is 20 ft or more due to deep aquifers. In regional language, wells are referred to as Pat Kuas, owned by a single to multiple households. As per the primary survey, there are two types of Pat Kuas that are predominant in the region. One is an open Pat Kua system (Fig. 16.3), and the second is a covered one (Fig. 16.4). The open Pat Kuas need more maintenance as the marginal community advocates them in most cases.

In contrast, the covered Pat Kuas are primarily constructed to protect the water from pollution, which are generally maintained by wealthy farming societies. For example, Fig. 16.3 shows an open Pat Kua system in Malthore village of Belma GP in Purulia block 2, which is mainly used for household drinking purpose and maintained by the marginal Kurmi (Mahato) community. On the other hand, Fig. 16.4 shows a closed elevated Pat Kua structure in Benryadi village of Balarampur block, which is used for drinking water purposes for households and maintained by the village Pradhan (leader).

(b) **Hallowed Geyser (Sita Kund)**: Among the different water harvesting sources, geysers are the natural source of water that comes directly from the ground water table through cracks and joints. Most of the plateau and mountainous regions have such natural water sources. In the Purulia district, some well-known natural geysers exist, among which Sita Kund (Fig. 16.5) is the most ritualistic and sacred water system of Baghmundi block at village Ayodhya.

Fig. 16.4 Closed Pat Kua structure at Benryadi village of Genera GP in Balrampur block

This hydrothermal feature has its own beliefs and significance since the local commons treat this feature as the construction of lord Ramchandra for his other half Sita. Hence, this structure is only used for ritual operations, mainly protected by the Santals community of the area.

(c) **Dari System**: Dari is a small semi-circular hole beside dry rivers semi-permanent in nature and collects subsurface water mainly in summer sessions,

Fig. 16.5 Sita Kund at village Ajodhya of Ajodhya GP in Baghmundi block

Fig. 16.6 Dari structure at Tamna village of Chakaltora GP in Purulia-1 block

primarily operated by women. The upper bed of the river is dry during summer, while the subsurface flow of water still consists of water from the subsurface that comes out from these human-made small holes. Diaries are considered natural filters as the water comes from sand particles. Hence, it is being utilized for drinking water. Figure 16.6 shows one of the semi-permanent Dari structures beside river Kansai of block Purulia1 at village Tamna.

(d) **Dighi System**: Based on the size, ownership, and utilization, there are five types of water bodies and reservoirs identified in the study area Dighis are more extensive, and structures like Pukhur, Hapa, Goriya, and Doba are being identified successively based on their size. Dighis are signified for sustaining ecosystem services and household water demand primarily. Sometimes, Dighis are too large that it serves more than one village. Generally, Dighis are not privately owned and maintained by the village Gram Panchayet. They are permanent and collect rainwater, but the amount of water in Dighis oscillates from summer to rainy session. Figure 16.7 shows the Dighi system at the village Biltora of Charra Dumdumi Gram panchayat of Purulia-II block. As Dighis are large, water utilization is gender, cast, and religion impartial. However, as the amount of water decreases in summer, the power struggle for water accessibility becomes a common phenomenon.

(e) **Pukhur and Hapa System**: In some cases, Hapa and Pukhur are more or less similar in size, but ideally, the area of Pukhur is larger than the Hapa system. Another difference between Hapa and Pukhur is that Hapa is mainly constructed to boost crop yield and pisciculture, whereas Pukhurs have multiple uses. Pukhurs are sometimes considered sacred grooves (having a spiritual connection protected by a particular religious community), but Hapa's are only constructed for economic gain (Malik et al. 2014; Asase et al. 2016). Figure 16.8 shows the

Fig. 16.7 Dighi system at Biltora village of Chharradumdumi GP in Purulia-2 block

Pukhur system in Keshargarh village of Hura block, which is presently used for bathing. The structure is known as Rani Bandh, as it was built during Kashipur king dynasty for royal uses. Currently, this structure is mainly conserved by Santals and the Bauri community of the village. Another example of water harvesting through village level religious dogmatism is in the village Bandgar of Charra Dumdumi Gram Panchayat at Purulia-2 block, where the pond is being utilized for the Hindu cremation site (Fig. 16.9). However, for a few years, water bodies that were only used for ritual traits have been utilized for multiple purposes. This is because of the limitation of choice for people to make separate utilizing from one single natural resource for a single aspect. Based on the nature of investment and regional requirements, Hapas are different in sizes and types, like-concrete tanks, Hapa in the pond, and Hapa in tanks and ponds (direct). Figure 16.10 shows the Ponds (direct) hapa system in Purulia-2 block, village Malhotra, Gram Panchayat Belma, which is primarily used for fishing, pisciculture, and small horticulture.

(f) **Goira and Doba System**: Goira and Doba are more or less similar in size, but in a few acute cases, Dobas have smaller areas than Goira. Both are small rainwater harvesting structures that are permanent or semi-permanent in nature. One dissimilar thing among these two water harvesting structures is that Goiras are adjacent to the human habitat (Fig. 16.11), with multiple uses ranging from fishing to cleaning. On the other hand, Doba is not uniform in structure; sometimes, they are too small that are only used for animal consumption (Fig. 16.12), and there are no such specific uses for Doba.

On the other hand, as per the man-nature relation and changing pattern of climatic parameters, the necessity for the amalgamation of traditional knowledge and modern

Fig. 16.8 Rani Bandh at Keshargarh village of Keshargarh GP in Hura block

Fig. 16.9 Pukhur at village Bandgar of Chharradumdumi GP in Purulia-2 block

Fig. 16.10 Hapa system at village Malthore of Belma GP in Purulia-2 block

Fig. 16.11 Goira structure in village Chakra of Lagda GP in Purulia-I block

water harvesting methods can be a unique approach for a secure water future. Since not all areas are coping with traditional water harvesting techniques and not all require modern water harvesting techniques. Due to the manifestation of man-environment interrelation, the traditional WHTs also get shifted and assimilated with modern WHTs. Hence apart from considering nature-based traditional WHTs, we need to welcome modern techniques for water harvesting within a setup. In this circumstance, we have obtained the traditional WHTs (from the secondary data sources)

Fig. 16.12 Doba structure at Bela village of Bela GP in Balarampur block

and proposed modern WHTs for the Purulia district for dry land–water security (Table 16.3).

The overall water security and different water harvesting methods are well balanced through the amalgamation of the local community, government policy, and regulations, with the identification of problems and solutions by academic scholars. These three groups need to integrate and set out the methodology for attaining a secure water future in the dry land area like Purulia district. We must accept the fact that achieving absolute WS is next to impossible in some locations due to geophysical constraints and changing man-nature interaction. Table 16.2 represents the threefold class for managing water resources in the Purulia district, where each group has a distinct level of water harvesting strategies. The traditional society secures water in a natural and eco-friendly nature-based way, which is economically viable (Karim et al. 2021), sustainable (Li et al. 2021), and separated from any communal disputes (Mushavi et al. 2020). The second category is the proposed action plans given by different academic domains. The district is being recognized as an ultimate area for water security research, where disciplines like civil engineering detect the suitable site for the construction of water reservoirs and tanks (Bera and Das 2021; Agarwal et al. 2013); in the field of geology, detecting liniment density to construct artificial recharge got prioritized (Sur and Acharya 2020; Chowdhury et al. 2021); a few of literature on rural studies have shown perception studies on WS and climate change nexus (Basu 2021; Basu et al. 2021, 2017); agriculture scientists have shown crop suitability analysis with different small-scale irrigation method (Sarkar et al. 2014; Habibie et al. 2021); the multivariable issues have taken by geographers, where the significant number of pieces of literature have shown the site suitability analysis based on physical and social parameters to construct water reservoir (Kar et al. 2020) and drought assessment (Roy and Hazra 2020; Mishra and Desai 2005); in the field

Table 16.3 Different types of water harvesting techniques practiced and proposed in Purulia district

Type of water harvesting technique	Name of the method	Nature of the method	Applied areas/blocks/tribal clans	Purpose	References
Traditional water harvesting techniques (practiced)	Plastic-lined Doba Method	Polythene-lined (200 um UV-stabilized black polythene), small pond for harvesting of direct rainfall	Mainly among Santhal tribes particularly Jhaldah1 and Baghmundi	Mainly for fruit orchard	Naik et al. (2016)
	Happa system	Mud-excavated rainwater harvesting structure	Abundant in all over the region	Mainly to grow paddy and vegetables simultaneously to reduce the risk factor at summer	Jana (2011); Phansalkar and Verma
	Sacred grooves	River, small watershed, or ponds are being considered as holy	Abundant in scatter form mainly in Santals tribe-dominated villages	People are not using water from sacred grooves for domestic or irrigation purpose but indirectly it maintains ecological balance	Khan et al. (2008)

(continued)

Table 16.3 (continued)

Type of water harvesting technique	Name of the method	Nature of the method	Applied areas/blocks/tribal clans	Purpose	References
	Moisture and dew storage	Specifically for sugarcane cultivation, farmers plow the land so it could absorb the dew at night and land becomes nourished with moisture	Mainly in Arsha block (Sirkabad)	For sugarcane cultivation	Bauri et al. (2020)
	Terrace cultivation	Constructing a series of canals in specific intervals to prevent runoff frequency	Applicable in upland and undulating areas mainly	Mainly for irrigation purpose	Sarkar, (2018); Mishra and Rai (2013)
	Drip irrigation through Bamboo	To use minimum amount of water, bamboos are used as pipe that drips water in the root zone of crops and vegetables	Purulia-II (Jahazpur)	Mainly for vegetable cultivation	Bauri et al. (2020)
Modern water harvesting techniques (proposed)	Rooftop WH cum Artificial recharge	Rainwater could be stored and transferred to the underground tank	Can be applicable in all over the region	For domestic purpose use	Halder and Sadhukhan (2012)

(continued)

Table 16.3 (continued)

Type of water harvesting technique	Name of the method	Nature of the method	Applied areas/blocks/tribal clans	Purpose	References
	Sub-surface dykes/underground dam	To raise surface water level particularly in summer to sustain a subsurface barrier across stream which retards the base flow and stores water upstream below ground surface. By doing so, the water levels in upstream part of ground water dam rise saturating otherwise dry part of aquifer	Ideal location for a dyke is a well-defined, wide, greatly sloping valley with a narrow outlet having limited thickness of loose soil or porous rock on the top with massive or impervious rock below	For small-scale irrigation mainly in summer season	Halder and Sadhukhan (2012)
	Water budget method	Assessment of water demand, supply, total water availability, and water loss within a system	Applicable in entire district	Drought tolerance Prevent risk factor from summer water crisis	Mishra et al. (2022)
	Sprinkler irrigation	To reduce the evaporation and effective use of water for crop production	Applicable primarily in small plot of land in all over the district	For vegetable production in small estate (Horticulture)	

(continued)

Table 16.3 (continued)

Type of water harvesting technique	Name of the method	Nature of the method	Applied areas/blocks/tribal clans	Purpose	References
	Rubber check dam	Rubber dam is just like a check dam, but made of rubber sheet, which is inflated with water or air	Applicable in low sloping to flat areas	For irrigation purpose	Deopura and Chahar (2011)
	Pond lining /farm pond	To prevent water percolation with the help of bricks, cement, paddy husk with cow dung	Applicable where the soil structure is sandy clay loam	Used for irrigation purpose	Kolekar et al. (2021); Reddy (2012)
	Semi circular bunds	Network of earth bunds shaped as half-circles with the tips upside and on the contour	Ideal for deep soils with low slopes and require even topography	Mainly for bushes and tree plantation	Oweis and Hachum (2009)
	Runoff strips	Crop strips alongside of steep slope to reduce the runoff	Mainly upland areas and steep sloping areas where agricultural lands are limited	Force cultivation of up steep slope	Yazar and Ali (2016)
Government Project/policy (applied)	Jal dharo jal bharo (2011)	Large-scale harvesting of rainwater and arresting runoff water	Comes under the entire district as well as adjoining parts of the state	Mainly for irrigation purpose	GoWB (2011)

(continued)

Table 16.3 (continued)

Type of water harvesting technique	Name of the method	Nature of the method	Applied areas/blocks/tribal clans	Purpose	References
	Ushar Mukti project (2)	Ridge-to-valley approach (watershed management)	Comes under the entire district and adjoining parts of the states	Multipurpose utilization and restoration of other resources with water	
	Jalatirtha Scheme (2015)	Water infrastructures (pond, tanks, and check dams) and minimizing evaporation	All over the districts and other adjoining parts as well	Irrigation and domestic use	GoI (2018b)
	West Bengal Inland fisheries act (1984 and 1997)	Ponds are coming under pisciculture cultivation through proper act	Throughout the district but in scattered form	For Pisciculture	Datta and Das (2013)
	West Bengal Wetlands and Water Bodies Conservation Policy, 2012	Tanks/ponds have been marked as wetlands and degraded water bodies are restored	In few major water bodies in the district	Mainly to restore ecology along with economy	Chowdhury and Behera (2022)

Source Based on the secondary data sources of zoology, different nature-based water harvesting methods are being prioritized (Bauri et al. 2020). Regional constraints and pre-existing provincial backwardness are major obstacles to applying the proposed water harvesting techniques given by scholars in different fields. Nevertheless, in the last decades, the region came into the light for the implementation of some state-level water-related policies like *Jal Dharo Jal Bharo* and *Ushar Mukti* that seek to endorse water harvesting strategies and ridge-to-valley development. The water governance in Purulia district has shown its reliability through the implementation of *the West Bengal Inland Fisheries Act* (WBIFA) successively in 1984 and 1997, which was mainly concerned with restoring tanks/ponds through the implementation of pisciculture where ownership can be transformed based on the norms and regulations (Chowdhury and Behera 2022). The main drawback of the above-mentioned schemes as they did not consider restoring ponds to secure water but rather launching pisciculture to strengthen the rural economy. As a result, the conservation of rural water bodies was not for water conservation but rather for securing the economy, which set out the dichotomy between economic enhancement and environmental consideration. Even per the act, local owners are bound to use their water bodies only for pisciculture, where they have no right to decide to utilize a pond system. During the eighth five-year plan (1992) state government launched Water User Association (WUA) which asserted that the local water users could make rules to restore and use water bodies effectively. During the second half of eight five-year plans, the Accelerated Irrigation Benefit Program (AIBP) was launched to promote micro-irrigation structures, including pond and canal water systems in rural areas. In 2005, the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) was launched to enhance employment in the rural sector, considered to provide irrigation water and enhance water infrastructure for agriculture production. However, MGNREGA has not meant to restore traditional water bodies in the rural sector, as it was not fully considered to restore water resources in the backward rural sector, rather paying attention to the specific water bodies which are efficient for irrigation purposes. Later on, in 2012, the National Wetlands Policy (NWP) was endorsed by West Bengal in different parts of the state, and it was the first time ponds and tanks were recognized as wetlands. The second half of NWP in 2018 was reversed from the first half, and it was not considered the pond and traditional water system as wetlands and practiced real estate development (Karthikeyan and Swathilekshmi 2017). Apart from the policies like WUA, AIBP, NWP, MGNREGA, and WBIFA, which are comprehensive and applied in every part of the state, programs like *Ushar Mukti* and *Jal Dharo Jal Bharo* are only meant to restore the dryland ecosystem and economy (GoI, 2014; 2018a; 2018b).

From the above discussion, it is clear that regions where water is inadequate need to have the amalgamation of local knowledge and modern water harvesting techniques for water sustainability. However, from the above discussion, some of the points that represent the gaps in water policy in the region that make it a prolonged water-insecure part of the state are as follows:

i. Conventional water bodies have not been acclaimed as the base to secure water in the region; instead, they are categorized only as economic entities.
ii. Excluding the programs like *Jal Dharo Jal Bharo*, most policies must be thoroughly water focused. For example, the *Ushar Mukti* program integrates land–water development through watershed improvement. However, it is the standard integration of all-natural resource development within a particular watershed instead of considering small water bodies and restoring the surrounding ecology.
iii. Policy inconsistency is another gap that leads to water-stress conditions in the region. For example, the NWP in 2012 considered the pond water system a wetland. In contrast, NWP in 2018 tried to incorporate the traditional pond system for real estate development instead of considering them as a tool for the local economy and ecosystem enhancement.
iv. In some instances, the spiritual beliefs on natural resources like water make aloofness from the regional policy where the occurrence of the struggle between indigenous values (religious or spiritual) and government policy regulation.

16.4 Limitation of the Study

The chapter undergoes with multi-level assessment of WHT in the light traditional knowledge for which it would be as essence to consider further observation on some of the extra water harvesting technologies by traditional society. In this regard, meticulous field examination is a way out to gather more information against the WHT by the traditional aboriginal society, but since many parts of the study area where the concentration of indigenous society is abundant are either inaccessible or unapproachable due to the geo-political constraints of the region. On the other hand, the current regional and global epidemic scenario there might be always a risk factor for overindulgence in some out-of-the-way parts of the study area.

16.5 Recommendations

The chapter primarily focuses on understanding aboriginal communities' acceptability of traditional WHTs in dry lands. In some specific instances, there might be a symbiotic relationship between modern water collection and traditional methods. However, the traditional methods are superior in water-insecure regions. Here said, the traditional WHTs could parallel the dynamic changes of environmental entities. Regardless of the favorable implication of traditional WHTs, it is also established in some cases where traditional WHTs seem more viable on a small scale. Therefore, due to geophysical and economic constraints, only some parts of a region may be capable of environmentally responsive water harvesting methods. This becomes more prominent through the application of water restoration policies by the state government of West Bengal. However, from 2011 to 2017, three total master plans were applied in Purulia and adjoining other districts. However, the characteristics of the applied plans are more or less similar, which brings the critical question of satisfactorily identifying the problem. Therefore, to make a sustainable water-secure future for the district, we have highlighted some of the recommendations:

i. First, the critical task is to identify the set of obstacles in different parts of the districts that creates water-stress condition.
ii. Identification of different geophysical sites where water is highly scarce and their physical water availability
iii. Make the traditional WHTs more appreciable through required assistance from local and state governments.
iv. As water harvesting is not an essence but a practice, it must also be spared among the water-poor and water-rich communities.
v. Creation of a hybrid water management system through the assimilation of planners and local community knowledge
vi. Multilevel planning needs to be more effective where some of the planes are water-focused, and some plans need to be more all-inclusive.
vii. Spreading out the concept to the community level that—water is a finite resource, it needs to treat as an economic good.
viii. In some cases, spiritual beliefs become integral to restoring water. Therefore, government regulation and policies must be separated from indigenous norms and values.
ix. Viable budget allocation and inclusive policy by state and central governments could bring more possibilities for sustainable changes for the district's water resources.

16.6 Conclusion

The present chapter seeks to endorse how traditional water harvesting methods could initiate and fill regional water demand and create a sustainable, secure future. Several works of literature have considered the positive aspects of TWH methods and water sustainability, particularly in a dry land where water is scarce. However, the research has not shown the long-term cost-benefit analysis of TWH methods in dry land. Is it possible that TWH methods would bring an optimum standard of living for the dry land communities? In this regard, it is obvious that the TWH methods are optimum for the water demand for small areal extensions.

On the other hand, it would be next to impossible to produce a bulk amount of productivity using TWH methods. Here, it is arguable whether economic efficiency and environmental conservation can parallel each other. It depends on a bunch of associated factors like policy, capital investment, and proper knowledge of resource utilization of local commons. The main problem in the global south, which brings non-parallel relation between environmental conservation and regional wealth generation, is regional biased development and negotiation of the marginal community by the name of adaptation. More simply, in the global south, capital investment is likely concentrated in some of the pre-developed parts of the country and areas where marginal communities are concentrated, and the planners impose nature-based resource utilization techniques. Even within the same region, the nature of water utilization could be seen in diverse ways. Where wealthy communities are likely utilizing water resources beyond their requirement, and aboriginal communities are under TWH methods. The traditional society adopts traditional resource management because they concentrate on fewer affluence parts within a region. Hence, adaptation of so-called eco-friendly resource management tools is only sometimes self-driven. Rather, they are associated with compromise and a lack of choices. In this scenario, adopting TWH methods or managing water resources is not only a choice but an essence, especially in the Indian scenario. Countries like India and other monsoon climatic regions must adopt water harvesting structures due to unpredictable climatic variables like rainfall and rising temperature. Hence, as we cannot control monsoons, we must make some positive behavioral changes, including recycling water, wastewater treatment, restriction in water consumption, and, most importantly, treating water resources as an economic good. Treating water resources as economic goodwill restricts the overconsumption of water, mostly among civil society. The managing system of water must have a network among the implementers, resource users, and moderators. Making a policy applicable in the long run requires the association of planners, policymakers, investors, and local commons. Moreover, for a more desirable eco-friendly water-secure future, the TWH methods need to be implemented to a larger extent with the association of traditional technology and modern water harvesting system. A sustainable water-secure future is not a sudden outcome; it is a daily practice for long-term solutions and a better water-secure future.

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Part IV
Science-Policy Interface Through Indigenous Knowledge

Chapter 17
The Journey Towards Understanding and Valuing Indigenous Knowledge for Climate Change Adaptation in Northland, Aotearoa-New Zealand

Sandeeka Mannakkara, Elrasheid Elkhidir, and Aimee Matiu

Abstract In recent years, Aotearoa-New Zealand has been experiencing a noticeable increase in storms, flooding, droughts, and wildfires along with sea-level rise and changes in temperature, rainfall patterns, and snowfall. Northland is a peninsula situated at the northernmost end of Aotearoa-New Zealand's North Island. Northland has been identified as a high-risk region vulnerable to coastal hazards, increasing temperatures, intense rainfall events, and drought periods. Rural communities, particularly Māori hapū and iwi (indigenous tribes of Aotearoa-New Zealand), are at high risk from these impacts due to their sociocultural reliance on coastal resources and the natural environment, and their economic reliance on primary industries such as agriculture and forestry. Māori possess extensive knowledge of local ecosystems, past disaster events, and climatic signs due to their close relationship with the land and environment, and rich tradition of preserving generational knowledge. Aotearoa-New Zealand's national climate change directives emphasise the importance of engaging with Māori and valuing mātauranga Māori (Māori indigenous knowledge). This research looks at how Northland's local government bodies are attempting to understand and engage with mātauranga Māori and hapū and iwi in their climate change and disaster risk-reduction efforts. The study adopted a qualitative research methodology with data collected from semi-structured interviews with local councils, hui (meetings) with a Northland iwi, and document review. The findings show that local councils portray significant interest and effort to incorporate mātauranga Māori. Smooth implementation is challenged by systematic obstacles, differing worldviews, and historic grievances of Māori towards colonisation and the

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_17

crown's actions against Māori. Focussing on common goals and understanding each other's challenges provide opportunities to overcome these challenges.

Keywords Climate change adaptation · Indigenous · Local council · Aotearoa-New Zealand

17.1 Introduction

The effects of greenhouse gas emissions from anthropogenic activities are becoming more prevalent with rising temperatures creating a range of adverse environmental and meteorological impacts around the globe (IPCC 2014). Several countries are working to alleviate their emission levels and build climate change resiliency in communities, including Aotearoa-New Zealand. A holistic perspective towards building resiliency requires the amalgamation of knowledge from different sources, such as scientific (Eurocentric or Western), administrative, local, and indigenous knowledge (Yumagulova and Vertinsky 2019). Indigenous knowledge refers to "systems of monitoring, recording, communicating, and learning about the relationships amongst humans, nonhuman plants and animals, and ecosystems that are required for any society to survive and flourish in particular ecosystems which are subject to perturbations of various kinds (Whyte 2017, p.157). It is gained through adaptive processes and passed between generations (Yumagulova and Vertinsky 2019). Indigenous knowledge thus tends to adopt a more holistic approach, unlike Western thinking and science (Morgan and Manuel 2020). However, indigenous knowledge is often overlooked as a credible source of knowledge in climate change and disaster research (Hosen et al. 2020).

Indigenous communities work closely with the environment and are already addressing the changes experienced by communities due to climate change. Using traditional knowledge to obtain food, preserve resources and forecast weather has given indigenous people the ability to be agile in responding to climatic change impacts (Mohamed Shaffril et al. 2020). The close relationship between indigenous people and the environment provides the potential for indigenous and traditional knowledge to fill gaps in climate change studies in Western science, especially at local levels. Indigenous communities perceive climate change issues as a physical representation of the dominant values of society. The dominant Eurocentric (Western) values that exist today prioritise economic development over the health of the environment (Cameron et al. 2021).

Recent attention has been given to indigenous knowledge and its importance in creating holistic climate adaptation and resilience-building strategies. The IPCC's fifth assessment report calls for combining traditional and indigenous knowledge with new strategies and policies to ensure long-term sustainability (Reisinger et al. 2014). Respecting indigenous communities and their knowledge, and aligning strategies and frameworks to the context and requirements of indigenous communities are integral for successful climate change adaptation plans (Mohamed Shaffril et al. 2020).

Since their first arrival in the land of Aotearoa (NZ), Māori (the indigenous people of Aotearoa-NZ) have observed, gathered, and transferred their learnings through "language, whakapapa [genealogies], technology, systems of law and social control, systems of property and value exchange, forms of expression, and much more" (Waitangi Tribunal 2011, p. 22). They have adopted several ways to codify their acquired knowledge, such as pūrākau (narratives), waiata (songs), maramataka (calendar), and whakataukī (proverbs) (Hikuroa 2017). This knowledge is known as mātauranga Māori (Māori knowledge). Mātauranga Māori is place-specific scientific knowledge in tune with the environment and climatic changes. The different ways of thinking evident between Western science and mātauranga Māori create different perspectives on climate change issues and how impacts should be addressed.

Aotearoa-NZ's vulnerability to climate change, coupled with its rich Māori knowledge, makes it a suitable site to study the importance of integrating scientific knowledge with indigenous knowledge. This chapter focuses on Aotearoa-NZ local authorities' efforts to achieve this in the Northland region which is home to a high proportion of Māori hapū and iwi (sub-tribes and tribes). Using data from semi-structured interviews with local councils in the Northland region, hui (meetings) with a dominant Northland iwi (tribe), and document review, the chapter aims to reveal the opportunities and challenges for understanding mātauranga Māori and engaging with and hapū and iwi in climate change and disaster risk-reduction efforts in the region. The study proposes a set of recommendations that could aid in bridging the gaps between local authorities and iwi to enhance the integration of mātauranga Māori in the authorities' climate change plans and efforts. An initial background about the projected climate change impacts in Aotearoa-NZ, te ao Māori (Māori worldview) and mātauranga Māori are presented, followed by the research methodology and case study information. Findings are then presented and discussed, followed by conclusions and recommendations.

17.2 Literature Review

17.2.1 Climate Change Impacts on Indigenous Communities

The most common impacts of climate change affecting communities include the changing frequency and magnitude of natural hazards such as droughts, heatwaves, wildfire, storms, flooding and landslides, and slow onset changes such as increasing temperature, sea-level rise, reduced snowfall, and melting ice caps (Archie et al. 2018; Hopkins et al. 2015; Yang et al. 2020). These changes impact the settlements, livelihood and economy, health and well-being, and heritage of indigenous communities. Despite their negligible contribution to greenhouse gas emissions, indigenous communities tend to be the most vulnerable to climate change impacts due to their close relationship with the environment, typically lower socio-economic status, and poor access to healthcare (Jones 2019). Indigenous communities are often also challenged with colonial histories that complicate their climate change adaptation planning with authorities.

Communities often tend to consider relocation as a coping mechanism when their livelihoods and the benefits they acquire from their surroundings, such as water and food, become unsustainable or start diminishing (Dandy et al. 2019). Climate change hazards pose several threats to the health and well-being of indigenous communities, including injuries and death from extreme events, damage to housing and healthcare facilities, adverse effects on mental health and productivity, and negative impacts on natural systems such as water, food, and air (Lansbury Hall and Crosby 2020). Historical assets and sites belonging to indigenous communities are exposed to the effects of climate change. In addition to their intrinsic value, historical sites increase the sense of attachment to land and community and are used for social congregations and networking in some areas such as the Pacific Islands.

17.2.2 *Indigenous Knowledge for Climate Change Adaptation*

Indigenous knowledge refers to "the understandings, skills, and philosophies of indigenous peoples, developed through long and multigenerational histories of interactions with the natural world and adapting to highly variable and changing ecological and social conditions including colonisation and globalisation" (Petzold et al. 2020, p. 2). Indigenous knowledge has enabled societies to successfully survive in a wide range of environments for many years. It constitutes a repository of experiences in and encounters within different types of environments and hazards. Indigenous knowledge has traditionally aided indigenous communities in detecting and predicting dynamic changes in the environment, enabling them to make informed decisions about harvesting, land use, and mobility. It also helped with monitoring climatic conditions, habitats, species, and landscapes of the environment to predict any possible environmental changes (Ford et al. 2020).

The literature provides several examples of the success of indigenous knowledge in enhancing the resilience of communities against climatic hazards. Indigenous knowledge was found to be highly relevant and beneficial in assisting indigenous farmers in Ghana in alleviating the risks caused by climate change, and File and Derbile (2020) recommended its adoption as a knowledge source for developing climate change adaptation plans. Chen and Cheng (2020) illustrated how the indigenous communities of Taiwan used environmental indicators such as the colour of clouds, the density of leaves on the plants, and tidal phenomena to predict upcoming floods. Hiwasaki et al. (2014) explored the indigenous knowledge related to hydrometeorological hazards in coastal and small-island communities in Indonesia, the Philippines, and Timor-Leste. Hiwasaki et al. illustrated how indigenous communities could mitigate, adapt, and prepare for climate-related hazards by using local food, materials and structures, observations of the environment, and customary laws and rituals. Granderson (2017) reported the exploration of integrating traditional bioclimatic indicators into early warning systems for climate hazards, and using the planting calendar as a baseline for assessing climatic changes in the local area by Vanuatu's indigenous communities. Petheram et al. (2010) voiced the concerns of Australian indigenous communities to address nonclimate issues such as health problems, loss of traditional knowledge, land rights, and infrastructure problems, including road access and water supply issues.

17.2.3 Indigenous Knowledge and Climate Change Adaptation in the Literature

The recent attention to the role of indigenous knowledge in climate change adaptation has sparked a plethora of research initiatives around the world. Classifying the available literature according to their research focus, four main categories could be identified including research in climate-related disasters, climate change monitoring and vulnerability assessment, community-based adaptation and co-management, and climate-related displacement and relocation research.

Climate-Related Disasters

Recent research on indigenous knowledge and climate change adaptation indicates the importance of integrating indigenous knowledge into disaster risk-reduction to increase the resilience and adaptive capacity of communities (Busayo and Kalumba 2021; Hiwasaki et al. 2015). Flooding and cyclones continue to attract significant research volumes (Bronen et al. 2020; Chen and Cheng 2020; Hutton and Allen 2020; Mwaniki and Stevenson 2017). Most studies in this field emphasise the importance of integrating indigenous knowledge into disaster risk-reduction phases like preparation, prediction, and recovery. Documentation and validation of disaster-related indigenous knowledge and utilisation of this in conjunction with scientific approaches can empower communities and result in better community buy-in for disaster risk-reduction plans and actions proposed to communities.

Climate Change Monitoring and Vulnerability Assessment

Valuable information that can be highly beneficial for planning purposes can be obtained from the observations of indigenous people regarding changes to weather patterns, biodiversity, and livelihoods (Wyllie de Echeverria and Thornton 2019). A significant portion of the livelihoods of indigenous communities is dependent on the environment, such as fishing and agriculture. Moreover, indigenous communities can occupy vast land areas. For example, indigenous people occupy almost a third of

Australian land, rendering them most aware and knowledgeable of their local environment (Sloane et al. 2019). The frequent interaction of indigenous communities with their environment continues to enhance their abilities in predicting environmental changes (Rosales and Chapman 2015). Community-based monitoring and assessment practices, underpinned by accumulated indigenous knowledge, provide the possibility of predicting further changes and decreasing the risks associated with climate change to communities (Salim and Monolisha 2019). For example, Sloane et al. (2019) reported how the indigenous communities of Northern Australia were able to report specific ecological changes and species dieback, making significant contributions to conservation science.

Community-Based Adaptation and Co-Management

Indigenous communities often rely on their acquired knowledge and their direct interaction with their environment to enhance their resilience and adaptive capacity. Collaborative efforts to alleviate the negative impacts of climate change are often adopted to device the appropriate measures to safeguard the whole community. Having unique worldviews, adopting different knowledge types and learning methodologies, using community-based institutions, and holding to cultural attributes were critical factors for climate change adaptation and resiliency (Galappaththi et al. 2021). For example, Sarkar et al. (2018) studied the fishery strategies adopted by the West Bengal indigenous communities and concluded that although the strategies required further optimisation, they could be used as a potential tool for adaptation and could confirm the practice of sustainable climate change-resilient fisheries management.

The provision of collaboration and co-management frameworks between governmental authorities and indigenous communities enhances the communities' resilience and yields better aligned plans and more sustainable climate adaptation planning (Christie et al. 2018; Weatherdon et al. 2016). However, despite the potential of using indigenous knowledge for environmental management applications, no consensus has been identified on the appropriate methods for incorporating indigenous knowledge within frameworks and plans. Although some aspects of indigenous knowledge cannot be fully included in environmental management, incorporating the values and worldviews of indigenous communities, and building relationships with them, increases the efficiency of climate adaptation plans and leads to more sustainable solutions (Zentner et al. 2019).

Climate Displacement and Relocation

Climate change impacts have caused the displacement of several communities worldwide. For example, communities of the Tlaxcala region in Mexico are forced to seasonally migrate in to cope with the declining precipitation rates affecting the agricultural livelihood, with similar circular migration trends exhibited in West and Central Africa (Warner et al. 2009). Similarly, floods exceeding the four metre mark jeopardise the rice agriculture activities in the Phnom Penh area (Cambodia), forcing the communities to relocate (Warner et al. 2009). With their deep sense of attachment to land and heritage, displacement of indigenous communities due to climatic hazards and events is a complex issue (Romero Manrique et al. 2018). However, relocation decision-making frameworks are lagging. The incorporation of indigenous knowledge into adaptation frameworks and support for community-led relocations can decrease the negative impacts on indigenous communities (Maldonado 2014). Empowering communities to monitor environmental changes and have the ability to make decisions with regard to the relocation can aid this process (Bronen et al. 2020).

17.2.4 Challenges in Integrating Indigenous Knowledge with Scientific Knowledge

Insights of indigenous knowledge are not entirely and effectively included in international climate change research (García-del-Amo et al. 2020). For example, Nelson et al. (2019) illustrated how the Iloilo indigenous communities in the Philippines had minimal influence over local and national decision-making on climate change adaptation plans, despite their valuable knowledge. They were seldom considered in academic, policy, and public discourse on climate change. Hill et al. (2020) explored co-production conditions between scientific and indigenous knowledge to support and help climate change adaptation pathways in central Australia, and concluded that respectful partnership, cultural governance, and working together are the foundations for knowledge co-production for climate change adaptation. Consent, trust, accountability, and revitalising the indigenous culture, knowledge, and practices constituted the foundations for good and sustainable relationships between the indigenous communities and the local authorities (Hill et al. 2020).

One of the challenges in studying indigenous knowledge is the lack of documentation of information about adaptation strategies for indigenous peoples in the peer-reviewed scientific literature. The experiences of the indigenous people are in the form of oral tradition, so they are not considered as valid as published scientific studies. This is one of the challenges of using indigenous knowledge in climate change adaptation. Another challenge is the translation of the concepts of climate change from tribal languages and maintaining the same meaning and concepts (Maldonado et al. 2016). It is essential to discuss climate change and adaptation in ways that acknowledge differences in knowledge systems.

17.3 Case Study Background: Northland, Aotearoa-New Zealand

Aotearoa-New Zealand's climate is predicted to undergo drastic change within the twenty-first century. Precipitation patterns are likely to undergo radical changes, with higher rainfall frequencies and floods in some regions and droughts in others (Ministry for the Environment [MfE] 2001). Sea-level rise is projected to reach as high as 1 m over the next century, magnifying the risks of coastal hazards, affecting a significant proportion of the Aotearoa-NZ population who prefer dwelling in coastal areas (Hughes et al. 2021; Manning et al. 2015). Extreme storms are also expected to adversely affect the regions of Aotearoa-NZ. Figure 17.1 illustrates the projections (2070–2099) for the average seasonal changes in Aotearoa-NZ. Aotearoa-New Zealand's climate change response is led by the Ministry for the Environment (MfE). The main relevant acts are the National Adaptation Plan, National Climate Change Risk Assessment, Resource Management Act 1991 (RMA), and the Climate Change Response (Zero Carbon) Amendment Act 2019, aligning Aotearoa-NZ climate change response to the goals of the Paris Agreement.

The Northland region (Fig. 17.2) is home to many Māori iwi and hapū, exceeding 64,500 Māori inhabitants (Northland Regional Council, n.d.-a). The Northland region has a total area of 13,940 km^2 with more than 3200 km of coastal fronts, exposing the region to sea-level rise, tsunamis, and coastal erosion (Northland Regional Council, n.d.-a). Māori-owned land tends to lay within low-lying areas prone to flooding and invasion by subtropical grasses. The forestry, dairy farming, agriculture, and tourism industries dominate the Northland economy (Chappell 2013; MfE 2018). Māori have deep-rooted connections with their land and often have lower socio-economic status with lower access to adaptation resources, increasing their vulnerability, and challenging their adaptation capacity (MfE 2001).

Northland's seasonal climate is temperate, with warm summers and mild winters. Precipitation patterns are intermittent, where rainfall is generous, but dry spells frequently appear throughout the year (NIWA 2016). The expected climate change

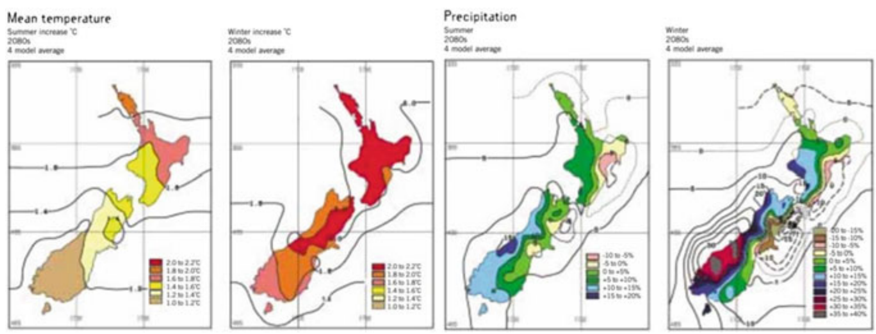

Fig. 17.1 Projected 2070 to 2099 average seasonal changes (MfE 2001)

Fig. 17.2 Map of Northland region. (Local Councils n.d.)

impacts on Northland are an increase in the number and frequency of coastal hazards, storms, droughts, disease, and invasive pests threatening biodiversity. Northland's temperature is expected to rise by 0.7 °C–3.1 °C by 2090, with an additional 13–75 days of temperatures exceeding 25 °C annually (MfE 2018). Precipitation is projected to decrease, and tidal records suggest that sea-level rise will continue to pose a significant threat to Northland's infrastructure (MfE 2018). Some livelihood crops, such as kiwifruit, will no longer be viable, mandating agricultural activity shifts, alternative crop consideration, or altering the land-use practices (MfE 2001). Social and economic issues will also emerge from the anticipated land-use changes and water availability and quality (Northland Regional Council, n.d.). The projected temperature rise and air pollution will cause health complications affecting the well-being of the communities. Northland Regional Council is attempting to address climate change through reducing carbon emissions, improving the infrastructure and communities' resilience to climate change hazards, funding and implementing research, and collaboratively joining efforts between the four Northland councils (Northland Regional Council, n.d.-b).

17.3.1 Māori Worldview and Indigenous Knowledge (Te ao Māori and Mātauranga Māori)

Te ao Māori is the Māori worldview that "acknowledges the interconnectedness and interrelationship of all living and non-living things" (Our Land and Water, n.d.). Te ao Māori considers that the spiritual and physical world are interconnected, and everything is viewed holistically. In Te ao Māori, fundamental values underpin tikanga Māori (the right way of doing things-based within Māori society) and cultural practices (Reilly et al. 2018). Tikanga is viewed as an ever-evolving way of life as it responds to the social, political, and environmental surroundings and adapts to the present, ensuring the well-being of the community. The set of values underpinning tikanga Māori include mana (authority), kaitiakitanga (guardianship), mauri (life force of the living), wairua (spirit and soul), whakapapa (genealogy), whanaungatanga (kinship), aroha (love), manaakitanga (kindness and hospitality), tapu (sacred), noa (balance and neutrality), and utu (seeking balance through reciprocity) (Carter et al. 2018; Reilly et al. 2018). Te ao Māori recognises that human existence relies on the existence of other humans and the environment, and that nurturing relationships and preserving connections are an integral part of life. This cultural belief is practised through the concepts of manaakitanga (kindness), whanaungatanga (sense of family connection), and aroha, where Māori show care and love and bring the best outcome to everyone (Reilly et al. 2018).

Mātauranga Māori is indigenous knowledge that early ancestors developed over many centuries. Early Māori encountered challenges in the new land and climate of Aotearoa. They had to adapt to their unknown environment by gaining knowledge through observing, testing, and interpreting (King et al. 2008). Their empirical research resulted in a collective knowledge of the land, sea, and sky. Underpinned by Te ao Māori, their knowledge base connected the physical and spiritual worlds (Carter et al. 2018; Morgan and Manuel 2020). Unlike Western knowledge, mātauranga Māori has and continues to be transferred orally through karakia (incantations), mōteatea (traditional song), whakataukī (proverbs), orero tuku iho (oral tradition) (Whaanga et al. 2020), and pūrākau (myths and legends). The continued use of mātauranga Māori today is a testament to the effectiveness of oral knowledge transfer and retention through memory and metaphors.

Mātauranga Māori is unique to Aotearoa and has always been intertwined with the Aotearoa-NZ environment and climate. (Reilly et al. 2018). The Māori traditions of monitoring weather patterns and extreme events through oral communication are thought to provide records and warn of dangers (King et al. 2008). Places of significance are named in ways which indicate risk and environmental change, whilst songs and proverbs which record significant environmental events can be directly mapped today (King et al. 2008). Mātauranga Māori can also reveal information about the climate of Aotearoa before the arrival of European settlers that is difficult to ascertain with science alone. Another example is the maramataka (the Māori lunar calendar) and tohu (location-specific environmental indicators). The maramataka and tohu are based on the stars and the environment, indicating optimal environmental timings for planting and harvesting different crops (Whaanga et al. 2020). Māori communities led by hapū and iwi, like those of this case study, first and foremost live in accordance with the Māori worldview, using mātauranga Māori in every aspect of their lives. Therefore, there is a pressing need to develop climate adaptation solutions that align with and value their indigenous knowledge and worldview.

17.3.2 Examples of Mātauranga Māori Climate Adaptation

He Huringa Āhuarangi, He Huringa Ao: A Changing Climate, a Changing World is a research report published in 2021 by Māori research organisation Ngā Pae o te Māramatanga (NPM) and Manaaki Whenua Landcare Research. The research aimed at providing guidance for hapū/iwi on mitigating and adapting to climate change, due to the lack of guidance from authorities despite their disproportionate exposure and vulnerability. The research adopted a te ao Māori perspective. The impacts of the climate change hazards on four domains were studied, including:

- He kura taiao (Living treasures),
- Whakatipu rawa (Māori enterprise),
- He ea o tāngata (Healthy people),
- Ahurea Māori, tikanga Māori (Māori culture and practices).

Twenty-five relevant risks were identified across the four domains and a comprehensive risk analysis was conducted. The projected impacts were scored according to their severity for whānau (families), hapū, and iwi now, and their projected severity in the years 2050 and 2100. The report provided adaptation alternatives for each of the identified impacts that are aligned with te ao Māori and are culturally acceptable. For example, Table 17.1 illustrates the research outcomes for the He Oranga Tāngata projected impacts and suggested adaptation strategies.

The report also identified several resilience-building initiatives that could be initiated and conducted at the hapū and iwi level, such as:

- Investigating suitable water supply and storage solutions.
- Tree-planting to limit erosion and provide shady areas.
- Evaluating relocation of cultural infrastructure.
- Riparian planting in coastal areas.

The report recommended further monitoring and research on climate change impacts to enhance the hapū and iwi decision-making process. It also promoted drawing upon both mātauranga Māori and Western science to further develop adaptation solutions and enhance Māori resilience.

17.3.3 Te Tai Tokerau Climate Adaptation Strategy

In an attempt to align the climate change adaptation efforts across Northland, the four councils comprising the region (Northland Regional Council, Whangārei District Council, Kaipara District Council and Far North District Council) developed a joint council working group to work collaboratively towards addressing the region's climate change adaptation issues. The local government meeting participants explained that the working group comprised eight members, including a nominated member from each council as well as a nominated hapū or iwi representative from

Table 17.1 Example climate change adaptation strategies for hazards affecting He Oranga Tāngata

Sector	Group	Interest	Risk		Adaptation Strategies
Maori health status and inequities	Individuals, whanau	Minimising health risks of climate change; maximising health co-benefits of climate action	Now	Moderate	• Individual/whanau level: walk/bike, use public transport, reduce meat and dairy consumption, and increase plant-based diets, ensure homes are insulated and energy-efficient • Communities—cut back on deforestation, plant trees, design towns/cities to encourage healthy, low-carbon transport, develop renewable energy systems (wind, sun), build healthy, energy-efficient housing, establish community food gardens, improve waste and recycling systems
			2050	Major	
			2100	Major	
Institutional health systems	Mainstream health providers, Ministry of Health	Equity	Now	Moderate	• Reorient systems to better enable iwi, hap and whanau to thrive as Maori, create healthy and sustainable environments in which to live and raise children • Dismantle colonial structures and systems that privilege Eurocentric values • Recognise the relevance and value of distinctive Maori knowledge systems and indigenous ways of knowing, being and doing that are embedded in kaupapa Maori models of care including rongoa Maori • Establish meaningful Maori—Crown partnerships • Ensure Maori health development is led by iwi and hapt, including both Maori health sector development and intersectoral action
			2050	Major	
			2100	Major	
Maori identity and health	Iwi, hapd, whanau trusts and incorporations, central government	Natural health, mental wellbeing, social connectivity	Now	Moderate	• Support mana whenua governance and kaitiakitanga of natural resources • Harness ecological restoration through tree planting to help reconnect Maori to the land, thereby strengthening matauranga Maori and Maori systems of healing • Realise non-timber-based products like rongoa Maori through replanting Indigenous species
			2050	Major	
			2100	Major	

Source Awatere et al. (2021)

each jurisdiction. The main focus of their efforts was to foster collaboration amongst the councils and with the iwi, as well as aligning policies, communication, information, methodologies and approaches, and providing an overall view of the regional adaptation planning.

In April 2022, the working group released the *Te Tai Tokerau Climate Adaptation Strategy* (CATT), the first comprehensive climate change strategy addressing the region as a whole, endorsed by all the councils and iwi involved. The strategy detailed the responsibilities of the central and local governments towards climate change impacts, overcoming the previous ambiguity shortcomings. It also addressed 46 priority actions across four categories including growing relationships, improving knowledge and understanding, reducing risk and vulnerability, and building capacity.

The CATT (2022) strategy placed Māori and hapū at the forefront of the strategy, and was framed around honouring the *Treaty of Waitangi/Te Tiriti o Waitangi* (the founding document of Aotearoa-NZ, stipulating the agreement between Māori iwi and hapū and the Crown) and seeking to empower communities. Priority Actions 1 and 2 of the strategy aim at ensuring that tāngata whenua (people of the land) are involved in the decision-making process, and that te ao Māori is embedded in the councils' processes. Most importantly, CATT adopts a systems approach to draw on principles of both Western science and mātauranga Māori. Several scripts from the CATT document illustrate the acknowledgement of te ao Māori such as whanaungatanga, mauri, and pūrākau. For example, CATT states:

> Discussing climate risks from these starting points could be more relevant for Māori communities, and the solutions that are identified may offer options for application in other locations (p. 16)

In addition to addressing various climate change impacts, the CATT strategy studied the impacts of climate change, the exposure, and the vulnerability of Māori communities. Priorities 9 and 10 of the strategy aim at undertaking iwi-/hapū-focussed climate change risk assessments, and creating iwi/hapū-focussed adaptation pathways. Furthermore, the CATT strategy analysed each of the identified climate change hazards across seven domains, including social well-being, Māori cultural values, governance, and business and economy. The strategy is considered an evolving document and will be updated to:

> Respond to new evidence from mātauranga Māori and Western science, the changing needs of communities and iwi/hapū partners, and changes in the legislative and legal environment. (p. 11)

17.3.4 Aotearoa-New Zealand National Adaptation Plan

Aotearoa-NZ released its first *National Adaptation Plan* (NAP) in August 2022. The plan is underpinned by the first *National Climate Change Risk Assessment* released in 2020. NAP responded to the Māori communities demanding more participation in developing adaptation actions, and a Māori participation platform is being developed.

The plan acknowledges the challenges and vulnerabilities of Māori communities and commits to partnerships with tāngata whenua through:

> Upholding the principles of Te Tiriti o Waitangi is a central aspect of the government's long-term adaptation strategy. This means developing adaptation responses in partnership with Māori, elevating te ao Māori and mātauranga Māori in the adaptation process and empowering Māori in adaptation planning for Māori, by Māori. (MfE, 2022, p. 13)

The NAP also recognises the role of mātauranga Māori in climate change planning and solution development, and promotes collaborative work between the government and tāngata whenua, stating that the:

> Government and Māori will need to make decisions together in a way that balances kāwanatanga (the government's right to govern) with rangatiratanga (the Māori right to make decisions for Māori). Mātauranga Māori (indigenous knowledge) and an indigenous worldview will provide a valuable lens for planning and considering solutions. (MfE, p. 26)

NAP aims to foster better risk informed decisions, drive climate-resilient development in the right locations, and study the possible adaptation options for the natural environment, homes and buildings, infrastructure, communities, and the economy. The importance of mātauranga Māori was highlighted in several sections of the NAP document as summarised in Table 17.2. However, no real implementation pathway could be identified within the plan.

17.4 Research Methodology

A qualitative approach to exploring the efforts of the local authorities in integrating mātauranga Māori within their frameworks was adopted. Four data collection methods were employed including document analysis, semi-structured interviews, meetings, and consulting with a subject-matter expert on iwi consultation, who is also involved with iwi leadershipā (the project's Māori advisor).

17.4.1 Document Analysis

A detailed review and analysis of available documents related to CCA in the Northland region was conducted (Table 17.3). The reviewed documents provided details on the current climate change legislation and frameworks, insights on the efforts to involve Māori and mātauranga Māori in decision-making frameworks and strategies, and background on the context of Māori, mātauranga Māori in the context of the Treaty of Waitangi.

Table 17.2 Mātauranga Māori in the NAP actions

Area	NAP action	NAP action No.
Risk-informed decisions	Produce guidance on integrating mātauranga Māori into adaptive planning and working with mana whenua	3.7.6
	"Improve how science, data and knowledge are used to inform emergency management." Mātauranga Māori and local knowledge and technical expertise will inform strategic decisions	3.12
	"Develop mātauranga Māori indicators of climate impacts on the natural environment"	3.21
	Produce new tools and guidance specific to mātauranga Māori and mātauranga indicators	3.24
Adaptation options	"Identify options to increase the integration of nature-based solutions into urban form." This action draws on the fundamental Māori values	5.16
Natural environment	"Implement the South-East Marine Protection Initiative." This action will inform future management through science, mātauranga Māori and monitoring	6.11
Homes, buildings and places	"Research how cultural heritage contributes to community well-being and climate change adaptation"	7.1
	"Partner with Māori landowners to increase the resilience of Māori-owned land, homes, and cultural sites"	7.2
	"Partner with Māori to support Māori-led approaches to adaptation planning"	7.3

17.4.2 Semi-structured Interviews

Interviews were conducted to reinforce the document analysis and add depth, rigour and further insight. Key members involved with developing the Northland CCA plans were interviewed. The interviews followed a semi-structured approach, chosen to give the participants the freedom to express their personal views on their terms and deviate slightly from the initial topic if appropriate (Cohen and Crabtree 2006). Four semi-structured interviews were conducted, as detailed in Table 17.4.

17.4.3 Meetings (Hui)

Two meetings were conducted. The first meeting was with representatives from an iwi in Northland to obtain the perspective on the efforts of the local authorities. Three

Table 17.3 List of reviewed and analysed documents

Document title	Author	Description
Te Rarawa Mauri Ora Mai Tawhito Iwi Hui	Aimee Matiu	Minutes of meeting on the climate change situation in Te Rarawa
Exploring the contribution indigenous knowledge can make to hazards and disasters research transcript	Dan Hikuroa	Transcription of the seminar about using mātauranga Māori in hazard and disaster studies
Draft climate action plan	Whangarei district council (WDC)	Whangarei district council's climate change action plan
Ngā Taumata O Te Moana implementation plan	Northland regional council (NRC)	Northland regional council climate change response plans
Ahipara Takiwā management plan (Te Rarawa environmental plan)	Te Rarawa Iwi	Outline of the environmental plan developed by the Te Rarawa Iwi, a Northland Māori Iwi
Ngā Taumata O Te Moana	NRC	Northland regional council climate change strategy
He Huringa Āhuarangi, He Huringa Ao report	Manaaki Whenua (Landcare Research)	Climate change research report utilising te ao Māori and mātauranga Māori perspectives
National adaptation plan	Ministry for the environment	Aotearoa-NZ's first national climate change adaptation plan
Te Tai Tokerau climate adaptation strategy	WDC, NRC, Far North district council, Kaipara district council	Joint climate change roadmap developed collaboratively by the four councils comprising the Northland region

Source Compiled by Authors

Table 17.4 Semi-structured interview participants

Participant	Code
Regional council member (climate resilience)	P1
Consultant planner: consultant to Northland district council	P2
District council member (natural hazards)	P3
District council member (natural hazards)	P4

of the four councils, which collaboratively developed the *Te Tai Tokerau Climate Adaptation Strategy* and that collectively comprise Northland region, were able to participate in the second meeting to express their insight on their efforts to integrate mātauranga Māori into their systems. The details of the meetings are detailed in the coming sections.

Table 17.5 Northland iwi climate change meeting participants

Organisation	No of participants	Expertise
Northland Iwi representatives	16	• Community
Engineering consultancy	1	• Consultant
Crown research institute	3	• Experts
Research institute	2	• Experts
University 1	2	• Academic
University 2	1	• Academic

Northland Iwi Climate Change Meeting

An online meeting was conducted on November 2021 with key participants from a Northland iwi, who wanted to engage and consult regarding their concerns around climate change. The meetings participants comprised representatives from several organisations as shown in Table 17.5. The meeting discussions expressed the indigenous perspectives, worldviews, and indigenous knowledge on the climate change impacts on the iwi and local region, the mitigation and adaptation pathways, and the role of legislation and the Treaty of Waitangi.

Local Government Meeting

A meeting was conducted at the Whangārei District Council on 15th March 2022. The meeting participants comprised representatives from Northland's regional and district councils as shown in Table 17.6. The meeting aimed to understand the current efforts of the local government authorities to involve the indigenous communities and incorporate indigenous knowledge into the climate change adaptation frameworks and decision-making processes.

Table 17.6 Local government meeting participants

Organisation	No of participants
Regional council 1	2
District council 1	2
District council 2	1
Government organisation (climate change)	1
University 1	2

Māori Advisor

The project's Māori advisor and iwi consultation expert provided the necessary liaison with the iwi and informed on the cultural protocols. The Māori advisor held preliminary discussions with the iwi, assisted with organising the meetings, and provided insight and feedback on the climate change issues facing the region based on their perspectives. The Māori advisor will be referred to as "A1" hereinafter.

17.4.4 Data Analysis

The document analysis phase comprised carefully reviewing the selected documents and coding all the themes relevant to the research scope. Data were analysed using the grounded theory method to determine implicit themes in the collected data (Chun et al. 2019). Information from the semi-structured interviews and meetings discussions were analysed based on the identified themes to supplement the data obtained from the document analysis. Adopting a grounded theory approach was deemed appropriate as no clear themes or hypotheses had arisen from the literature review.

17.5 Findings

Integrating indigenous knowledge with Western science is challenging and influenced by several factors. The following sections present the research findings illustrating the differences between Western science and indigenous knowledge, their action drivers and motivations. The findings also present examples of mātauranga Māori climate change knowledge, and a timeline of the efforts and changes to integrate mātauranga Māori within governmental legislation and frameworks in Aotearoa-NZ.

17.5.1 Mātauranga Māori Versus Western Science: The Differences

Mātauranga Māori is an accumulation of complex systems of knowledge gathered from Māori experiences of adapting to the changing environment (Iwi meeting). The *Te Rarawa Iwi Environmental Management Plan (ATMP)* states:

> Over centuries of occupation and use, Te Rarawa have accumulated knowledge, customs, practices, and protocols that we can apply today to assist in creating a better balance of life, human use and management and the environment.

Interviewee P2 stated that tāngata whenua, the people who live by the principles of te ao Māori and use mātauranga Māori in the fundamental aspects of their daily lives, are considered experts of their own local area:

> Māori have always been scientists. They did not navigate that expansive ocean on myths and legends. They did not arrive here, apply a detailed regionally specific division of time, thrive, and immerse with the natural rhythms of the environment without having science. Science is the cornerstone of their undertakings.

The depth of engagement of mātauranga Māori in climate change issues is evident. For example, in his document, Hikuroa (2017) refers to the 2005 Matata flash flood which devastated the region—the three marae (complex of carved buildings and grounds that belong to a particular iwi, hapū or whānau) in the area were not affected by the floods due to their construction on elevated grounds based on local indigenous knowledge. Moreover, indigenous records of similar storms in the past has permitted scientists to realise that the frequency of such storms was 1 in 27 years, instead of 1 in 500 years as meteorologically deducted, arguing that mātauranga Māori may provide greater precision than scientific data in identifying past natural events, as it records events spontaneously.

Mātauranga Māori tends to adopt a holistic approach towards climate change considering four pou (factors) in decision-making, including the economic, social, environmental, and cultural well-being of the community. The comprehensiveness of such a holistic approach enables hapū and iwi to consider the cascading effects of climate change rather than trying to address the primary impacts of hazards (iwi meeting). Interviewee P2 explained that the *Te Ao Māori Decision-Making Framework for Climate Change* revolves around:

> Te Puku o Te Whenua (the middle of the earth) and what are the issues in terms of their connectivity to other areas as traced from kōrero tuku iho (oral tradition or history) and mātauranga.

Factors affecting the community's well-being are at the core of te ao Māori. For example, food and water (kai and wai) hold great importance to Māori (iwi meeting). Interviewee P2 further explained:

> One of the things that we're also trying to do with Whangārei District Council is to understand the connection between wai and kai because if you don't have those two things then you can't live.

Interviewee P1 stated an interesting analogy between the mātauranga Māori approach and the Western science approaches adopted by the local authorities, stating:

> The values in te ao Māori are quite holistic. If we at Northland Regional Council are studying a hazard, the values that we look at might be quite different, because we might just consider what's the impact on infrastructure and maybe the impact on houses and property. But actually, it's really about our well-being, or about our ability to look after the whenua (land), or our ability to gather kai, which is more how Māori look at it.

In contrast, primary impacts are typically the main focus of adaptation measures for local governing bodies. As primary impacts occur first, they are considered the core issue requiring attention (local government meeting). This could be exemplified in the range of projects set out in the *Ngā Taumata O Te Moana Implementation Plan (Northland Regional Council's Climate Change Strategy)* which is mainly focussed on modelling and monitoring primary impacts. The responses of Interviewee P1 regarding the main impacts of concern to Northland Regional Council included only primary impacts such as "river flooding, sea-level rise, coastal flooding, and coastal erosion." Interviewee P1 provided the following comparison:

> We mapped coastal hazards across the whole region; we've got LiDAR across the whole region, sea-level rise values are in there [and] we've also mapped river floods across the whole region with a 2D model so that gives you river flood hazard risks and then they interact in coastal areas. We are also looking at forecasting droughts through the water balance model. These exhibit greater access to and usage of Western science in local governing bodies.

17.5.2 Climate Change Action Drivers: Iwi Versus Local Government Perspectives

From a hapū and iwi perspective, the intentions to enhance te oranga o te taiao (the well-being of the environment) stems from te ao Māori values and drivers that guide the Māori communities addressing climate change issues (iwi meeting). In this regard, A1 stated:

> If the healthiness of te taiao is not there, then hapū and iwi are not there. The natural environment is the source of food, water, and other vital elements. There needs to be an act of reciprocity to care for Papatūānuku [the Earth Mother], who sustains the people.

Kaitiakitanga (guardianship) is one of the main drivers of responding to climate change issues, and upholding the mana of the environment across generations is critical (iwi meeting). Interviewee P2 highlighted the role of kaitiakitanga as mentioned in the ATMP document, stating:

> The hapū and iwi leaders are there to serve their people and a lot of them undertake leadership roles because they actually care about what happens on the ground. The practice of kaitiakitanga bears no relation to the Western concept of "ownership" because humans are the siblings of the natural world and reside within it, not outside or above it.

The main driver for local Northland governing bodies to respond to climate change issues in the region was identified to be legislative or statutory obligation (local government meeting). Legislation frameworks, such as the *Local Governments Act 2002*, lay the responsibility and accountability of promoting environmental, social, cultural, and economic well-being of their communities and taking a sustainable development approach to the local authorities. For example, the *Ngā Taumata O Te Moana* document mentions the statutory obligation of Northland Regional Council to develop a climate change strategy aligned with the agreed-upon commitments to the Paris Agreement.

17.5.3 Consideration of Te ao Māori and Mātauranga Māori in Northland's Climate Change Strategies and Plans

Several legislative frameworks in Aotearoa-NZ, such as the *Local Government Act 2002, the Resource Management Act 1991, the Civil Defence Act and the Climate Change Response (Zero Carbon) Amendment Act 2019* render local governments responsible for planning their climate change actions within their jurisdictions. Each of the four councils in the northern region have developed their own climate change strategy or plan (local government meeting). For example, Whangārei District Council released its *Draft Climate Action Plan (DCAP)* in mid-2021 after 7 months of consultations with communities across the district. DCAP focuses on honouring Te Tiriti o Waitangi and commits Whangārei District Council to working collaboratively with iwi and hapū. The plan recognises that the Māori communities in the region experience disproportionate adverse effects of climate change due to their lower socio-economic status and their coastal settlements. Mātauranga Māori is recognised as a critical component in understanding risks, identifying opportunities, and building interconnected relationships. DCAP seeks to develop a framework based on te ao Māori for decision-making, monitoring and evaluating, and promotes partnerships with iwi, and commits to support the use of mātauranga Māori along with Western science such as geographic information systems. Similarly, Northland Regional Council released its climate change strategy and implementation plan, *Ngā Taumata O Te Moana*, in mid-2021. The Far North District Council had its climate change roadmap. Kaipara District Council also published their *Climate Change Action Plan* in September 2021.

However, the interviewees and meeting participants had divergent opinions on the climate change governance within the northern region. Interviewee P1 acknowledged the complexity of collaboration between three different councils and one regional council, stating:

> City councils are mostly involved with environmental management and planning. District councils look after services such as, stormwater, wastewater, or roads. We have different functions.

Interviewees P1 and P2 further stated that the four Northland governing councils each developing its own strategy had resulted in a siloed approach. Interviewee P1 also highlighted some ambiguities in the legislative frameworks, mentioning:

> The legislative responsibility around hazards such as sea-level rise, coastal flooding, and coastal erosion, is a little bit less clear. It often falls on property owners to protect their own property.

Interviewee P3 criticised the current frameworks and considered that they were lacking in some areas. For example, P1 stated that the current legislation does not identify who exactly is responsible for building flood protection:

> There is guidance on new developments in hazardous identified areas. However, there is not much guidance on existing developments, and the risks to those individuals who are already

> settled in hazardous zones. For example, some guidance around developments in coastal flood areas is available, but they do not specifically say who has to build coastal protection.

Interviewees P3 and P4 mentioned a further example of a managed retreat programme that they had undertaken in Panguru. They mentioned that they achieved only 30% of their targets due to the little guidance available regarding managed retreat, even when the managed retreat properties were fully funded by the government.

17.5.4 Challenges

The major challenge in integrating mātauranga Māori within climate change frameworks and legislation stems from the differences in worldviews. Whilst local authorities adopt Western knowledge systems, applying more of a Eurocentric logic and approaches, mātauranga Māori acknowledges the link between the physical and the spiritual worlds and adopts a holistic approach. Interviewees P1 and P2 expressed that the local authorities are still in the early stages of integrating mātauranga Māori into legislation and frameworks, and that integrating the two worldviews will be a challenging task. Interviewee P2 mentioned:

> I think Western practitioners of science have difficulties understanding the depth and richness of mātauranga Māori because science is wrapped up in our cultural beliefs and in our spirituality.

Interviewees P1 and P2 both agreed that the historic grievances from colonisation resulted in a lack of trust between the local authorities and the Māori communities. Interviewee A1 further added that the authorities' isolated approaches created arduous impacts on the Māori communities. Interviewees P2 and A1 expressed that the current government processes are frustrating and exhausting for iwi and hapū. Interviewee P2 stated:

> The Māori communities don't trust the authorities because of the way the policies and rules have been done and implemented in the past, so there's a lot of grievance that's still in existence.

In this regard, Interviewee P1 iterated that it is the council's responsibility to lead the process to recovery and build a genuine relationship with Māori.

Interviewee P1 added that funding allocation constituted a significant challenge for the local authorities. Furthermore, Interviewee P2 highlighted issues associated with underinvestment in enhancing Māori communities' socio-economic status. Interviewee P4 described a situation in Panguru area in Northland, where raising the low points on a major road prone to flooding was the best adaptation alternative. However, funding restraints prohibited the implementation of this adaptation alternatives and cheaper measures were sought.

17.5.5 Potential Opportunities for Māori and Local Governments

Analysis of documents like the *Te Rarawa Mauri Ora Mai Tawhito Iwi Hui* (TRHM) document shows that there is an emphasis on the prospect of employment that arises from climate change adaptation plans. One of the climate change concerns is the increased intensity of drought, which will affect farming activities. There will be a need for better water-storage systems to cater to future drought seasons, increasing the demand for the installation and maintenance of water tanks. The TRHM document also speculated that there will be more workforce demand in the areas of infrastructure maintenance and other jobs such as gutter servicing. Interviewee P1 stated that delegating such activities to the local hapū and iwi could save council workforce costs and travel time to collect the required data or conduct the jobs. Interviewee P2 also envisioned the participation of communities and schools in climate change adaptation projects to build a stronger sense of community and intergenerational collaboration.

Further opportunities to be explored included climate change education and research funding. The TRHM documents discussed opportunities to fund researchers to help approach and act on the climate change issues. Dialogue regarding how school children and teachers could also be involved in giving back to the community was identified as an opportunity to be explored.

Mātauranga Māori can contribute significant knowledge to aid local governments and councils (local government meeting). Whakawhanaungatanga (building relationships) can be mutually beneficial to both parties. Interviewee P1 mentioned that councils and iwi do not need to agree on everything, but they do need to understand each other. Interviewee P1 shared an example of how whakawhanaungatanga can function, mentioning:

> We probably need to do a lot more work on the impact of climate change on the natural environment. The rising temperatures, heat waves, and marine heatwaves are affecting the ecosystems, biodiversity, and biosecurity. This is an area of expertise for iwi and hapū. They can notice even the subtle changes that occur in nature. This generates the basis to incorporate mātauranga Māori to inform science, which will aid the council with monitoring and verifying what they found through Western science.

17.6 Discussion

Whereas local governing councils adopt Western science approaches and Eurocentric values, mātauranga Māori applies a more holistic view incorporating the four pou affecting communities. The knowledge base of mātauranga Māori has been evolving over decades as an accumulation of the direct experiences and engagement of Māori communities with their surrounding environment, making it an evolving knowledge source. Mātauranga Māori has been continually transferred through generations through oral practices such as pūrākau. Knowledge transfer across generations through oral mechanisms aided in preserving the knowledge base and provided significant historical information about past climate events that are difficult to infer through science alone. Information on historical events could enhance and complement contemporary risk identification and assessment practices. They could also enhance the outcomes of proposed adaptation measures, such as restricting relocation or land development in areas with a history of landslides. Subtle differences in ecosystems and the environment could be spotted by Māori communities due to their continued interaction and connection with the environment, providing early warning capabilities. Furthermore, mātauranga Māori can provide details critical for verifying and evaluating climate change models and scenarios developed by scientists.

A substantial difference between mātauranga Māori and Western Science lies in the focus of the climate adaptation perspectives. The statements of the research participants illustrate their perception of the Western Science climate adaptation approaches as focussing on the primary hazards. In contrast, Te Ao Māori and mātauranga Māori adopt holistic approaches targeting the four pous and addressing the cascading impacts of hazards. Māori tend to act by their Te Ao Māori principles, constantly striving to act in the best interest of the environment and the well-being of their community. The cascading or secondary climate change impacts are equally important and should be prioritised. As the most vulnerable and exposed to primary climate change impacts, Māori communities are more concerned about the secondary impacts such as water availability and food sustainability. The difference in focus and perspectives highlights a greater understanding of the interconnectivity between primary and cascading impacts. It also signals the need for shifting towards holistic impact assessment and adaptation decision-making by the authorities. The difference in focus between te ao Māori and Western science is evident when comparing *He Huringa Āhuarangi, He Huringa Ao: A Changing Climate, a Changing World,* and the NAP. *The He Huringa Āhuarangi report* comprehensively analyses factors such as ecosystems and living, community health, community cultural attributes, and livelihoods. Such factors may not be fully considered in the NAP despite the involvement of Māori communities in the development.

Mātauranga Māori could thus be very beneficial if integrated with Western science approaches. However, the results showed that despite being more exposed and vulnerable, Māori communities, their worldview, and mātauranga Māori were not given adequate consideration and were under-represented in climate change planning efforts. Whereas Māori communities respond to climate change driven by their physical and spiritual connections with the environment, local authorities are guided by frameworks, and legislative responsibility as their primary drivers. Although Te Tiriti o Waitangi promotes inclusion and partnerships between the authorities and the Māori communities, adopting policies and frameworks underpinned by Western and Eurocentric values may have contributed to the under-recognition and under-representation of Māori and their worldview. Furthermore, historic colonial grievances and past practices have exacerbated the discord between the authorities and Māori communities.

Many Māori communities in Aotearoa are coastal area dwellers, and most of their lands are low-lying. The levels of exposure and vulnerability are further exacerbated by their lower socio-economic status, as stated in the reviewed documents and by the research participants. The research findings also signalled a lack of attention and guidance to Māori communities. The mātauranga Māori knowledge base has been overshadowed by Western science and Eurocentric approaches to climate adaptation. Moreover, the climate adaptation frameworks and legislative procedures were not perceived as adequate and were considered by the research participants as lacking guidance.

The research participants also indicated uncertainty about the risk management responsibility and adaptation between the central, regional, and local governments. As councils and local authorities are in charge of their districts and jurisdictions, decentralised responsibility results in low engagement from the central government. More involvement from the central government and creating central funding for adaptations will ensure a fairer distribution of funds and more effective utilisation. As the local governments interact directly with the communities affected, it is essential to provide these local governments with the support and assistance they require. The responsibilities of the councils and local authorities were also perceived as falling short in some areas. For example, the council's statutory role is to support communities through climate change impacts and administer appropriate infrastructure and adaptation strategies. However, the decision-making and implementation of such solutions could be unaffordable to Māori communities.

To cater to the prevailing shortcomings, Māori researchers and iwi leaders exerted efforts to apply their mātauranga knowledge base to create environmentally and culturally aligned adaptation strategies designed for Māori communities. An example is the *He Huringa Āhuarangi* report, which demonstrates how the risks relevant to Māori communities were analysed and how adaptation alternatives were developed.

There is evidence that councils have come to understand the significance and potential of mātauranga Māori, as evident from recent documents such as the Draft Climate Action Plan and Ngā Taumata O Te Moana Implementation Plan. However, there are some challenges. Māori feel that non-Māori accessing their environmental knowledge may represent a new form of colonisation, creating a reluctance in sharing the knowledge, as it may be used out of context or misused. Furthermore, the recent controversy on the validity of mātauranga Māori as science concerns Māori about whether the mana (authority or spiritual power) of the knowledge will be preserved. The fundamental cultural concepts of manaakitanga, whanaungatanga and aroha are drawn from the worldview that focuses on connections, networks and bonds to other people and the environment. A shift from only fulfilling legislative responsibilities to establishing and nurturing genuine partnerships is required. For Māori, it is whakawhanaungatanga and whanaungatanga, a pathway to genuine, long-term relationships.

Promising results are sought after the recent publishing of the Te Tai Tokerau Climate Adaptation Strategy and Aotearoa-NZ National Adaptation Plan in 2022.

The involvement of iwi representatives to work alongside council staff in developing the Te Tai Tokerau Climate Adaptation Strategy signals the will and ambition of the local authorities and Māori communities to establish good collaborative relationships. It also signals that mātauranga Māori is becoming more recognised and appreciated in the policy domain. The direct interaction and involvement with hapū and iwi members provide opportunities for the councils to unencrypt and comprehend mātauranga Māori, as it may be challenging to communicate. A similar promising trend could also be identified in the National Adaptation Plan. The plan clearly states the importance of integrating mātauranga Māori and acknowledges the disproportional impacts experienced by Māori communities due to climate change hazards. Nevertheless, more effort should be exerted to clearly identify and map practical pathways for the implementation and integration of mātauranga Māori within governmental legislation and frameworks.

The recent progression in incorporating mātauranga Māori into government legislation and frameworks provide several opportunities. A genuine spirit from the local authorities and whanaungatanga from Māori could establish good relationships between the two parties and nurture the possibilities of helpful collaboration endeavours. Te ao Māori values and mātauranga Māori could compliment Western Science and contribute to the overall understanding and decision-making process required for climate change adaptation. The social cohesion between the ethnicities involved could also be enhanced due to the continued interaction. Furthermore, the involvement of hapū and iwi could aid the local authorities in data collection and reporting requirements in secluded areas, saving the authorities time and cost. Māori communities could also be a valuable workforce source to satisfy the expected demand increase required for the adaptation measures in the region.

17.7 Conclusions

Western Science and indigenous knowledge exhibit several differences in terms of responsibility drivers, knowledge type and usage, focus and scope, and transferability and dissemination mechanisms. However, Western Science and indigenous knowledge share the same challenge, climate change impacts. Joining forces and considering all the available alternatives is required for enhancing the climate change response and may offer various opportunities for meeting the global targets and goals on climate change issues. Integrating Western Science and indigenous knowledge approaches could enrich the climate change knowledge database. Furthermore, the climate change response would be more aligned and satisfactory to the indigenous communities, their knowledge, and their cultural context, enhancing the communities' resilience and making them more climate change aware and ready.

It will be imperative for the local authorities, which usually adopt Western Science approaches and indigenous communities, to acknowledge each other and make genuine efforts to resolve prior discord and historical colonisation grievances. Genuine relationships and trust building between the authorities and indigenous communities could provide mutually advantageous collaboration opportunities. Further to the scientific benefits that can be gained, the local authorities could benefit from employing members of indigenous communities, especially with the expected rise in workforce demand. They could also benefit from outsourcing monitoring and data collection responsibilities to those communities.

With the higher exposure and vulnerability of indigenous communities and challenges faced due to central governments are urged to extend further support to local governments in terms of funding, technology, and guidance to work more closely with indigenous communities. Further research opportunities and funding can also contribute to alleviating the stresses of indigenous communities, and building and maintaining genuine relationships that create the space for co-creating mutually beneficial solutions. The continued interaction between local authorities and indigenous communities could improve social cohesion. Moreover, co-planning and co-managing the environment by involving indigenous communities, schools, and special groups contribute towards enhanced preservation and transfer of indigenous knowledge to the younger generations.

Acknowledgements The authors would like to thank the Association of Commonwealth Universities Climate Resilience Challenge Grant for funding this research; student researchers and research assistants Hana Dmitrovic, Shu Mak, Stephanie Park, Zahra Jalali, Anqi Yang, and Teringa Horton. The authors express their gratitude to the iwi for supporting this research and the councils and other interviewees for their time and willingness for open discussion.

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Chapter 18
Assessments for Disaster Risk Reduction by Analysing the Gaps and Future Scopes in Resilient Indigenous Practices

Mohd Kashif, Syed Haris Muaaz, Ilma Nafees, Rashad Anwar, and Ilma

Abstract Disaster management aims to lessen the impacts of calamities, minimising losses of life and property. Since the early 1990s, the United Nations has been advocating policies and measures to reduce risks, before such hazards evolve into disasters and impact vulnerable communities. Research on the phenomena of disasters in the Asia–Pacific region over the past decades has resulted in a wealth of knowledge on the strong link between resilience and indigenous practices. Human practices that evolved over centuries have been tested by time and proven to be sustainable and effective in both reducing disasters and managing unavoidable hazards, yet there continue to be gaps in translating this knowledge into action. It is important to ask whether more could be done to anticipate the occurrence of such happenings, limit their impact, and enable the affected populations to recover more quickly through better resilience. Reducing exposure to hazards, lessening the vulnerability of people and property, wise management of land and the environment, and improving preparedness for adverse events are all examples of disaster risk reduction. The paper will extensively analyse the factors binding disaster risk reduction, and climate change and characterise the parameters that are influencing the correlation between indigenous practices and DRR. The study will assist in analysing the process of establishing factors of counter practices for the mitigation of disaster. The paper will also help us analyse the distinct scenario and its interpretive beginning, the evaluation and transformation of indigenous practices. Furthermore, it will discuss the vast reserve of knowledge and actions for disaster risk reduction (DRR), outlining the need for a more holistic procedure consisting of bottom-up and top-down actions, local and scientific knowledge, and a vast array of stakeholders. Hence, it will assist in finding new challenges in addressing the need for an integrated process which will be outlined alongside a potential future road map for bridging gaps in DRR.

Keywords Disaster risk reduction · Integration · Knowledge · Stakeholder · Knowledge sharing risk expertise · Science-policy interface · Disaster governance

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_18

18.1 Background

Buildings and construction industry contribute significantly to climate change, accounting for almost 38% of all energy-related CO_2 emissions worldwide, effectively hitting the highest CO_2 level ever in 2019 that was ever tallied in emissions for this industry. While simultaneously, we are already putting a strain on living circumstances and seeing a rise in asset damage such as severe weather occurrences, particularly in coastal regions where the bulk of people on earth reside. The anticipated consequences of climate change, including heat waves, droughts, cyclones, and sea level rise, will become more frequent on the built environment, which in turn will impact society at large Rajat Gupta (Oxford Brookes University) 2022 (Fig. 18.1).

According to recent studies, by 2050, 1.6 billion urban residents would frequently experience extremely high temperatures, and over 800 million people will reside in more over 570 cities, making them vulnerable to coastal flooding and sea level rise (C40 cities, 2022). When unprepared with their surroundings and heavily exposed to severe conditions, buildings become generators of vulnerability due to climatic conditions instead of offering sanctuary, resulting in both human casualties and financial losses. Low-income settlements that are overpopulated and poorly designed are most at risk from climate change. Nearly 90% of storm-related fatalities during the previous 20 years occurred in lower-income nations, even though they accounted for just a quarter of all incident storms (UNISDR 2015). To address the present and future climate concerns, mitigation and adaptation must both be actively sought. The building's future-proofing, resilience, and reducing GHG emissions require this sector as their focal point for mitigation. For instance, using green roofs and facades or passive design lessens building occupants' sensitivity to heat and their need for energy for thermal comfort and mechanical cooling (Fig. 18.2).

Fig. 18.1 Disaster risk reduction. *Source* https://www.researchgate.net/figure/Multidisciplinary-elements-of-disaster-risk-reduction_fig1_267376199

Fig. 18.2 Over 800 million people will reside in more over 570 cities, making them vulnerable to coastal flooding and sea level rise. *Source* https://resourcecentre.c40.org/climate-action-planning-framework-home

Authorities, project developers, funders, and other stakeholders can reduce the impact of climate change by incorporating locally appropriate climate adaptation techniques in post-disaster rebuilding, owner-driven construction, slum upgrading, building retrofits, and new builds. Community members must encourage and inform individuals, provide rewards, and create an atmosphere that is favourable for the promotion and innovation of sustainable criteria for architecture and construction that can enhance community resilience global warming. This book chapter will present a range of adaptation interventions to respond to droughts, flooding, sea level rise, heatwaves and warming, cyclones, and strong winds for different building types and different settings, which governments and policymakers can promote and scale up by integrating them into policies and regulations for the built environment.

18.2 Introduction

Disasters take many forms and shapes. Although they are predictable but in any form, they cause huge damages to life, property, economy, and most importantly environment. We cannot completely circumvent disasters, but we can address and prepare for them. Efforts made for the prevention help in reducing the disaster's impact on the communities and lessen the suffering thus protecting and helping communities recover (Fig. 18.3).

Indigenous knowledge that has been garnered over years is a very effective tool for disaster risk reduction. It needs to be recognised and upgraded from a body of undocumented anecdotal practices to a validated body of applicable knowledge. Indigenous knowledge should be promoted as an element of formal education within the numerous curriculum development exercises being carried out in the region for school as well as higher education on disaster risk reduction.

These are human practices that have evolved over centuries and have been tested through different courses of severity and facets. They have proven to be effective and sustainable in both reducing hazards, managing them and their impacts. From this, wealth of indigenous knowledge came out the solutions that solve global problems of increasing disasters.

The science of disaster management is also the end result and the process of preparing effectively for and responding to disasters. The first step of DRM is to identify risks and for that purpose risk assessment is the best way forward (Omar Bello 2020). Scientific knowledge that is adept is progressively becoming a crucial and key part in the management of disaster risk reduction systems (Fig. 18.4).

Fig. 18.3 Natural disasters. *Source* https://www.ncei.noaa.gov/sites/default/files/2018-08/billion-dollar-disasters-collage_1200x630.png

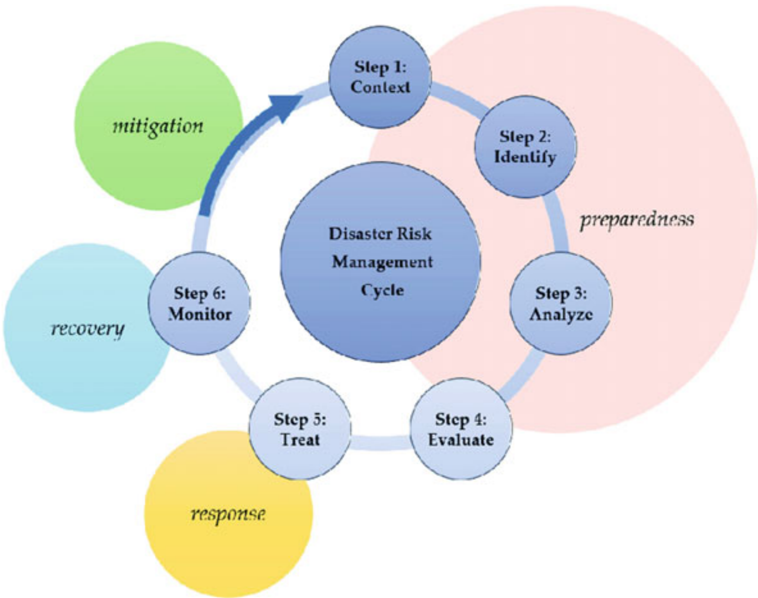

Fig. 18.4 Disaster risk management cycle. *Source* https://www.researchgate.net/figure/Multidisciplinary-elements-of-disaster-risk-reduction_fig1_267376199

As a consequence of this development, the role of science has changed for better in the management of hazards and risks at the policy level which includes ideas, plans, and practices in the preserve of disaster risk reduction. Nowhere is this more apparent than in India, with its technocratically governed and highly industrialised societies. Although India is making substantial progress in this end, we still need to configure and discuss in this paper, the challenges that prevail in integrating and incorporating science and expertise into disaster risk reduction strategies, plans, and policies.

The changing role of science in correlation to disaster management and disaster risk reduction is inherently tied to how disasters are discerned politically and culturally. There was a time when disasters were once regarded as nature's unforeseeable and incalculable rage or simply God's wrath, compared to today when disasters are recognised in relation to humans (in)ability to predict or prevent them (Alexander 2014; Steinberg 2006). In this view, disasters do not only result from natural causes. Natural disasters are not at all natural, as researchers have observed over the last century. The inability of a human system to address intricate interconnections of interconnected processes of vulnerability between society and the environment is how they are instead defined (Oliver-Smith 1999). Hazard, risk, vulnerability, and resilience, which are the four main ideas in contemporary disaster research, all indicate that social structures interact with hazards to cause catastrophes. Disasters, therefore, have social causes. Since society is organised today, disaster management depends on our capacity to incorporate pertinent knowledge into the institutional

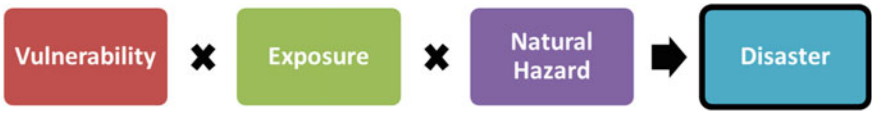

Fig. 18.5 Factors that result in disaster. *Source* https://blogs.egu.eu/network/gfgd/files/2015/01/Picture1.png

arrangements and policies that support our capacity to address disaster risks. To do this, scientific expert knowledge is essential because it enables us to draw lessons from the past (Fig. 18.5).

In order to understand how government systems operate in all phases of disaster risk management, including recovery, prevention, mitigation, readiness, and risk reduction, it is important to analyse the evolving role of science and expert knowledge in connection to catastrophes. Throughout the many stages of disaster risk management, incorrect or poorly interpreted scientific input has the potential to cause catastrophic losses for the impacted communities and people. Therefore, it is essential to have correct knowledge as well as common perceptions about the structure, meaning, and responsibility of this knowledge. Although this requirement has long been acknowledged, it is probably more urgent and difficult to address how to incorporate expert knowledge in order to lessen disaster risks. Regarding how expert knowledge functions inside and alongside catastrophe risk reduction plans and practices, there are a wide range of deeper systemic, cultural, and institutional challenges that need to be taken into consideration. A more thorough and organised analysis of the current issues is required for this (Fig. 18.6).

Fig. 18.6 Underlying disaster drivers. *Source* https://www.undrr.org/sites/default/files/2021-04/UDR-Terminology.png

18.3 Rationale of the Study

Ancient civilisations, a multihazard environmental context, recurrent disasters, manifold geo-cultural communities and large populations, and scarce resources have all led to the evolution of very low cost ways of life that include indigenous knowledge and disaster risk reduction (Disaster Risk Reduction) in a very strong yet inconspicuous way. While such local practices are based on sound principles of interaction between humans and nature, the policy context for disaster management in most countries in the region has evolved from the governance domain. In spite of increased investments in the area of disaster management in recent decades, the losses continue to mount. There is an evident gap between practice and policy. The need to bridge this gap with adequate recognition of the domain of indigenous knowledge and local coping capacities is very urgent. There is a strong need to recognise the potential of community knowledge and actions, and of switching to a bottom-up approach that uses appropriate community practice as the base for policy formulation. A more ambitious, systematic, and team-based strategy to adaptation is needed to confront the climate catastrophe. There are tested methods for proactively enhancing climate resilience. Lack of money and guidance for governments and indigenous communities to improve climate resilience are a key problem (McBean 2022).

Let us take, for instance, the traditional earthquake safe construction practices of the Kashmir region, where two types of construction practices are prevalent: Taq system (timber laced masonry) and Dhajji-Dewari system (timber frame with infill walls) (Fig. 18.7).

Dhajji-Dewari System

In the Dhajji-Dewari system, timber frames for confining masonry in small parcels are used. The timber frames, not only have vertical elements, but also have cross

Fig. 18.7 Dhajji-Dewari system. *Source* http://www.world-housing.net/wp-content/uploads/2011/08/Dhajji_Thumb_02.jpg

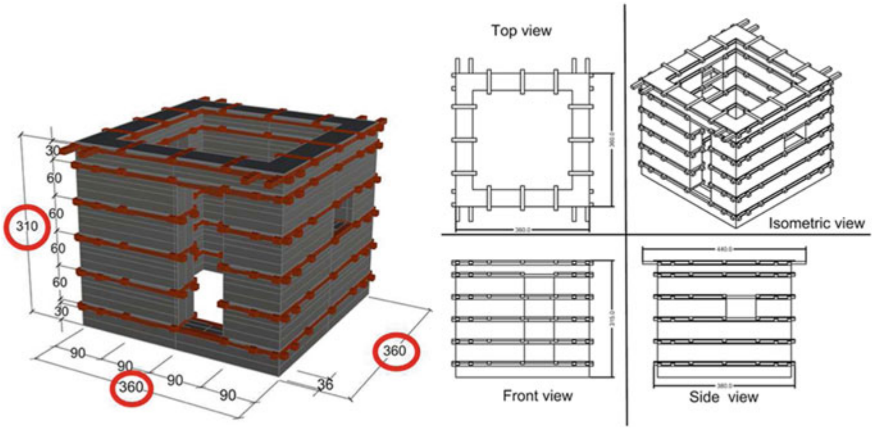

Fig. 18.8 Taq system. *Source* https://www.frontiersin.org/files/Articles/336954/fbuil-04-00018-HTML/image_m/fbuil-04-00018-g009.jpg

members, which divide the masonry infill into various small panels. The most important characteristic of this type of construction is the use of lean mud mortar. A common practice in the region is to use the Dhajji-Dewari system in the upper story walls, especially for the gable portion of the wall (Fig. 18.8).

Taq System

In the Taq system, large pieces of wood or timber are used as horizontal runners embedded into the masonry walls. These runners are located at floor level and at the top of windows. These runners tie together all of the elements of the building or house and keep the entire structure in concert, thus preventing spreading and cracking of masonry. The runners are joined together with small pieces of timber, giving the shape of a ladder laid over a wall covering two exterior faces of the wall. In the local language, Taq means window. This generally refers to a modular layout of the piers and window bays which make up this type of construction. Piers are almost 1.5–2.0 ft^2 and the bays are about 3.5 ft wide. There is no practice of putting a complete frame of timber. The timber runners act like horizontal reinforcement which ultimately holds the masonry together (Indigenous Knowledge for Disaster Risk Reduction 2022).

After the Kashmir Earthquake in 2005, existing construction practices of the region were assessed to find appropriate earthquake resistant features. The following were some of the observations:

- Building conditions were found to be quite poor due to the lack of earthquake resistant features in the existing houses and buildings. In cases where traditional knowledge had been applied, using either Taq system or Dhajji-Dewari technique, the houses and buildings were able to withstand the earthquake. There were numerous instances where a portion of a house or building having the Dhajji-Dewari and

Taq system sustained the shock of the earthquake, even when the portion without such system had given away.

- Houses, constructed using quality material like load-bearing masonry with stone in cement and lime mortar and bricks in cement mortar, performed poorly when built without proper and adequate professional knowledge. In the absence of proper professional guidance, reinforced cement concrete structures became highly hazardous and resulted in the complete collapse of the structure during severe shaking. The Kashmir earthquake clearly demonstrated the advantages of traditional practices for house or building construction over modern techniques, which were employed without proper application of professional know-how.
- The traditional techniques of Dhajji-Dewari and Taq system for house construction have not been popularly employed in recent times. These techniques need to be reintroduced in order to demonstrate their advantages over modern techniques. More Kashmiri masons should be imparted training in constructing houses using these techniques

Traditional Practices of a Flood-Affected Desert Region in India

August 2006 saw unprecedented heavy rains and flooding in several villages of the otherwise drought-stricken Barmer District of the desert state of Rajasthan in western India. Over one hundred hours of continuous rains inundated several villages in up to thirty feet of water. Such rains and floods had never been witnessed in this region in over 200 years of recorded history, and the local communities and administrative system were not prepared for such an emergency situation. SEEDS, a national NGO, immediately visited the affected areas and carried out a damage assessment along with a study of the local natural and built environment. The team examined the traditional construction practices in the area, which were based on mud walls and thatch roofs, with circular shelter designs. The houses had many benefits to the existing environmental conditions. Nonetheless, while the traditional mud structures were appropriate for other types of disasters, such as earthquakes and sandstorms, they did not have a high water resistant capacity and had, therefore, suffered severe damage during the floods (Fig. 18.9).

Communities living in rural Rajasthan are used to constructing houses with local materials and indigenous technology for many generations. For construction of their dhani, all the family members play a major role and have assigned responsibilities. While the men of the family collect soil of good quality from nearby places, the womenfolk gather cow dung, which they mix with the mud to prepare the basic construction material. The women of the family do the plasterwork for the new house, as well as for regular maintenance of the walls and floor. The roof is made by tying and weaving the dried stalk and by-product of the local Jowar crop.

The house is oriented in such a way that the wind direction and sun path ensure good ventilation and thermal comfort, which is very critical since summer temperatures in this region reach about 50 °C. Normally, the size of the openings is very small as it reduces heat gain and also gives less exposure to sand storms, which are a common local threat.

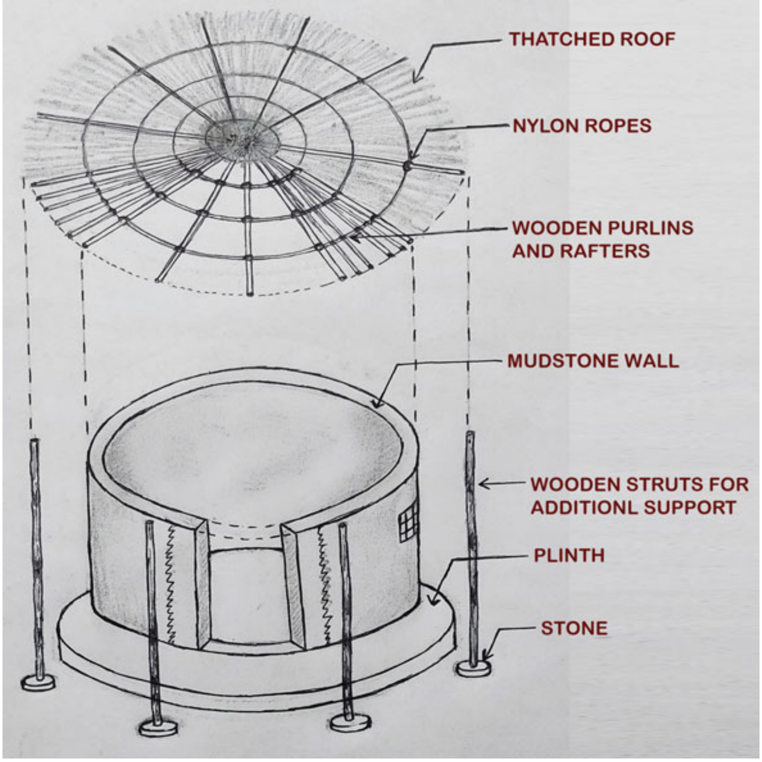

Fig. 18.9 A diagram of the Dhani. *Source* https://www.unisdr.org/files/3646_IndigenousKnowledgeDRR.pdf

The people generally produce houses that are circular in plan and opt for lower heights. This is usually due to the location in the High Wind Velocity Zone where there are heavy winds especially during the summer. The circular plan helps to streamline the airflow with the least amount of resistance (Good Practices and Lessons Learned from Experiences in the Asia–Pacific Region 2022) (Fig. 18.10).

18.4 Interaction Between DRR and Indigenous Practices

The role and relationship of human being as an agent in DRR is pivotal. The present focus on the interface and relationship between science and policy in the context of disaster risks must also be seen in relation to the wider discussion regarding the role of science for policy. An analysis of how knowledge is being transferred to an imagined policy domain should depart from the perspective that the interface between science and policy is shaped by a range of competing interests from multiple actors—academic, political, and bureaucratic. Indeed, frictions and tensions that are

Fig. 18.10 Factors for the survival and propagation of indigenous shelter technology. *Source* https://www.unisdr.org/files/3646_IndigenousKnowledgeDRR.pdf

endemic to science-policy interfaces writ large are also impacting the role of science for policy and decision-making for disaster risk reduction throughout the world. The utilisation of indigenous knowledge by practitioners while dealing with disasters is undervalued in the present discourse since the knowledge is frequently seen as antiquated and primitive. Despite this significant potential, the studies have discovered that practitioners frequently disregard the communities' traditional knowledge of disaster risk reduction. The practitioners assert that indigenous knowledge cannot be scientifically validated since it lacks documentation, is not present in all generational classes, is contextualised for certain communities, and is not documented. This study has the potential to challenge the notions, provide benefits to the community, policymakers, and DRR practitioners by ascertaining the strong relationship between indigenous practices and DRR.

18.5 Role of Identification of the Gaps in Disaster Risk Reduction

Over the past century, science has considerably increased its influence on public decision-making in a variety of policy fields. In their function as advisors, some writers claim that scientists have evolved into a fifth branch of government (Jasanoff

1990). Others have cited the emergence of professional experts as evidence of modernity (Perkin 1989) or referred to the current era as the "period of assessment" (Rayner 2003, p. 164). As a result, the idea of the science-policy interface—which can be defined as social processes and relations between scientific experts, policymakers, and other actors in the field of policymaking—has emerged. This idea promotes "exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making". Research is really growing more important for society, not less, despite recurrent complaints from scientists that politicians reject their demands for them to address current issues (Gluckman 2016) (Fig. 18.11).

This has important implications for both science and politics. The ongoing "scientification" and depoliticisation of politics can be criticised from a policy perspective (Weingart 1999); however, from a scientific perspective, it promotes the instrumentalisation and politicisation of science, which is accompanied by a public backlash against the perceived authority of science (Irwin and Wynne 2003). The role of scientists and researchers is frequently messier more context-dependent than official reports may suggest, even if politicians may be more inclined to adopt their advise when it is in line with a preexisting political agenda (Spruijt et al. 2014). The increasing dependence on scientists and experts does, however, bring forth new difficulties, such as the murky culpability of scientists if policies have unfavourable outcomes.

This may be more significant in lowering catastrophic risks than most other areas where knowledge and policy are connected (Lauta 2014b). The topic of catastrophic risk reduction is by no means immune from other instances of general issues that produce friction at the science-policy interface. First, as scholars have remarked,

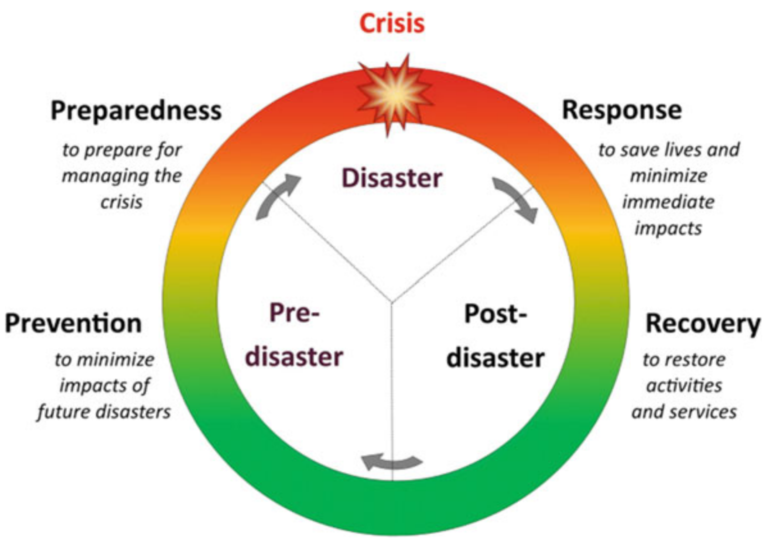

Fig. 18.11 Disaster management. *Source* https://www.slideshare.net/FayazAhmad1/disaster-management-cycle-249505426

scientists' duties as policy advisors are shaped by the subjects they are requested to provide guidance on as well as by their own opinions and areas of expertise (Spruijt et al. 2014). Second, while working in the policy field, scientists typically have to make a variety of "trade-offs" where the communication of expert knowledge—like the uncertainty of scientific findings—needs to be adjusted to fit a specific setting (Sarkki et al. 2014). Furthermore, as Birkland (1998) has demonstrated, there is usually a tremendous lot of public concern following large catastrophes, which converts these discourses into focal events that frequently, but not always, lead to changes in policy.

As a result, the significance of expert scientific knowledge in the process of enacting policy changes depends on the political agenda that is set and the attention that the public is given. These elements do not address the issues with how science is (or is not) used to inform policy choices. However, they bring attention to the fact that experts like scientists must navigate a bureaucratic environment within the arena of policy and the policy cycle wherein decision-makers do not simply take scientists' suggestions and put it into practice. Additionally, the effects of knowledge transfer are not always assured because certain knowledge may not be relevant to people in charge of making decisions or policies. In times of disaster, the issues that occur when science and policy intersect tend to be amplified.

In contrast to the requirement for time, deliberation, and thoroughness in the research domain, disasters enhance the demand for haste in the policy domain. Evidence suggests that this is not always the case, while policy changes may be undertaken in the wake of disasters and emergencies that are informed by scientific discoveries (Birkland 2006). Therefore, it is essential to continually assess sources of friction at the science-policy interface for disaster risk reduction if governments are to make preparations for future disasters using the most up-to-date expert information. According to the United Nations International Strategy for Disaster Reduction, disaster risk reduction is "the concept and practise of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events" (UNISDR 2009).

The increased emphasis on catastrophe risk reduction rather than a narrow focus on disaster response and recovery suggests an understanding that risk reduction may lessen both the human and financial costs of disaster (Schreve and Kelman 2014). According to the United Nations International Strategy for Disaster Reduction, disaster risk reduction is "the concept and practise of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events" (UNISDR 2009). The increased emphasis on catastrophe risk reduction rather than a narrow focus on disaster response and recovery suggests an understanding that risk reduction may lessen both the human and financial costs of disaster (Schreve and Kelman 2014). Researching efforts to reduce disaster risks must thus start with an understanding of how knowledge is absorbed into policy processes, as outlined in this section (Weichselgartner and Pigeon 2015).

In the sections that follow, we identify three significant challenges that we believe underlie concerns with addressing the integration of science in disaster risk reduction activities. We do this as disaster risk practitioners, policymakers, scientists and/or experts, and members of the general public. These issues should represent trends rather than issues that states experience because of the research's nature. A recent evaluation of the role of science in the management of catastrophe risk in the country found that scientists and experts are frequently quite active in other aspects. However, the chapter also notes that "the chance to resolve the difficulties of integrating science in catastrophe risk management is small" and that "the use of scientific discoveries do help but are restricted in reality". In other words, it seems that this article's conclusions are in line with other points of view.

18.6 Disaster Knowledge Gaps

As we read about and experience disasters, many of us are deeply concerned about the lack of relationship between knowledge that we have about the disaster gaps. We advocate for the need for more scientific research, government collaboration, and funding to help adapt to and mitigate disasters. But moving forward in an unknown future with a high possibility of frequent and severe climate-induced disasters, it is crucial for us to rethink our disaster risk management strategies and for this we need to take into account the three gaps very crucially and in detail.

18.6.1 The Epistemological Gap

The difference between science and policy, as well as subfields within each of these, in terms of how knowledge is conceptualised and how it should be applied is known as the "epistemological gap". The sheer level of societal complexity produced by problems with catastrophe risk reduction is one of the causes behind this disparity. Scientists, politicians, and decision-makers, according to academics, represent quite disparate worlds that need to be harmonised. It is naturally challenging to incorporate the findings of research into practices for catastrophe risk reduction because of some of the contrasts between these domains.

Choice-makers operate in a field where making an immediate decision is a must, but scientists are often cautious to make premature comments about occurrences about which there is still substantial ambiguity. According to Knorr-Cetina (1999), the epistemological divide may be seen as referring to the fact that the realms of research and politics reflect two separate epistemic cultures. The various scientific traditions (natural sciences, social sciences, humanities, and so forth) and disciplines (geography, sociology, climatology, meteorology, legal science, among others) that infrequently engage in dialogue and interdisciplinary problem-solving are a major factor in why policymakers are prone to misunderstand the scientific and expert communities. The "scientific illiteracy" of policymakers is another factor contributing to their difficulties understanding science. The language and vocabulary used by researchers have been identified as an issue in numerous of the examined nations, as was previously mentioned.

This refers to information sharing with the public, boosting risk awareness, and the understanding gap between public servants and researchers. The operation of science and academic knowledge creation as a whole plainly requires the use of certain terminologies that provide a detailed investigation into the phenomena under study. However, there is a need to enhance the manner in which scientists and researchers may more effectively communicate challenging information about the urgent issues involved in catastrophe risk reduction. It is not just a matter of "dumbing down" science; rather, it is a matter of coming up with innovative ways to explain complicated issues in a manner that is understandable, such as by using scientists as interpreters and public officials who have both theoretical and practical experience with disasters. Terminology issues are only a surface-level manifestation of a much larger issue: ambiguity. It is frequently challenging to give decision-makers and policymakers with definitive answers when transferring information from one area to another since science and research are based on intellectual contestation and critique, producing contingent and ambiguous knowledge. This also applies to the field of catastrophe risk reduction, as was the case for the mitigation of climate change (Lahsen 2005).

According to academic research, processes are defined by the interaction of technical, social, and economic discourses on a multidimensional and cross-cultural scale (Wesselink et al. 2013, p. 3). Therefore, scientists cannot be the only group that defines and evaluates risks and problems. A more comprehensive strategy is required, where risk evaluations are supported by scientific advice and take into account the political, ethical, and cultural aspects of every particular community (Gaillard and Mercer 2013). In this sense, politicians and decision-makers play a crucial role. Decision-makers are compelled to follow a Boolean, binary, logic when choosing a policy choice for catastrophe risk reduction, despite the fact that the outcome of scientific study is (ideally, at least) a nuanced proposal based on probabilities and careful evaluation of uncertainties (Woo and Marzocchi 2012). Decision-makers are frequently pressured to act quickly in the aftermath of a tragedy, weighing the likelihood of low occurrence against potential catastrophic effects (Dolce and Di Bucci 2015). This is the case, for instance, when predicting short-term earthquakes. Models may indicate that the presence of a seismic series may raise the likelihood by as much as a thousand times, but the absolute probability still remains very low (often around 1%). Given that any warning might very well be a false alarm in this low-probability scenario, these probabilities provide a daunting challenge to decision-makers who are responsible for implementing risk-reducing and mitigating measures (Woo and Marzocchi 2012).

18.6.2 The Institutional Gap

For catastrophe risk reduction, integrating science and policy involves more than just managing uncertainty and dealing with many sources of knowledge. Both institutional building and governance are equally important. To successfully contribute to risk assessments and other key catastrophe risk reduction activities, the scientific community's function within the relevant government structure (municipalities, agencies, ministries, etc.) must be clearly defined. The Sendai Framework's implementation is thought to place a high priority on the relationship between science and policy (Pearson and Pelling 2015), so the main concern is how to create the most advantageous institutional frameworks that enable the scientific community and scientists working for government entities to contribute to it. But at the moment, the scientific community's participation is mostly reliant on the political will of decision-makers. Thus, we may speak of an institutional gap in the sense that the lack of new institutions and modifications to existing ones directly contribute to the hurdles to the integration of research into policy for disaster risk reduction. Despite an increase in the development of catastrophe risk reduction information, the conversion of scientific data into practical applications and choices has been slow thus far (Weichselgartner and Pigeon 2015). This is not to imply that this topic is not receiving broad attention and awareness, as evidenced by a number of recent papers and research studies (IPCC 2012; Southgate et al. 2013; Aitsi-Selmi et al. 2016; Poljansˇek et al. 2017). However, a review of the different project's findings reveals a dearth of institutional frameworks that support knowledge transmission (Amaratunga et al. 2017b).

The institutional gap has a large component related to the problem of a lack of catastrophe competence. In addition to the public governance institutions, the corporate sector and nonprofit groups are all affected by the problem of a shortage of risk specialists. One of the key parts of this issue is the divide between academics and practitioners working on related issues in disaster risk reduction and climate change adaptation, who are seldom in conversation since there aren't enough forums, venues, or chances to start such a conversation. As a result, it is possible to think of the intersections between science and policy as "a complex landscape that is best defined as a multi-level system of governance and knowledge generation" (2007) (Vogel et al., p. 351). There are numerous and diverse stakeholders in disaster risk reduction who compete for financing and attention, two resources that are plentiful when catastrophes strike but scarce otherwise. Since academics participates in these stakeholder interactions, science—the process of creating knowledge—is entangled in fights for influence in the formulation of policies for disaster risk reduction. In catastrophe research, the characteristics of disaster risk reduction as a new paradigmatic field of knowledge have an influence on the dynamics of the science-policy interaction.

Building on the preceding description of the UNDRR (formerly UNISDR), disaster risk reduction may be described as a shift away from reaction and recovery towards resilience, preparedness, and prevention. However, how catastrophe risk reduction strategies and practices actually work differs depending on the situation.

Academically, social scientists have largely pushed for the decrease of catastrophe risk (Wisner et al. 2004). Even though vulnerability models are quickly taking over disaster analysis in the natural sciences, it is still difficult to incorporate such perspectives into the natural sciences that deal with hazards and risks (such as hydrology, volcanology, or seismology) that aim to produce statistical risk assessment models. However, given that viewpoints on disaster risk reduction have been predominantly promoted by the social sciences (particularly sociology, human geography, anthropology, and development studies), there is an important knowledge gap across various disciplines of study when it comes to disaster research.

18.6.3 The Strategic Gap

The lack of consensus about the nature and applications of knowledge and the absence of institutions that can assist the application of that knowledge between the two domains are referred to as the epistemological and institutional gaps. The lack of shared perspectives on how to advance is referred to as the strategic gap. The communication gap is one of the main problems with the strategy gap. There are limited venues for debate and discussion of pertinent topics and long-term strategic outlooks among scientists and relevant officials. Standards and international frameworks, such as the Sendai Framework (UNISDR 2015), have suggested paths for the inclusion of science in disaster risk reduction measures on a worldwide scale. At the local level, sector-based integration and knowledge transfer are more common than cross- or multi-sectoral processes. According to research, catastrophe risk reduction has the potential to result in greater financial savings than relying just on disaster response (Schreve and Kelman 2014).

There has not been a similar level of focus on such goals at the national and local levels, and frequently institutions dealing with risk reduction fail to see the need for training on integration across domains, despite the fact that international frameworks such as Sendai place great emphasis on risk reduction and capacity development, including educating and nurturing of disaster expertise. As Lavell and Maskrey argue: "Specialized disaster risk reduction institutions lack the political authority or technical capacity to influence development sectors" (Lavell and Maskrey 2014, p. 269).

As a result, although they may exist at the international levels, the articulation of shared visions for the science-policy interaction is uncommon at the national and local levels. Disaster risk reduction is described as being hampered by conflicting aims and priorities, both within policy frameworks and between policymakers and scientists (Raju and van Niekerk 2013). This challenge is mutual in character as a result. While policymakers must develop and adopt more complex conceptions of creative knowledge creation for disaster risk reduction, scientists must comprehend cultural and institutional subtleties in order to produce knowledge inputs for sustainable, comprehensive policies.

A communication gap exists between scientists and the general public as well as between science and policy. The earlier discussed problem of risk perception and public risk awareness amply illustrates this communication gap at various levels. The problem of public risk perceptions clashing with professional and scientific risk evaluations may always exist. Though it may not always be a matter of a lack of communication, but rather a matter of epistemological and cultural factors (Douglas and Wildavsky 1982) leading to diverging risk perceptions, measures for experts to better understand the dynamics of public risk perceptions need to be prioritised. Last but not least, there is a communication gap between scientists and policymakers as well as across various scientific fields, and the natural sciences are continually given priority in hazard analysis and crisis management (De Groeve and Valles 2015).

18.6.4 Analysis of the Three Gaps in Relation to the DRR

This section offers an analysis of how the three concerns connect to the three gaps, which serves to condense the conclusions and arguments we have addressed in the preceding sections. When attempting to understand the barriers and challenges that stand in the way of the integration of science and policy for disaster risk reduction, it is important to understand how many factors and root causes are at play. This is why conducting an analysis of the correlation between the problems and the gaps is relevant. All three gaps ultimately have to do with governance, or how to restructure governmental and legal structures to advance the fusion of research and policy in the area of catastrophe risk reduction. The three gaps and the three concerns do not, in our opinion, exhaust the difficulties that the science-policy interface for disaster risk reduction in Europe faces, but they do serve as an effective beginning point for debate. However, it must be understood that what we refer to as the scientific-policy interface (in keeping with Van den Hove 2007) should take into account the occasionally divergent objectives of science and policy players. To put it another way, we don’t want to embrace a normative deterministic perspective that assumes science and research should and can always be used to inform policy decisions, or that all policy decisions inevitably benefit from scientific input. The two fields frequently have quite different conceptions of what knowledge is, how to structure its generation, and how it might be applied to risk reduction. Disaster risk reduction is still a developing topic of study in both academic and practitioner contexts, despite the fact that risk reduction approaches are now integral to international frameworks like Sendai and are ingrained in practices promoted by organisations like the Red Cross. It is, therefore, unclear what exactly constitutes the kind of expertise required for academics and professionals in relation to disaster risk reduction. However, the focus should be on comprehending the underlying causes of vulnerability and on the idea that resources should be allocated to preparedness, prevention, and resilience rather than just response and recovery. Despite these uncertainties, we contend that scientific discoveries hold a great deal of promise for helping societies in India and beyond with regard to catastrophe risk reduction strategies and plans. As a

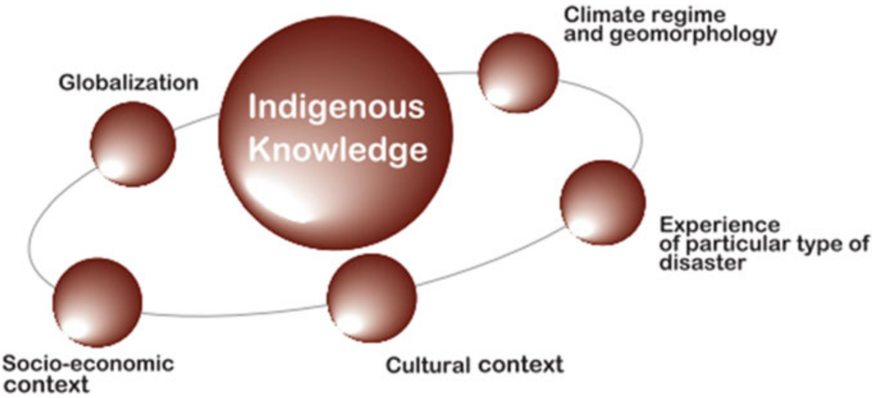

Fig. 18.12 Factors of indigenous knowledge. *Source* https://www.slideshare.net/FayazAhmad1/disaster-management-cycle-249505426

result, the examination of the problems and gaps provides ideal typical methods of conceptualising problems for disaster risk reduction that do not directly correspond to the real world but serve as useful categories for discussion of real policies and programmes.

18.7 Materials and Methods

This study presents the qualitative component of large mixed methodology. It took into account the factors of indigenous knowledge and disaster risk resilience in India. Many documents such as research papers and reports of UN, UNDP, NDMA, GFDRR, and UNDRR were gone through to form the conclusion (Fig. 18.12).

18.8 Results and Discussion

Important publications on disaster risk management, including its concept, identification, evaluation, mitigation, monitoring, and resilience, have been published by UNESCO and ICOMOS. In India, however, there is a significant disconnect between concept and execution. There are now 2000 monuments in India that barely comply with the current standards. Consequently, a comparison analysis was finished in 2012, and some significant concerns were discovered, such as too many electrical infrastructure, a lack of effective firefighting tools, and a management deficiency. Through the improvement of the management, some major risk can be mitigated.

- One way to demonstrate leadership and support risk reduction in buildings is to expand and revise building codes.

- Beyond the building-specific questions above, and equally important to ensure success, is the need to strengthen, develop, and incorporate local knowledge and capacity within the community.

18.9 Challenges/Limitations of the Study

- DRR is widely mentioned in relation to climate change and natural disasters, but seldom in relation to political instability or violence. Given the difficulties of maintaining objectivity, foreign money and security procedures, political affiliations, and interventions in associations are uncommon. Politics is not used to paint over conflict. Because of this, programming (of any sort) is potentially challenging and difficult when seen through the prism of moral principles. Even if these issues cannot be prevented in each situation, various groups prefer to work in emergency situations and in rather of taking on greater risk as a reaction to inherent risk openly political environments.
- There are many more risks than conflict that are underrepresented in the DRR literature. For instance, biological and financial risks settings with several hazards receive little to no pay close attention, especially while studying the objectives of the different organisational bodies in the DRR realm (ISDR 2004). These topics demand more investigation if we are to better comprehend the capabilities of those impacted communities for better programming and design.

18.10 Conclusion

Disaster management seeks to mitigate the effects of catastrophes by reducing human and material losses. The United Nations has been promoting policies and initiatives to decrease risks since the early 1990s, before such hazards turn into catastrophes and have an impact on vulnerable people. There is a lot of evidence about the close relationship between resilience and indigenous traditions as a consequence of decades of research on the catastrophe phenomenon in the Asia–Pacific area. However, there are still gaps in putting this knowledge into practice. Human behaviours that have developed over ages have stood the test of time and have been shown to be sustainable and successful in controlling inevitable dangers and decreasing calamities. It is crucial to consider if more might be done to prepare for such occurrences, lessen their effects, and improve the resilience of the communities impacted, allowing them to recover more rapidly. Disaster risk reduction practices include lowering vulnerability of people and property, reducing exposure to dangers, managing land and the environment wisely, and increasing readiness for unfavourable occurrences (Fig. 18.13).

Fig. 18.13 Success factors in disaster preparedness. *Source* https://preparecenter.org/wp-content/uploads/2020/07/Process_Flow_1.png

This book chapter has investigated the connections between disaster risk reduction and climate change in great detail and described the variables affecting the relationship between indigenous traditions and DRR. The study will aid in the analysis of the procedure for establishing factors of countermeasures for catastrophe mitigation. The essay will also assist us in evaluating and changing indigenous customs, as well as analysing the unique circumstance and its interpretative starting. The extensive body of knowledge and practices for disaster risk reduction (DRR) will also be covered, underlining the need for a more comprehensive process that incorporates bottom-up and top-down activities, local and scientific information, and a wide range of stakeholders. As a result, it will help in identifying fresh problems in fulfilling the requirement for an integrated process, which will be described together with a potential future road plan for filling in gaps in DRR (Fig. 18.14).

At the local, national, and international levels, catastrophe management is growing more and more difficult. At the national and local levels, disaster risk practitioners, policymakers, and experts face the challenge of implementation in which the role of science is becoming ever more crucial but yet harder to put into practice. This

Fig. 18.14 Success factors in DRM cycle. *Source* Author

is happening while the world stage debates the trajectories laid out in the Sendai Framework. Prioritising choices for catastrophes is a challenge for policymakers. There is no one scientific field, one government agency, or one stakeholder that can be claimed to speak with authority in the field of disaster management. Disaster management involves a wide range of players. We have spoken about the difficulties that the science-policy interface faces when it comes to disaster risk reduction in India, as well as the possibility for developing institutions, platforms, and methods for dealing with catastrophes that are stronger and more effective. First, we briefly discussed the knowledge transfer, disaster expertise, and risk awareness concerns that the country and has found what was consistent with the literature already available in the field of scientific policy in disaster risk reduction. We then presented three gaps—an epistemological gap, an institutional gap, and a strategic gap—that we contend can explain some, if not all, of the problems facing the science-policy interface in disaster risk reduction.

- The epistemological divide highlights the reality that the kind of information that policymakers and public officials, need should be vital and viewed as useful are driven by fundamentally divergent interests.
- The institutional gap shows that there are several organisational and institutional obstacles preventing greater collaboration between scientists and policymakers.
- Finally, the strategic gap demonstrates the lack of collaboration between the research and policy fields, which is mostly a result of poor communication and a lack of mutual awareness of this interdependency.
- The epistemological gap brings to light the fact that the kinds of knowledge that scientists, researchers, and specialists need are similar to what policymakers and public officials, consider as important and beneficial, are motivated by fundamentally different objectives.
- The institutional gap demonstrates that there are several structural and institutional barriers impeding closer cooperation between scientists and decision-makers.
- The strategic gap, which is mostly the result of inadequate communication and a lack of mutual knowledge of this interdependency, shows that the research and policy domains do not work together.
- The epistemological divide highlights the reality that the kind of information that politicians and public officials view as significant and valuable is driven by quite different goals than those that scientists, researchers, and experts do.
- The institutional gap illustrates how various structural and institutional obstacles prevent closer collaboration between scientists and decision-makers.
- The strategic gap, which is mostly the result of poor communication and a lack of understanding of this interdependency on both sides, demonstrates the lack of collaboration between the research and policy domains.

The current paper has aimed to clarify why the scientific-policy interface in disaster risk reduction faces significant hurdles in the decades to come, despite recent success being apparent in the transfer of knowledge into disaster risk reduction (GFDRR 2014a, b; Poljansek et al. 2017). One thing is for sure: we won’t require less information in the future. It is hoped that these can assist policymakers as well as academics in rethinking how to positively handle the current demand for greater knowledge in disaster risk reduction.

All in all authorities, project developers, funders, and community members can motivate and educate people, provide incentives, and create a favourable environment for the promotion and innovation of sustainable building design and construction standards that advance community resilience to climate change by incorporating locally adapted climate adaptation measures in post-disaster reconstruction, owner-driven construction, or slum upgrading, as well as building retrofits and new constructions.

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Chapter 19
Disaster Risk Reduction Through Local Knowledge and Practices—A Case Study of the Indigenous Boti Tribe, Timor Island, Indonesia

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Abstract At this time, there are still some discourses that underestimate the practice of local knowledge in dealing with disasters because they are considered old, primitive, and out of date. This study attempts to examine these assumptions by analyzing the potential contribution of local wisdom or traditional knowledge practices in disaster risk reduction. Boti village located on Timor Island, East Indonesia, was used as a case study with the consideration that this village is one of the areas prone to disasters, especially earthquake, landslides, and drought, and this area is inhabited by the indigenous Boti tribe—the oldest tribe on Timor Island which is known to still adhere to its traditional knowledge, customs, and culture. A combination of literature studies and field observations was used to collect data related to local wisdom practices identified as being able to reduce disaster risk. The results found that there are several practices of the Boti tribal indigenous community that can reduce disaster risk, ranging from a belief system that upholds environmental sustainability, astronomical abilities for early warning systems, terrace system to reduce the risk of landslides, food preservation system to prevent starvation, and traditional house structures that protect against landslides or earthquakes and settlement patterns which able to minimize transmission of disease and livelihood diversification to anticipate crop failures.

Keywords Disaster risk reduction · Landslides · Local knowledge practices · Indigenous community

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_19

19.1 Introduction

The United Nations through several resolutions calls on countries in the world to prioritize disaster risk reduction efforts as an integral part of sustainable development programs. The Hyogo Framework for Action (HFA) 2005–2015 which was born at the World Conference on Disaster Reduction in Japan in 2005 which was signed and ratified by 168 countries including Indonesia is committed to achieving the expected results, namely a significant reduction in the loss of life and social assets, economy and the environment due to disasters experienced by the community and the state. After ending in 2015, the Hyogo Framework was replaced with the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030. SFDRR 2015–2030 formulation was adopted on the agenda of the United Nations Third World Conference on Disaster Risk Reduction (3rd WCDRR) in Sendai, Japan, in 2015. With the ratification of the SFDRR 2015–2030, the international community has a new framework for action related to disaster risk reduction, disaster risk that will be a guide in disaster risk reduction activities until 2030 (United Nation 2015).

The 2015–2030 SFDRR has four priority actions and objectives: Priority 1—understanding disaster risk with the aim of understanding the correct risk based on science, technology and local wisdom; Priority 2—strengthening disaster risk management to manage risk with the aim of improving the governance system in disaster management through the application of the principles of participation, fairness and equality, professionalism, independence, efficiency in the use of resources and on target/effective; Priority 3—invest in disaster risk reduction for resilience with a view to investing in structural and non-structural development that is sustainable and accountable at all levels, and which does not create or increase economic and social risks; and Priority 4—improve disaster preparedness for effective response, and "Build Back Better" in recovery, rehabilitation and reconstruction with the aim of governments and communities having the capacity to respond effectively to disasters independently and capable of being resilient after a disaster event and build a better life (United Nation 2015).

In addition to producing the 2015–2030 SFDRR, in the WCDRR the Indonesian delegation fought for several things related to disaster risk reduction. The first is the international community's recognition of the concept of "disaster-prone countries with specific characteristics, such as archipelagic countries, as well as countries with extensive coastlines." The second is the issue of emphasizing the importance of local capacity building in dealing with disasters. This needs to be done by all countries in the world, considering that disaster management must be carried out in synergy by involving all stakeholders at the local, national, regional, and global levels. Another issue is that Indonesia also supports the importance of recognizing and developing traditional knowledge which is generally found in indigenous peoples in DRR activities, considering that traditional knowledge has been proven to reduce the number of casualties during disasters.

These indigenous peoples are proven to have the ability and knowledge in dealing with or minimizing disasters. For example, the local wisdom of the people of

Simeulue Island in reading coastal natural phenomena has saved thousands of people from the Tsunami disaster on December 26, 2004. Early warning through the warning “screaming” semong (the sea water receded and they had to run to the hills), which was obtained from generation to generation, learned from the disaster several decades ago. The screams proved to be saving many people on Simeulue Island which is close to the epicenter of the earthquake/tsunami. Another example of local spatial wisdom is the management of agricultural land with a terraced system in areas with steep slopes aimed at reducing erosion and preventing landslides.

These traditional knowledges in disaster risk reduction are generally found in indigenous peoples around the world. Globally, the number of indigenous peoples around the world is around 476 million people or about 6% of the global population (World Bank 2022). In Indonesia, data from the Alliance of Indigenous Peoples of the Archipelago—*Aliansi Masyarakat Adat Nusantara* (AMAN) states that in 2020 there will be approximately 70 million indigenous people spread over 2371 communities, of which the largest indigenous community is on the island of Borneo. The Customary Territory Registration Agency—*Badan Registrasi Wilayah Adat* (BRWA) noted that there were 1034 maps of customary territories with an area of about 12.4 million ha spread over 29 provinces and 136 regencies (BRWA 2021).

The Boti tribe, the oldest tribe on the island of Timor, East Nusa Tenggara, is one of the known examples of indigenous people as a tribe that still upholds customs in everyday life. Studies on the Boti tribe are dominated by studies in socio-cultural aspects, including studies on the traditional Boti dance-bonet (Andung and Nope 2017), culture and customary rules in natural resource management (Prasetyo and Ndolu 2017), education-based the culture of the Boti tribe in schools around the Boti tribal area (Sandiningtyas and Wiyono 2018); the role of Usif-Raja in the management of the natural environment of the Boti indigenous people (Nope 2019); cultural landscape (Nubatonis et al. 2019) and the nine-day time function in the Boti cosmology (Konay et al. 2021). Several studies were also found in ecological/biophysical and economic aspects, including studies of plant species and their use (Benu et al. 2013) and studies on sustainable cultural tourism opportunities in the Boti tribe (Sudin 2017). Meanwhile, studies related to disasters are still limited, some of which are the study of the Boti traditional house as a form of disaster resilience and food security (Iswanto 2021), thermal security in the traditional house of the Boti tribe (Junianto and Saputri 2022).

19.2 Rationale of the Study

Referring to the Indonesian Earthquake Source and Hazard Map issued by The Ministry of Public Works and Housing (2017), Timor Island is crossed by the Semau Fault, Flores Back Arc Thrust, Savu Trust, and Timor Fold Thrust Belt faults. Due to these geological factors, Timor Island is prone to earthquakes. The location is around the equator, which has tropical climate, prone to landslides, extreme weather, extreme waves, drought, forest fires, and abrasion. Negative impact of global climate change has made Timor Island more vulnerable to various disasters related to the impacts of climate change.

Based on data from the National Disaster Management Agency (*Badan National Penanggulangan Bencana*—BNPB), the Boti Village area in particular and the South Central Timor District in general are classified as disaster-prone areas. The dominant type of disaster is landslides, which are likely to occur due to the hilly and steep topography and high rainfall during the rainy season. Other disasters that threaten are drought and food insecurity caused by a semi-arid climate characterized by a long dry season and short rainy season. The ability of the community, especially the indigenous Boti tribe to deal with disaster vulnerability, already exists, but has not been well documented so that it cannot be replicated or imitated by the ordinary community around it or related parties in the context of reducing disaster risk. Therefore, it is necessary to study the identification of local wisdom of the Boti tribe in disaster risk reduction.

19.3 Literature Review

a. Disaster Concepts

Disasters are natural or man-made events that suddenly or slowly occur with great severity resulting in material losses, environmental and human damage so that the affected community must respond with extraordinary actions beyond their capabilities (United Nations International Strategy for Disaster Reduction/UNISDR) (2009). According to Lassa et al. (2014), disasters are a function of the risk process. Disasters are the result of a combination of hazards, vulnerable conditions, and insufficient capacity or action to mitigate the potential negative consequences of risk. Disasters occur when danger and vulnerability combine. A hazard will become a disaster if the community has a lower capacity than the incoming hazard, or if the community's vulnerability is higher than the hazard. The higher the vulnerability of a person/community, the greater the risk accepted. Disasters are natural or man-made phenomena that can cause physical and economic losses and threaten human life. Various types of disasters include:

- Natural: earthquakes, volcanoes, floods, landslides, drought, strong winds, and others
- Biological: epidemics/outbreaks of disease outbreaks, HIV/AIDS, bird flu, and others
- Social: social unrest, war, civil society conflict, terrorism, gang/mafia activities, and others.
- Economy: hyperinflation, economic collapse, debt/financial crisis, economic transition period, unemployment, crop failure, and others.
- Politics: political failures, coups, etc.
- Human error: technological/industrial/nuclear failure, transportation accident, city fire, and others.

- Environment: air and water pollution.

Disaster risk is the amount of loss that may occur (loss of life, injury, property damage, and disruption to economic activities) caused by a certain hazard phenomenon when the threat of danger meets vulnerability. Disaster risk occurs due to the meeting of hazard threats with vulnerabilities triggered by potential disasters without any capacity.

Vulnerability is a factor or obstacle that leads and causes physical, social, economic, behavioral, and motivational consequences that adversely affect (decrease the ability) of the community/community toward disaster management efforts. There are five categories of vulnerabilities, namely:

- Natural vulnerabilities.

Natural vulnerabilities are vulnerabilities related to natural geography or natural topography and structures. For example, lowland, unstable soil, and steep cliffs.

- Physical/material vulnerabilities

Physical/material vulnerabilities are vulnerabilities related to physical forms (such as buildings, houses, public facilities, and others).

- Social/organizational vulnerability

Social/organizational vulnerability is a vulnerability related to social/organizational. Experience shows that people who are excluded from social, economic, and political life are more vulnerable to disasters than those who are organizationally active. Lack of community knowledge and skills will trigger vulnerability and inability to deal with disaster impacts.

- Motivational vulnerability

Motivational vulnerability is a vulnerability related to motivational. Experience also shows that people who do not have confidence in their abilities, especially in the face of disasters, cannot control their emotions. They will be more severe if hit by a disaster, compared to people who have high enough confidence to change their fate.

- Economic vulnerability:

Economic vulnerability is a vulnerability related to economic aspect. Poor people who have few material resources usually suffer more during disasters than rich people. These factors make them more vulnerable in dealing with disasters and also they need a longer time to survive and recover to normal conditions, compare to those with a better economy.

The purpose of disaster risk management is to reduce and prevent disaster risk by reducing threats and reducing vulnerability:

- Reducing threats: There will still be danger. Some natural hazards cannot be prevented from occurring, but we can reduce the threat. For example: planting mangrove forests to withstand the pounding of the big waves.

- Reduce vulnerabilities. The most important thing in reducing disaster risk is to reduce vulnerability so that people become "resilience" (resilience) to disasters. Various changes due to physical factors, social, economic, and geographical conditions reduce the community's ability to prepare for and cope with the impacts of natural hazards. For example: building a house with a strong structure to withstand the vibrations caused by an earthquake.
- Strengthening capacity/ability: In order to strengthen community resilience in the face of disasters, the existing capacity needs to be increased. For example: in dealing with seasonal floods, community groups have flood posts that are ready to run every time a flood occurs. Capacity building is carried out by increasing the provision of flood prevention facilities and infrastructure, emergency response training for volunteers, and so on.
- Disaster risk reduction is prevention, mitigation, and preparedness actions taken before a disaster occurs to prevent and minimize casualties and material losses. It can be seen in the comprehensive disaster management cycle chart below:
- Prevention is an effort to eliminate or reduce the threat of danger. For example: reforestation, relocation of residents' housing to areas that are not prone to disasters.
- Mitigation is efforts made to minimize disaster risk. In contrast to preparedness, mitigation efforts are usually aimed at the long term. This effort can be in the form of actions to reduce disaster risk, both in the form of physical development and awareness and capacity building of the community in dealing with disaster threats. For example: training to build the movement of mosque congregations against the threat of disaster. There are two types and forms of mitigation: (1) Structural mitigation: risk reduction measures more physical disasters. Structural mitigation can be physical or policy. Examples of physical mitigation: building earthquake-resistant buildings, so that when an earthquake occurs, the house will not be too destroyed by earthquake shocks. Example of policy mitigation: preparation of Regional Regulations on Disaster Management; (2) non-structural mitigation: any effort to reduce risk disasters that are carried out but are not physical. Usually, many casualties and losses arise due to people who are not ready to face disasters. For example: awareness, increasing knowledge, and increasing skills.

Forms of mitigation: providing training, so that we are better prepared to face disasters. With the increase in our knowledge of disasters, the more we know how to deal with disasters, the more prepared we are to face them, the more disaster risks can be minimized

b. Disaster Management

As a country that is full of disaster threats with a much wider landscape and a much larger population, Indonesia should no longer bet on disaster issues. Disaster mitigation and preparedness programs and activities must be initiated and developed immediately. Disaster awareness education and training in dealing with disasters must be immediately familiarized. Disaster management policies and management must be immediately organized and created. Centers for study and training in dealing with disasters must be created and fully supported. Indonesia is at high risk of disasters because: (1) high threat (related to geographic and geological position); (2) high community vulnerability (demography, socio-cultural diversity, low education and knowledge, low awareness of safe culture). Indonesia is located in the Pacific ring of fire, which is a confluence of three world tectonic plates, namely the Indo-Australian Plate, the Pacific Plate, and the Eurasian Plate. Indonesia's population consists of various ethnic groups, religions, and customs. This diversity is the wealth of the Indonesian people. However, because high population growth has not been matched by equitable and adequate economic, social, and infrastructure policies and development, gaps have occurred in several aspects and sometimes social jealousy has arisen. This condition has the potential to cause conflict in society which can develop into a national disaster.

Disaster Risk Reduction (DRR) is a new concept of disaster management that needs to be disseminated to all disaster management actors in Indonesia. There has been a paradigm shift in disaster management in the world:

- From responsive to preventive.
- From sectoral to multi-sectoral.
- From a mere government responsibility to a shared responsibility.
- From centralization to decentralization.
- From emergency response to risk reduction.

c. Local Knowledge for Disaster Mitigation

Local wisdom is defined as a collection of information passed down from generation to generation in a particular location obtained from accumulation of experiences, relationships with environment, and traditional rituals, practices, and institutions (Kelman et al. 2012). Understanding the potential of local wisdom that exists in a particular community will be explored through a participatory approach (Retnowati et al.2014). Communities with their "capabilities" (local knowledge, local technology, local institutions) will easily understand and accept planning and design products if the "language" they use can be understood (Wikantiyoso 2010).

Local people generally have local knowledge and ecological wisdom in predicting and mitigating natural disasters in their area (Retnowati et al. 2014). This local knowledge is usually obtained from rich empirical experience as a result of interacting with the ecosystem (Kurnio et al. 2021). Local people who live on the slopes of Mount Merapi, Central Java, for example, already have the ability to predict the possibility of an eruption (Dove 2008). The local wisdom of the people of Simelue Island in reading coastal natural phenomena has saved thousands of people from the Tsunami disaster on December 26, 2004. Early warning through the warning "scream" semong, (the sea water receded, and they had to run to the hills), which was obtained from generation to generation, learned from the incident disaster decades ago. In contrast to the people around Pangandaran Beach who actually ran to the sea to pick up fish because the water was receding, causing a relatively large number of victims. Semong for the people of Simeulue Island is always socialized by becoming a legend by local community leaders so that this term becomes embedded and entrenched in the hearts of every resident of Simeulue Island. This term saved almost all the people of Simeulue Island even though geographically it was very close to the center of the disaster. People who come from Simeulue Island and work along the west coast of Sumatra have become heroes because they saved many people by ordering and forcing people to run as fast as possible to high places as soon as they saw the sea water receding. Local knowledge, such as this is very diverse, with traditional terms and methods, must be seen as a potential in disaster mitigation planning based on the potential of local wisdom (Wikantiyoso 2010).

19.4 Materials and Methods

a. Study area

The Boti tribe is located in the interior of Timor Island and administratively is located in Boti Village, Ki'e District, South Central Timor Regency, NTT Province (Fig. 19.1). The Boti tribe is a sub-tribe of the Amanuban—one of the three major tribes on the island of Timor, in addition to the Amanatun and Mollo. The Boti tribe is divided into two, namely: (1) the Boti Dalam (Inner Boti) tribe, which still maintains its traditions and culture and still adheres to tribal beliefs called Halaika and (2) the Boti Luar (Outer Boti) tribe, which is open to development and has accepted religion and the state. Boti Village has an area of about 1700 ha and is located at an altitude of about 1500 m above sea level and is about 64 km from the city of Soe (capital district of South Central Timor Regency) which can be reached in about 3 h by vehicle (BPS Kab. TTS 2020). Natural conditions are characterized by hilly land and steep topography as well as soil that is prone to landslides and the condition of limited water resources. The population of Boti Village in 2019 was around 2175 people with 567 families, of which 80 families or around 300 people were residents of Boti Dalam (BPS Kab. TTS 2020). Livelihoods are dominated by subsistence farmers with corn and other dominant crops are tamarind and candlenut. Education and welfare levels are still low, so the Ministry of Village, Development of Disadvantaged Regions and Transmigration to classify Boti village as an underdeveloped village.

b. Conceptual Framework

This study follows the framework developed by Hadlos et al. (2022), which based on his review of hundreds of studies related to the application of local knowledge in disaster management, found that indigenous peoples' belief systems shape early warning systems, knowledge and perceptions of disaster risk, anticipatory measures, action structural, livelihood-based adaptation and collective/social action (Fig. 19.2).

The belief that generally develops in indigenous peoples is that disasters are a form of sanctions for bad deeds from humans. From a religious perspective, disasters are also often seen as warnings and divine tests. Some community groups also consider that religious practices are considered as protection against future disasters and as a means of strengthening or recovering from disasters that have already

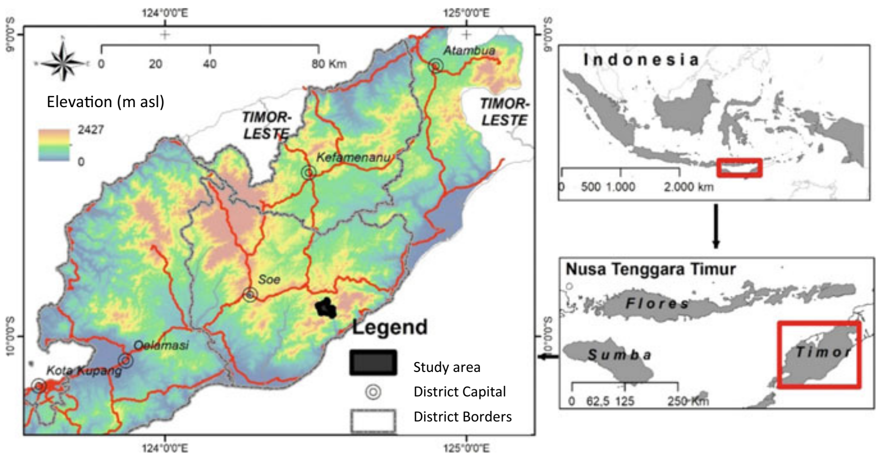

Fig. 19.1 Study area, depicted by elevation (digital elevation model). *Sources* United States Geological Survey—USGS (2018); BIG (2014))

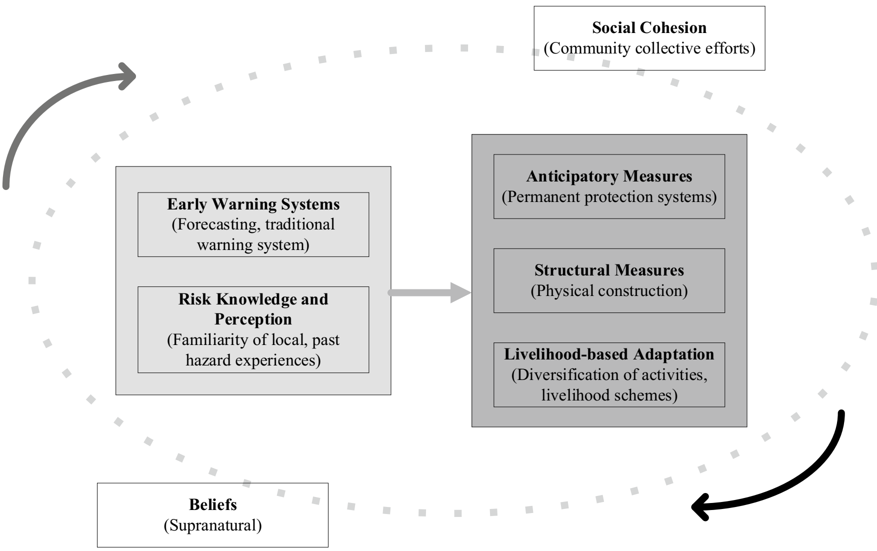

Fig. 19.2 The link between different types of local indigenous knowledge practices in disaster risk reduction. *Sources* Hadlos et al. (2022)

occurred. The continuous interaction between indigenous peoples and their environment allows them to identify signs and signals from nature that can indicate the danger of an impending disaster, which in this case is often referred to as an early warning system. Disaster preparedness requires community understanding and assessment of environmental threats. Knowledge and perception of risk are developed when people are embedded in or have an understanding of their environment, as everyday encounters teach them what these hazards can cause, why and how they occur, and how to deal with them. Knowledge and perception are obtained from a good familiarity with the surrounding environment and past hazard experiences. Initial actions can be in the form of permanent protection systems and strategies ("mitigation") or non-technical preventive measures ("preparedness") aimed at reducing risks in the face of hazards. Livelihood-based adaptation can take the form of modification of livelihood schemes and product/activity diversification (Hadlos et al. 2022).

c. Methods

This study was focused on the study of local knowledge practices related to disaster mitigation in the Boti tribal community. Based on previous studies, several types of disasters that occurred at the study site were, for example, landslides, earthquakes, and drought. The method used in the study was a descriptive research method with a qualitative approach. Data collection was carried out through a combination of literature studies, observation, and interviews. Literature studies were obtained from previous publications in the form of reports, maps, books, scientific journals, and other related references. Observation activities were carried out in the pattern of settlements and structures of traditional house buildings, land use zones, and customary forests with their various biodiversity. Meanwhile, the interview was conducted to the resources and key informants, namely the Customary Leaders (King—*Raja*) and the elected Boti residents. The key informant was selected by snowballing method starting from the village head to the community who were very aware of the topic of local knowledge practices to reduce the risk of disaster. Furthermore, data and information were processed using a qualitative descriptive analysis to produce traditional knowledge practices that were compiled in accordance with the conceptual framework.

19.5 Results and Discussions

a. Belief

Local beliefs grow through genealogy, namely inheritance to embrace certain beliefs from generation to generation. This concept makes local beliefs an exclusive group, meaning that this group does not have a doctrine to spread their beliefs. Local beliefs that develop grow in certain areas, they live in a community that inhabits one area (Sirait et al. 2015). In line with this quote, the beliefs held by the Boti tribe, especially the Boti Dalam tribe, are local beliefs that are passed down from generation to generation. This belief also does not have a doctrine to propagate, considering that the *Halaika* belief only develops in the Boti area. The Boti tribe, through their belief called *Halaika* earlier, believed in the existence of *Uis Pah* and *Uis Neno*.

Uis Pah itself means God of the Earth. In the belief of the Boti tribe, *Uis Pah* is likened to a mother who fulfills the needs of her children. *Uis Pah* is what gives prosperity, and oversees and maintains the life of the universe. *Uis Pah* is also the one who raises and protects humans, especially the Boti tribe. Meanwhile, *Uis Neno* in the Boti tribe's belief is the father who is the ruler of the afterlife. *Uis Neno* is the one who will determine whether a person can go to heaven or even go to hell based on the actions of the human being during his life. If associated, then the concept of *Uis Pah* is "Ruler of the Earth," while *Uis Neno* is "Ruler of the Sky." *Uis Pah* is a place of human existence where humans get life and protection, while *Uis Neno* is a source of life and human life itself.

One element of culture that cannot be separated from community groups is the existence of rituals. Rituals are not only a means to strengthen social bonds, but also a form of connecting humans with the sacred. The existence of the Boti tribe cannot be separated from this. Pehiadang (2019) in his research explained that the Boti Dalam tribe has a *Poi Pah* ritual to honor *Uis Pah* as the God of the Earth who has given them life through the nature around them and respects the spirits who live behind the rocks, trees, and mountains. This ritual is usually carried out in the forest (*Fain Maten*) which has been sacred by the Boti Dalam tribe. At the time of the ritual, the Boti Dalam tribe people bring valuable objects that they have, such as cloth that they wove themselves, some food ingredients that come from the harvest and certain animals that will be used as offerings. Their purpose of paying homage to *Uis Pah* is that they may always be blessed, protected, given safety, and ask that the produce of the earth that they will or have harvested can be blessed so that they will always have enough (Pehiadang 2019).

Apart from carrying out rituals, the way for the Boti tribe to be grateful for the life they get is through behavior or living habits. Suminar (2018) in his research explains that for the Boti tribe this life is so sacred, so to respect the earth which is considered their mother, they cultivate it in a very careful way. They even make taboos in their practice of life, one of which is not wearing footwear such as sandals and shoes to step on the earth. They also abstain from selling land to anyone, because land is considered as "Mother." Whoever sells their land, it is the same as selling their mother. The men of Boti have their hair cut once in their lifetime, and because their hair is long, the men's hair is tied around their heads. For them, hair is like leaves on trees that can only fall by itself. This is possible, because Halaika's teachings are centered on nature (Suminar 2018).

Kitchen utensils such as plates, spoons, and glasses are made from coconut or bamboo shells by the Boti men. The closeness to nature is also evident when they are sick. Like, using candlenut (*Aleurites moluccanus*) as a massage medicine, and coughing by drinking candlenut and turmeric (*Curcuma longa*). Forests function as "pharmacies" because there are various types of plants available to treat various diseases. Personal hygiene is also with nature, as can be seen from the way they wash their hair with the fruit extract of *keben* tree (*Barringtonia asiatica*), and wash clothes with the trunk of *damar* tree (*Agathis dammara*) as a substitute for soap. Proof that nature gives them whatever they want.

The King's directive to always live side by side with nature must be maintained so that there need to be activities regarding nature conservation. It is important to protect nature for future generations. Life is not depending on the help of others.

Nature gives anything they want. Furthermore, they refuse government assistance is that they do not want to get used to depending on others. Government assistance is good for them, but if they accept it, then they will be lazy to work.

The King wanted the Boti people to get used to working hard to support themselves. It does not mean not wanting to cooperate with outsiders. The habit of living together, participating, and contributing to development programs in the Boti tribe is highly respected. It is better to join and participate in helping through cooperation and participate by contributing to development programs. The Boti tribe rejects development programs because they do not want to be seen as people asking for help. Boti people has the principle of not wanting to depend on other people, including, in this case, the government, and assistance from outsiders.

The uniqueness of the Boti tribe is their calendar calculation system called the Halaika Calendar. One week in the calculation of the Boti tribe consists of nine days. According to the view of the Boti tribe, the earth is round and has a center point as well as the number "9" which has a round shape and has a center point. So, when the earth rotates like a wheel it will return to its center point (Tey 2006). The explanation is as follows:

- The first day is called *Neon Ai* or the day of fire. Today, it is interpreted as a bright and sunny day. However, care must also be taken in using fire so as not to cause harm to the community.
- The second day is called *Neon Oe* or water day. Today, it is assumed that the community must be responsible for the use of water
- The third day is called the Iron *Neon* or iron day. Today, people will be careful in using sharp objects such as knives, machetes, and so on.
- The fourth day is called *Neon Uis Pah Ma Uis Neno* or the day of the God of Earth and God of Heaven. On this day, people glorify the Creator and Sustainer of Life.
- The fifth day is called *Neon Suli* or the day of strife. This day is used by the community to settle disputes. In addition, the public must also be careful in carrying out interaction so as not to cause conflict.
- The sixth day is called the *Neon Macat* or the day of struggle. Today is used to work as well as possible because today is a good opportunity to achieve success.
- The seventh day is called *Neon Naek* or the big day. Today is an opportunity to communicate more intensely between people because today is full of nuances of friendship brother.
- The eighth day is called *Neon Li'ana* or children's day. On this day, all the children of the Boti tribe are given freedom to express themselves and their happiness through play and creativity.
- The ninth day is called *Neon Tokos* or rest day. On this day, people take a break from all activities such as raising livestock, gardening, and others so that they can do self-reflection.

Time becomes the measures of basic participation for every action of the Boti tribe people. They see the cosmos as part of themselves "humans together with nature". Mountains, stones, and trees are analogous to bones, water as blood, soil as flesh that everyone must protect. This view illustrates that humans are given the responsibility to take care of the earth (Konay et al. 2021). The Boti tribe community is taught to always be grateful and fulfill all their life needs by utilizing what is around them. *Uis Pah* has provided all the necessities of human life through *Uis Neno*. Therefore, preserving nature is a necessity.

Prohibition of water, forests, and animals is a very important part of life. As a form of their appreciation for mountains, stones, trees, water, and soil, the Boti tribe makes a living agreement. Such as the cycle of natural resource utilization, planting rules, prohibitions on collecting/harvesting forest products, and garden products. If they violate, they will get sanctions. Direct sanctions from the natural authorities (*Uis Neno* and *Uis Pah*) in the form of disease, crop failure, and other disasters, while sanctions from the King (*Usif*) are more educational, for example, if someone damages plants or cut down trees, he must re-plant as many as 5–10 replacement trees (Nope 2019).

If the violations are committed and the perpetrators are dishonest and do not admit their actions, the people of the Boti Dalam tribe will experience a long drought even though the rain has arrived, they regard this as a form of *Uis Neno* and *Uis Pah's* anger toward them. The drought will disappear when the perpetrator wants to admit all his mistakes in front of *Usif (King of Boti*), then Usif will perform a ritual as a form of apologizing to *Uis Neno*. The people of the Boti Dalam tribe are taught to always be honest in all their behavior as a form of their devotion and respect for *Uis Neno* (Pehiadang 2019).

The Boti tribe lives in the shadow of blessings and curses. If they spend their days on good behavior, they will get a blessing. But if they have bad behavior, they will get a curse. This perception of a life filled with sacredness and everything is transcendental, making the Boti tribe very careful to guard their lives, because they believe, if they violate it, it will result in very bad catastrophe (karma) in their lives. Therefore, they try to live honestly and do not dare to steal and commit crimes. The Boti tribe lives are filled with mystical perceptions that make life only able to survive where they live. Moreover, their beliefs and the King did not allow Halaika adherents to attend school. The children in one family are divided into two, half of their children are allowed to go to school to study knowledge while the others are not allowed to hold fast to their traditions. This prohibition is carried out so that they can still uphold the purity of *Halaika*'s teachings, so that they are still able to read insights from nature, *Uis Pah* and *Uis Neno* which they worship. Thus, the Boti tribe rejects all forms of modernity, such as electricity, television, radio, and others with the nuances of technological engineering. They also forbid them to mine their homes, which are rich in manganese and stones that can be used as jewelry, because they are believed to damage the natural composition which will have a direct impact on the life they will receive (Suminar 2018). The attitude carried out by the Boti tribe is nothing but a form of self-defense effort to maintain the values of ancestral cultural traditions so that they are not lost to the times. This of course must be appreciated and respected by other communities in order to create a harmonious social life.

The Boti people know an earthquake as "Nain Nun" which means ground shakes. They believe that the earth has an owner. In addition, they believe that the earth is being carried and upheld by a giant human, namely “Moa Hitu.” The earth is carried on one shoulder and alternately with the other. “Nain Nun” or earthquake because of “Moa Hitu” shakes the earth to finding out the existence of the inhabitants of the earth. When the earthquake occurred, the Boti men shouted in response so that “Moa Hitu” heard them that there were still humans inhabiting the earth so that “Moa Hitu” would not destroy the earth. Although this is a myth, this is a profit alarm because they already know that if there is a shout, it is a sign of an earthquake coming. Without thinking, they rushed to save themselves from inside the house.

b. Early warning system

Local wisdom the Boti people are also known to have astronomical abilities in reading star and moon clusters. The Boti tribe believes that Uis Neno is the sun and Uis Pah is the moon. Both of them alternately ruled day and night. If both are sleeping, the earth will be dark, but if the sun is sleeping, darkness will be illuminated by the light of the moon. Stars are children of the sun and the moon and are messengers of *Uis Neno* and *Uis Pah* (Tey 2006).

The moon and stars as the Boti tribe life guides. The position of moon and star clusters is associated with cultural events including the cycle of farming and life such as the amount of corn to be planted, the intensity of rain, the birth process, the implementation of traditional rituals, and the cycle of time (9 days division) (Iswanto 2021). For example, if it rains a lot, the community must prepare sufficient supplies of corn in the traditional house called ume kbubu and anticipate landslides. Likewise, when there is little rainfall, it can cause a drought.

The Boti community recognizes two-star clusters, namely theta and ma’ la’fu. The dry season and the growing season are determined by the position of the two-star clusters. If both are in the east, it is a sign that it is the rainy season. On the other hand, if it is in the west, it is a sign that it is dry season. The sayings that become the philosophy of life for the Boti people related to these two-star clusters are quintuplets *hitu apinat aklahat*, *quints hitu mathitu amelat aekat* (seven layers of eyes, seven shining brightly, seven layers of eyes, seven wiping tears of sorrow) (Iswanto 2021).

c. Anticipatory measures—mitigation and preparedness

There are two local wisdoms of the Boti community related to disaster mitigation and preparedness, namely land use in dealing with landslides and preparedness in food preservation. In relation to landslide prevention, the Boti community carries out agricultural activities in the garden in a relatively flat area, and if the land is slightly sloping, they will make terraces which aim to reduce erosion and prevent landslides. The retaining terrace is made of pieces of wood to prevent landslides and to keep topsoil from being carried away by rainwater. Meanwhile, in areas with a steep slope, the vegetation above them, generally large trees, will be allowed to grow and develop.

Mitigation from landslides is also carried out through regulations. The Boti tribe is always guided by their *Usif* to always do good to the environment by protecting, caring for and preserving the forests. They have rules such as not destroying protected forests (*hutan larangan*) (Fig. 19.3), keeping some types of plants growing according

Fig. 19.3 Protected or sacred forest of the Boti tribe. *Source* Field observation (2021)

to natural cycles without too much human intervention, planting more trees than the number of trees that have been cut down and protecting water sources. These regulations are not only for mitigating landslides but also for water crises. Water sources in Boti village are limited. To meet their need for clean water in every dry season, they have to walk about 2 (two) kilometers to the water source. In addition, some take water from river that still flows a little, which is called the White River.

Regarding food preservation, the Boti indigenous people use local wisdom to be able to manage food sources for a year or one planting period. Management of food sources starts from determining how much corn will be planted, harvest time, storage, and food processing. The Boti people store corn in *ume kbubu*. Corn stored in *ume kbubu* can last up to one year. Corn preservation technique in ume kbubu uses smoke drying technique. In addition, the corn is tied in certain knots, usually 4 or 8 ears of corn per bundle.

Ume kbubu's local wisdom related to food security can be seen from its function as a corn storage place for the family. Based on the *ume kbubu* building, the second floor is used as a place to store food. This structure is also interpreted as a symbol of the importance of the corn pen to the life of the Boti community. Adherence the of storage to the rules of storage, preservation and consumption of corn in *ume kbubu* makes corn enough to be used throughout the year and can even be used as a preparation for possible food crises caused by certain disasters, such as drought.

Local wisdom in the form of knowledge in the field of food preservation cannot be separated from the existence of *ume kbubu*. There, smoking techniques to preserve corn, were studied and preserved. As explained in the previous section, one of the functions of the *ume kbubu* ground floor is as a kitchen for cooking. The firewood used during the cooking process will turn into charcoal. The prevailing custom among the Boti community requires that the smoke from the charcoal must not die. The charcoal that must continue to burn shows the cultural meaning of *ume kbubu* as a symbol of life. But on the other hand, functionally aims to preserve food that is on the roof.

How to store and consume corn in ume kbubu is specifically regulated. Every four ears of corn tied up and used to feed a family. The cooking process is pounded into Bose corn. This preservation and utilization system becomes a local community food security system. Obedience to the rules for storing, preserving, and consuming corn at *ume kbubu* makes food sufficient for year-round needs even as preparation for a possible food crisis (Iswanto 2021).

To prevent any member of their community from food shortages, they have social capital. Apart from having their garden, the Boti community also has a communal garden that is managed together. The harvest is given to those who are in need. The Boti tribe is among the indigenous peoples who have high resilience during COVID-19 pandemic (Kementerian Pendidikan, Riset dan Teknologi, 2022). Apart from the minimal number of cases of COVID-19 transmission, Boti was also not affected socially or economically. During the COVID-19 pandemic, the Boti tribe chose to be independent by producing their medicines for the prevention of COVID-19. The regional quarantine is carried out by closing the Boti Village from visitors and implementing health protocols such as wearing masks. Their closeness to nature allows them to be independent and able to carry out regional quarantine without worrying about food shortages. An important note from the success of the quarantine of indigenous territories in Boti tribe is that they have strong leadership, social capital, and food security and can support their needs during the pandemic.

d. Structural measures

Regarding technical mitigation/structural measures, local wisdom in the Boti tribe can be seen from the structure of traditional buildings/houses and settlement patterns. The structure of the traditional house—*ume kbubu* (Fig. 19.4)—is a form of adaptation of the community to the unique natural environment. The structure of this building adapts to geological conditions, namely hills and steep slopes. The construction of the *ume kbubu* building is made in such a way that it is stable in conditions prone to landslides. The houses were built with a system of wooden foundations and stone mats. The light roof system (made of wood and thatch) and the small volume of the house make the house building resistant to natural disasters, such as earthquake shocks. The *ume kbubu* building structure with its distinctive construction will be stable if it is built on a sloping topography.

The footing of *ume kbubu* is made of strong stone with a height of 20–40 cm. The height of footing can prevent water and rodents from entering *Ume Kbubu*. The footing structure is round with compacted floors. The post that connects between floors and connections, consists of four large log wood which is plugged into symmetrically on four sides. The wood has high strength and is resistant to the weather, namely *merah* trees (*Pterocarpus indicus*) or *putih* trees (*Melaleuca leucadendra*). The wall consists of bamboo blades or pinang (*Areca catechu)* tree trunks or gewang (*Corypha utan*) tree trunks so that they are strong from the wind and weather changes. Connection with peg techniques that are resistant to earthquakes because the peg can reduce friction between connections better when compared to square houses with

Fig. 19.4 *Ume Kbubu*—traditional house of the Boti people (left) & cross-section of the traditional house (right). *Source* Junianto Saputri (2022); Iswanto (2021)

permanent connections. The connection technique with pegs (without nails) keeps the house structure from breaking when an earthquake occurs because this connection technique allows the supporting beams to rotate like hinges and flexible building structures can absorb vertical shocks and horizontal earthquake forces. Roof made of reeds made from *gewang* trees that they planted themselves. The end of the wall is given a stumped stone to avoid termites. The cone-shaped roof adjusts the shape of the floor plan and roof frame. All construction details are resolved with the principles of bonds, the pedestal, related pedestals, pegs, and connections.

Regarding the pattern of settlement, the settlement structure of the Boti community is in the form of groups based on kinship ties and groups in small groups. One small group consists of only five to seven houses and one *ume kbubu*. The settlement complex has a very large yard and is surrounded by a guardrail for each small group.

Every new family addition in the Boti community will be accompanied by the construction of new houses. But in reality, the growth in the number of new families occurs very slowly. This of course resulted in the number of members of the Boti tribe also decreasing.

This type of settlement structure supports the maintenance of the cultural system and ecological cycle. Good residential spatial planning also provides support for the construction of a higher quality human life system, both regarding the ecological space for the availability of food, public health conditions, the implementation of cultural activities, as well as the preservation of flora and fauna that are important for human survival.

There are also social interactions that limit the social interaction between these two different groups. With limited social interaction and limited access to Boti village due to natural conditions, it indirectly builds resilience mechanisms against disasters. Public health conditions, for example, can be well controlled, including during an infectious disease disaster. Therefore, it can be said that the location of houses that are not close together, monitoring in a tight social system, lack of interaction with people from outside the tribe, as well as a simple lifestyle, logically can prevent the

Boti community from epidemic of a disease. Therefore, it is not surprising that at the COVID-19 pandemic, no Boti people were affected by the COVID-19 virus.

e. Livelihood-based Adaptation

The Boti tribe believes to work hard to cultivate land that does not always provide abundant harvests. However, the land has been blessed with *Uis Neno* must be maintained by farming to cultivate the land (Petrus 2019).

Livelihood-based adaptation can be seen from the livelihood diversification of the Boti community. The Boti community, like most other regions in Indonesia, also applies the slash-and-burn method in terms of opening new land for agricultural activities. When the planting season has arrived, they will cut and then burn the new land. However, before carrying out new land clearing, the Boti people always carry out traditional rituals first, this ritual aims to ask permission from *Uis Neno* so that they will be given smoothness when planting and harvesting later.

According to Petrus (2019), the tradition of farming consists of preparation and processing stages. The preparation stage includes choosing land to be used as a garden, asking permission from *Uis Neno* and *Uis Pah* to get soil fertility, and honing a machete to prepare tools to be used for farming.

The processing stage consists of an opening/cleaning of the land, burning shrubs, planting, stepping water flow, first harvesting, and thanksgiving for Uis Neno and Uis Pah. The opening/cleaning of the land is a sign to start farming by cutting down trees to be used as a garden, usually in July. The burning of the land for land clearing is carried out after wood and tree branches that are cut have been dry. The burning is done in the afternoon to avoid wind and keep the fire from spreading into the surrounding forest. The planting is done when the rainy season arrives. The stepping the flow of water at beginning of the rainy season to keep disasters, especially floods and erosion in the peak of the rainy season so that plants can continue to grow well. Related to reducing soil erosion, in case of land with steep slope, the Boti people apply a mountain belt systems, which is planting that follows the contour line by making a terrace.

Every stage of farming is always passed with rituals. Implementation of ritual cycles and strict sequence of activities as an effort to maintain balance and continuity of life and avoid disasters. If a disaster occurs, they will be rituals to ask their ancestors and correct the sequence of activities that have been carried out.

Like other areas on the island of Timor, Boti's natural condition is relatively dry, with limestone soil that lacks nutrients. But, Boti is a fertile area when compared to other areas on the island of Timor (Hutubessy et al. 2021). Also, the Boti indigenous people can get around the limitations of natural resources, one of which is by planting various types of plants that can grow well on dry land. They grow rice, corn, sorghum, barley, bananas, and various tubers using a permaculture system (Fig. 19.5). These food crops are grown between woody plants in the customary forest and the yard of the house.

This condition is supported by the behavior of the Boti people who respect the natural surroundings. For the Boti tribe respecting the earth is the same as respecting their own mother. The Boti people even assign *kae* or Pemali (prohibition) to several

Fig. 19.5 Livelihood systems of the Boti people—agriculture, livestock, and weaving. *Sources* Benu et al. (2013)

types of plants so that the existing plants are still sustainable. Plants belonging to the *kae* (pemali) group can only be reused after the Poit Pah ceremony is carried out. If someone is found cutting down or using *kae* (pemali) plants before the *poit pah* ceremony is carried out, the sanction is to pay a fine in the form of animals to be slaughtered. The Boti tribe, in addition to stipulate a prohibition on cutting down or using prohibited plants, and also a prohibition on hunting birds. For the Boti tribe, birds are considered sacred animals because they help them to spread plant seeds in the forest.

Apart from farming, the Boti community also has another source of livelihood, namely raising livestock. The animals they raise include chickens, pigs, cows, and goats (Fig. 19.5). With the livelihood system in Boti, Boti also has a different calendar system compared to the conventional calendar system. In addition to farming and livestock, the Boti indigenous people, especially the women of Boti, also carry out weaving activities (Fig. 19.5) that produce traditional fabrics with natural motifs, such as lizards, birds, and plants.

19.6 Challenges/Limitations of the Study

Some of the challenges and threats faced in applying local knowledge for disaster risk reduction.

- The confiscation or forcible transfer of customary lands and sacred sites has eroded the relationship between indigenous peoples and their environment.

When forced to migrate and resettle in new environments, indigenous peoples find that their knowledge and practices must be adapted to new and often difficult circumstances.

- Indigenous knowledge is also sometimes lost as a result of language extinction.
- Poverty is another threat to indigenous knowledge.

It often happens that when people are poor, conservation is not the top priority, and they will take from the environment whatever is necessary for their survival.

- Misuse of indigenous knowledge in the form of biopiracy—unauthorized use of genetic resource.

19.7 Recommendations

On a local level, the recommendation of this study is to combine local knowledge with modern (scientific) knowledge in terms of early warning systems, mitigation measures—preparedness, traditional house structure and construction, and livelihood-based adaptation.

On the broader scope, following UNISDR recommendation which has developed a ten-point checklist to help local government leaders take steps to reduce their disaster risk. The ten points are:

- Provide organization and coordination to understand and reduce disaster risk, based on the participation of citizen groups and civil society. Build local alliances. Ensure that all departments understand their role in disaster risk reduction and preparedness. Respect indigenous people's institutions and organizations when building alliances and promoting coordination.
- Set a budget for disaster risk reduction and provide incentives for homeowners, low-income families, communities, businesses, and the public sector to invest in reducing the risks they face. Design culturally appropriate incentives for indigenous peoples.
- Maintain up-to-date data on hazards and vulnerabilities. Prepare a risk assessment and use this as a basis for city development plans and decisions. Ensure that this information and your city's resilience plan are publicly available and fully discussed with them. Separate data by gender and ethnicity. Ensure that plans are prepared in multiple languages and disseminated using traditional means

of communication; incorporate non-traditional and cultural issues in the risk assessment.
- Invest in and maintain critical risk-reducing infrastructure, such as flood drainage, that is adjusted where necessary to address climate change. Collaborate with related indigenous communities.
- Assess the safety of all schools and health facilities and improve if necessary. Collaborate with related indigenous communities.
- Implement and enforce building codes that are realistic and commensurate with risks and land use planning principles. Identify safe land for low-income residents and increase informal settlements, if possible. Consider indigenous peoples land use practices.
- Ensure that education and training programs on disaster risk reduction are in place in schools and local communities. Take into account the language of the account; involving indigenous leadership; making full use of local indigenous institutions,
- Protect ecosystems and natural buffers to reduce flooding, storm surges, and other hazards that may leave your city vulnerable. Adapt to climate change by establishing good risk reduction practices. Climate adaptation plans and actions should collaborate appropriately with indigenous knowledge.
- Install an early warning system and emergency management capacity in your city and conduct regular public preparedness exercises. Warning systems should integrate traditional practices.
- After any disaster, ensure that the needs of the affected population are placed at the center of reconstruction, with support for them and their community organizations to design and help implement the response, including rebuilding houses and livelihoods. Consider indigenous spiritual healing systems, medicinal practices.

19.8 Conclusions

This study found that the Boti indigenous people have traditional knowledge that can be used for disaster risk reduction, ranging from astronomical abilities in forecasting weather or disasters that can be used for early warning systems; land use terrace system on steep topography which is useful for preventing landslides; smoking corn in food preservation used to prevent starvation due to crop failure/drought; traditional house structures with natural materials that provide two benefits as well as thermal comfort and protection against landslides or earthquakes; a spreading pattern of settlements that provides flexibility for human activities, plant growth and animal habitats as well as being useful as an insulator in infectious diseases/plagues; as well as diversification of livelihoods (farming, livestock, and weaving) as a form of livelihood-based adaptation to anticipate crop failures, and last but not least the Halaika belief system with the Gods of Heaven and Earth, which serve as guidelines for the life of the Boti tribe and are oriented toward nature and environmental sustainability.

Acknowledgements We express our gratitude to, the local government of South Central Timor Regency and indigenous people of Boti tribe for research permit and assistance in data collection.

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Chapter 20
Disaster Risk Reduction: Assessment of Gaps in Policy Framework and Future Scopes in Implementation of Indigenous Practices in India

Shreya Chaurasia and Navneet Munoth

Abstract Despite taking various disaster mitigation measures and reduction processes, India has lost around 80,000 lives in the last two decades due to several deadly and devastating catastrophes like cyclones, earthquakes, floods, etc. according to UN Office for Disaster Risk Reduction (UNDRR) Report. The chapter analyses various gaps in implementation of policy frameworks in accordance with Sendai Framework (2015–2030) which is a successive instrument or extension of Hyogo Framework for Action HFA undertaken in 2005. The study does a comparative and gap analysis on specific indicators adopted by Indian states in disaster-prone areas and those advised by United Nations for respective risk assessment, preparedness and recovery. It suggests policy recommendations based on successful indigenous field practices and role of multiple stakeholders for futuristic scopes in framing a resilient structure.

Keywords Disaster · Risk reduction · Policy framework · Indigenous practices

20.1 Introduction

Modern technology and innovations have certainly given rise to the development of various sectors in the economy of India. In such an age of technical knowledge, where there should have been very few casualties due to natural disasters, people have faced failures as far as management of disasters and its risk reduction is concerned. India is on number three in globally most affected countries in last two decades (2000–2019) having 321 events of catastrophes, after China and USA having 577 and 467 disaster events, respectively, according to UNDRR's Human Cost of Disasters Report 2019 (UNDRR 2019). It is the second most affected country due to floods in the world, experiencing 17 flood events per year on an average. It is not that we are not advancing in science, but with so much high-tech machines and information

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_20

systems, it is expected to reduce human issues and not enhance them. No doubt that with huge population, India and China together experience world's 70% disasters, but even after having no lack in machinery, telecommunications, artificial intelligence, allocation of funds, globalization, etc. policy makers need to rethink and rebuild the path for effective risk reduction through indigenous practices.

A beautiful evidence of ancient practice is the use of 18 m thick wall by the people of Dholavira, a Harappan city (now in Gujarat). These were not for enemy protection but for tsunamis, as even the Great Wall of China was 4–9 m thick at the bottom. They also used Mansar and Manhar seasonal streams or nallahs in the north and south, respectively, for water-harvesting solutions simultaneously (Nidam et al. 2016). In the book 'Dying Wisdom', the authors have written about India's ancient knowledge system of living with nature as a part of it and every area had separate techniques for handling disasters, for example, 'Ahar Pyne' was a traditional technique used by the South Bihar people in which river channel system is used for flood control and for harvesting rainwater at the same time; bamboo drip irrigation system was used by the Meghalaya people; Kerala people used Ghats for diverting and collecting the rain water, and Tamil Nadu people used cascade tanks which are earthen embankments and many more (Agarwal and Narain 2008). Most of these are in dilapidated conditions because of negligence of stakeholders. After the advent of Britishers, the management of resources were transferred from common man to bureaucracies, which can be seen to even this date that PWDs (Public Works Department) and Central Ministry handle these resources, and because of this, engagement of local people and local practices became lesser and lesser with time. Disasters were not so frequent and intense in the past as they seem to be now. There is a need to look back to adopt those indigenous techniques to combat against such natural hazards and environmental pressures.

There is no harm in understanding and evaluating the methods suggested by famous ancient teachers, philosophers and royal advisors like Kautilya or Chanakya. A collaborative approach of ancient as well as modern techniques with mitigation, preparedness, rehabilitation and resilience must be incorporated in the nation's policy in dealing with Daivyam Vyasna (Natural Disaster) and Manusam Vyasna (Man-made Disasters) (Goswami et al. 2016). Kautilya believed that preventing a disaster is a better tool than curing it. He suggested various methods in Arthashastra to prevent these, for example, for fires he suggested for keeping inflammable material with caution in every house of the city. The city dwellers must follow the rules, and on violating them, City Superintendents appointed by the King would charge fines depending on the level of disobedience. For famines, there must be secret grain dams for management in crises. For floods, he suggested that those who live near rivers must vacate the place during rains and migrate to higher altitudes, and every house must have wooden planks, boats and bamboos for emergencies along with a constant check on the level of waters. He emphasized over preservation of environment, forests, reservoirs, biodiversity, ecology, etc. as an essential part of human life. Incorporating such indigenous practices with modern disaster management system would enhance its effectiveness (Sharma 2017). Hence, incorporation of ancient science in modern disaster management measures may prove to be of more fruitful results in dealing with havoc and chaos caused due to such calamities.

The descriptions in mythological scriptures like Srimad Bhagwat Geeta assert that the purity and impurity in the internal environment (mind, intellect and ego) has an effect on external environment (land, fire, sky, water, air, forests, etc.). It is written in its Chap. 14 that every activity done in or by material nature belongs to three modes of goodness, passion and ignorance. For example, the SARS virus which caused a biological disaster in the whole world originated in Wuhan, China, where people consumed bat soup and the genome in virus was seen closest to that found in the horseshoe bats, and also that corona virus is a recombinant of the same (Lau et al. 2020). Some other studies done on a group of people show that consumption of non-vegetarian food exhibits certain psychological characteristics such as supporting domination, inequality, etc. and also it is at higher risk of carrying dangerous pathogens than plant fibre (Loughnan 2014; Fessler and Navarrete 2003; Rozin et al. 1997). Thus, an action-reaction impact of domination over environment, or causing unnecessary harm to nature, on humans can be seen evidently.

The main aim of the study is to make it notable that incorporation of ancient wisdom and prevalent indigenous practices along with technology may prove to be of a better alternative in saving lives of people and animals, effective reduction in death and destruction due to natural or environmental hazards. The major objectives of the study are as follows:-

- Understanding frequency of disasters by observing the number of events happening in the past and take an account of dominant and impactful ones till date
- Recognizing and analysing the required information of indigenous knowledge from different parts of India as well as other nations which can be implemented over areas which lack resources
- Understanding global and national tasks for disaster risk reduction
- Bringing back the attention of policy makers and stakeholders to important indicators in the nation's policy framework which needs more focus
- Tabulating risk measures which may help in bridging the gap between a researcher's suggestion and ground implementation for effective results in achieving the set national targets for disaster risk reduction

The chapter focuses on the research gap of risk measures, which can be taken with an integration of indigenous, practical, scientific and technical knowledge which addresses the death toll in disaster-prone areas, and policy framework, as well as gives corresponding recommendations for how the intended national targets can be achieved. Without area-based local traditional knowledge, sole use of technology may not prove to be worthwhile in reducing disaster risks and controlling the damages.

20.1.1 Basic Concept and Meaning of Terminologies

One needs to understand about actual meaning of the related terms that are going to be discussed in the chapter. Disaster is defined in simple terms as a serious destruction and unusual sudden distortion in the normal functioning of a society which results in loss of life and property, economic losses, disruption in environment, etc. Risk reduction can be defined as reducing the risks caused due to disasters with the help of systematic execution of attempts to evaluate and lessen the factors causing a disaster. Mitigation refers to reduce the impact of hazards via proactive measures before their occurrence. Preparedness is the set of measures taken to ensure the safety of life and property before and after the disaster has happened.

Response refers to the number of events and activities done to estimate the current need of affected ones, lessen and limit the suffering and damage caused. Recovery is to regain the original state of being as it was before the hazard. Rehabilitation is the immediate action taken after the disaster for relief from physical damage and social damage, giving psychological support to the victims and restarting the normal functioning of all the systems. Reconstruction is rebuilding of important structural and non-structural infrastructures and services which is a long-term process to meet affected people's needs. Indigenous knowledge is referred to as local or traditional knowledge concepts belonging to a particular community or given in a unique sociocultural settings mostly descended by ancestors through oral recitations and practical performance which may include a ritual, a ceremonial event, a scientific practice based on experience, etc. It is repeated through ages, and the knowledge is reinforced and reproduced with every new event. Different communities may have different traditional knowledge systems regarding disasters and is most probably not documented anywhere.

20.1.2 Classification of Disasters

Indian High Power Committee which was constituted in 1999 listed 5 groups of disasters such as natural disasters which are climate and water related; geological disasters; man-made disasters which are chemical or industrial disasters; accidental disasters; and biological disasters; these have been further classified into 32 sub-types with some additions or amendments and are listed in the following Table 20.1 (Report 2011). Although with same types, UNDRR has 6 classifications with 17 sub-types as shown in Table 20.2 (UNDRR 2019).

Some more types can be seen in NDMP (National Disaster Management Plan) 2019 such as urban fires caused by earthquakes, liquefaction, lava flow, pyroclastic flow, ash fall and tsunamis due to which underwater earthquakes have been categorized under geophysical type. Others such as coastal erosion, coastal floods, debris flow, flash floods and wind-generated wave action are kept under hydrological type of disasters: Glacial Lake Outburst Flood (GLOF), drought, extreme hot and cold

Table 20.1 Types of disasters as per Indian High Power Committee 1999

Types	Sub-type
1. Climate and water	i. Floods ii. Tornadoes and hurricanes iii. Cyclones iv. Cloud Burst v. Hailstorm vi. Avalanches vii. Heat wave and cold waves viii. Sea erosion ix. Droughts x. Thunderstorm xi. Tsunamis
2. Geological	i. Landslides and mudflows ii. Dam failures and dam bursts iii. Earthquakes iv. Minor fires
3. Industrial	i. Chemical ii. Nuclear
4. Accidental	i. Urban fires ii. Forest fires iii. Oil spills iv. Mine flooding v. Bomb blasts vi. Building collapse vii. Festival related, e.g., firecrackers viii. Electrical fires ix. Road, rail and air accidents x. Boat capsizing xi. Village fire
5. Biological	i. Epidemic ii. Pest attacks iii. Cattle epidemics iv. Food poisoning

Source Disaster Management in India Report (2011)

conditions and wildfires under climatological type. The most widely accepted and broad classification of natural disasters can be studied from UNDRR as follows.

20.2 Percentage Distribution of Natural Disasters in India

The following two pie-charts in Figs. 20.1 and 20.2 show that dominant disasters causing maximum deaths in India are hydro-meteorological (which are floods, storms and cyclones) and earthquakes. Hence, more focus of policy makers must be on those policies and measures which include risk reduction for these disasters.

Table 20.2 Types of disasters as per UNDRR

Types	Sub-types
1.Geophysical	i. Earthquake ii. Mass movement (dry) iii. Volcanic activity
2. Hydrological	i. Flood ii. Landslide iii. Wave action
3. Meteorological	i. Storm ii. Extreme temperature iii. Fog
4. Climatological	i. Drought ii. Glacial lake outburst iii. Wildfire
5. Biological	i. Epidemic ii. Animal accidents iii. Insect infestations
6. Extra-terrestrial	i. Impact ii. Space weather

Source UNDRR (2019)

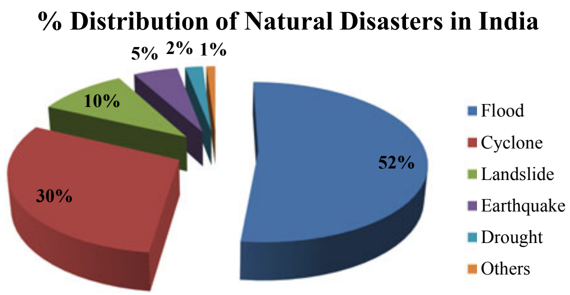

Fig. 20.1 Percentage distribution of natural disaster events. *Source* Rao and Mohan (2020)

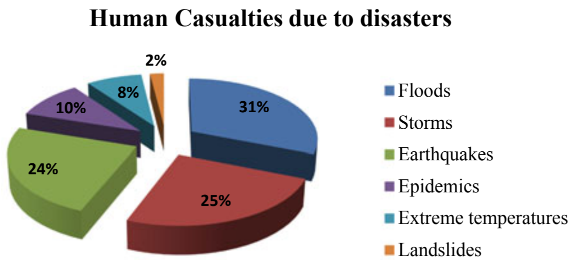

Fig. 20.2 Percentage distribution of human casualties in last 50 years. *Source* Mishra et al. (2016)

20.3 Decadal Death Toll Due to Natural Disasters in India

Not much achievement can be seen in reducing the mortality due to natural disasters where it is same as it was 20 years ago. Average decadal death toll of three decades from 1991 to 2020 due to forces of nature remains above 1.5 lakhs (1,72,434 to be precise). Decadal deaths can be seen in the following Table 20.3 and graph in Fig. 20.3. These figures in last decade exclude deaths caused due to corona virus pandemic.

Table 20.3 Year-wise deaths due to forces of nature in three decades from 1991 to 2020

Year	Deaths	Year	Deaths	Year	Deaths
1991	4447	2001	36,651	2011	23,690
1992	4183	2002	16,723	2012	22,960
1993	11,125	2003	14,954	2013	22,759
1994	4439	2004	18,937	2014	20,201
1995	21,600	2005	22,415	2015	10,510
1996	18,930	2006	21,502	2016	8684
1997	18,908	2007	25,153	2017	7143
1998	22,762	2008	23,993	2018	6891
1999	27,506	2009	22,255	2019	8145
2000	17,366	2010	25,066	2020	7405
Total	151,266		227,649		138,388

Source (Authors; National Crime Records Bureau (NCRB) Accidental Deaths Reports of respective years)

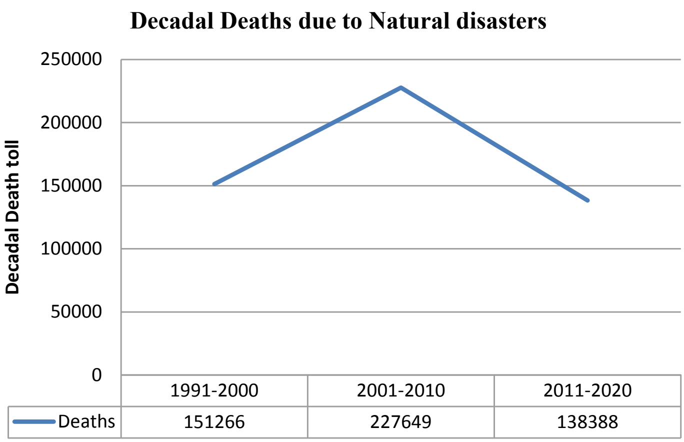

Fig. 20.3 Decadal deaths due to natural forces in India from 1991 to 2020. *Source* (Authors; National Crime Records Bureau (NCRB) Accidental death Reports)

20.4 Disaster Prone Areas in India

Around 12% of land which is more than 4 lakh km^2 of India is prone to floods and also erosion in rivers. Around 59% of total India's landform is prone to earthquakes from moderate to a very high intensity. Around 5700 km of coastline out of total 7500 km is prone to cyclones and tsunamis. About 68% of productive farmlands are prone to drought. Majority of world's 10% of cyclones are hitting over East Coast of India more than the Western coast. About 10% of the world's tropical cyclones affect the Indian coast. Of these, the majority of the cyclones hit over the Bay of Bengal coast. Approximately five to six tropical cyclones are likely to form every year, of which two or three could be severe. Around 308 cyclone events have occurred from 1891 to 2000, and out of theses 103 were severe (NDMP 2019).

Around 7.5 million hectare of land is affected yearly by floods out of 40 million hectare of the flood-prone area. Urban flooding has recently caused a lot of damage to functioning of cities like in Bangalore floods 2022, where the whole IT sector collapsed, lifts in living apartments and buildings crumbled, functioning of treatment plants and drainage system broke down. To overcome these issues, Urban Floods Disaster Management (UFDM) has different set of guidelines set up by NDMA (National Disaster Management Authority) in 2010, and after the event, various commercial and industrial encroachments over Storm Water Drains are being removed by the civic authorities. The three major earthquakes that affected India include Gujarat in January 2001, Jammu and Kashmir in October 2005 and Sikkim in 2011. Many smaller quakes have been occurring in various parts of India. Seven states in North East (Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura and Meghalaya), the Andaman and Nicobar Islands and part of eight other States/UTs (Bihar, Gujarat, Himachal Pradesh, Uttarakhand, Jammu & Kashmir, Ladakh, Punjab and West Bengal) are in Seismic Zone V i.e., prone to very high damage risk. Landslides occur in the hilly regions of India such as the Himalaya, North-East India, the Nilgiris, Eastern Ghats and Western Ghats. It is estimated that 30% of the world's landslides occur in the Himalayan ranges. The mean rate of land loss is to the tune of 120 m per km per year and annual soil loss is about 2500 tonnes per km^2. variability. In recent years, concern has grown worldwide that droughts may be increasing in frequency due to climate change. It affects parts of Rajasthan (chronically), Gujarat, Maharashtra, Madhya Pradesh (MP), Uttar Pradesh (UP), Chhattisgarh, Jharkhand and Andhra Pradesh causing severe distress in the affected areas (NDMP 2019). Various other events such as thunderstorms, lightening, hailstorms, cloudbursts, avalanches, etc. are affecting large population and normal functioning of a place. Following are some maps which delineate disaster-prone areas (Figs. 20.4, 20.5, 20.6).

Fig. 20.4 Flood hazard map of India. *Source* (BMTPC—Building Materials and Technology Promotion Council)

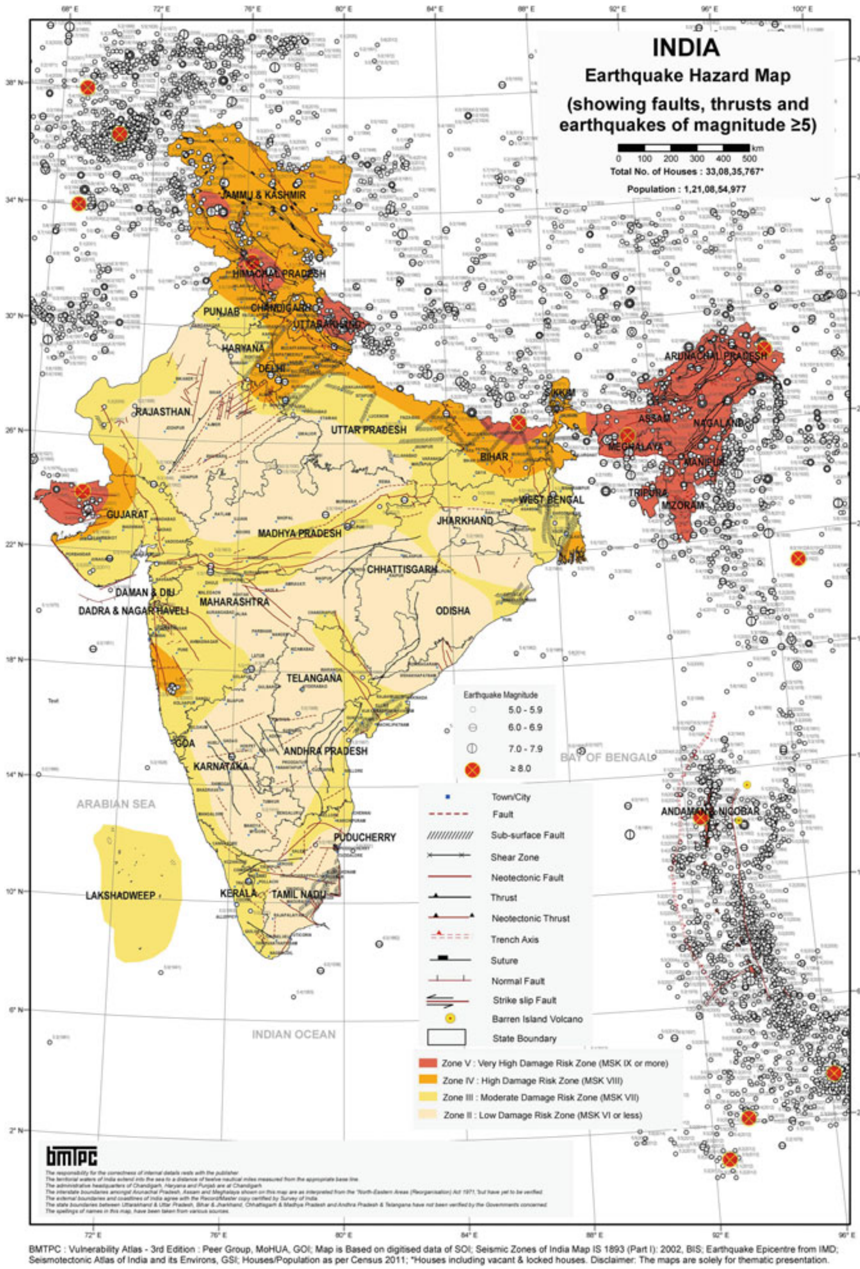

Fig. 20.5 Earthquake hazard map of India. *Source* (BMTPC—Building Materials and Technology Promotion Council)

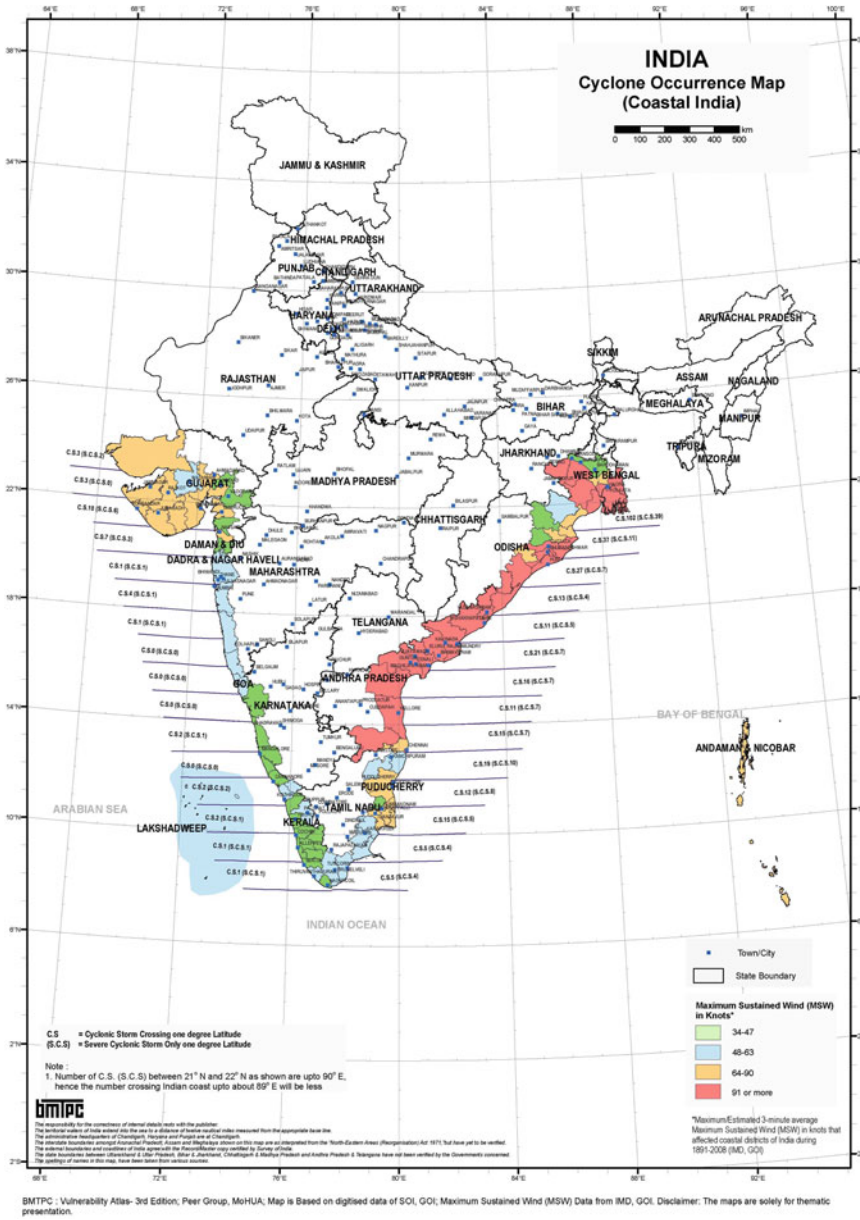

Fig. 20.6 Cyclone occurrence map of India. *Source* (BMTPC—Building Materials and Technology Promotion Council)

20.5 Major Disasters in India

India is affected by hydro-geological/meteorological disasters more. Following Table 20.4 shows the deadliest natural disasters in the past 20 years (from 1999 up to 2022 in order to figure out latest losses) which took place in India, leading to heavy destruction of life, property, land, resources, etc. (Chakraborty and Joshi 2016). Apart from this, very well-known COVID-19 pandemic due to SARS virus has already taken lives of around 5.27 lakh people and is still continuing (Figs. 20.7 and 20.8).

20.6 Policy Framework and Gap Analysis

Different frameworks of policies and strategies have been put up on international and national levels to reduce the disaster risks. These include the Special High Level Council of IDNDR (International Decade for Natural Disaster Reduction) in 1990s, Earth Summit in 1992, Cartagena Declaration and Yokohama mid-term review in 1994, Millennium Declaration and Inter-agency Framework under UN system for ISDR (International strategy for Disaster Reduction) in 2000, World Summit in Johannesburg in 2002, Bonn Conference for Early Warning systems in 2003, Mauritius Strategy for Small Island States in 2005, Hyogo Framework from 2005 to 2015 and finally Sendai Framework from 2015–2030 (Sunil et al. 2018).

Certainly many measures have different action plans focusing on preparedness, mitigation plans, response and recovery, reconstruction and rehabilitation, and many indigenous practices have been adopted for such emergencies that will be discussed later in the chapter. Let us look at the latest adopted global targets to be achieved in the policy action plans of Sendai Framework. It aims at the following:

- Reduction in mortality, affected people, economic loss, damage to infrastructure and services
- Increment in number of countries adopting Sendai Framework DRR strategies at national and local levels, increase in international support for capacity building, etc., in developing nations, increase in access to multi-hazard risks information system and early warning systems or forecasting systems

The four major targets under the Sendai Framework are as follows:

1. Understanding the disaster risk
2. Strengthening disaster risk governance to manage disaster risk
3. Investing in disaster risk reduction for resilience
4. Enhancing disaster preparedness for effective response and to 'Build Back Better' in recovery, reconstruction and rehabilitation

India's National Policy Framework

The National Disaster Management Plan updated in 2019 basically consists of 5 targets as follows (NDMP 2019):

Table 20.4 Major natural disaster and affected areas in India with total death toll (1999–2022)

S. No.	Year	Disaster	State/UTs/areas	Death toll
1	1999	Cyclone	Orissa: Balasore, Bhadrak, Kendrapara, Jagatsinghpur, Puri and Ganjam	15,000
2	2001	Earthquake	Gujarat: Kutch-Bhuj, Ahmedabad, Jamnagar and Rajkot	20,000
3	2004	Tsunami	Andhra Pradesh, Tamil Nadu, Kerala, Andaman and Nicobar Islands Pondicherry: Karaikal, Kanyakumari, Nagapattinam, Cuddalore, Velankann, Ernakulam, Alappuzha, Kollam, Manginapudi, Prakasham, Singraikonda, Port Blair	10,749 (Indians) out of 2,30,000
4	2005	Flood	Bihar: Darbhanga, Madhubani, Sitamarhi, East Champaran, Samastipur, Muzaffarpur	527
5	2005	Flood	Maharashtra: Mumbai, Raigad, Chiplun and Khed, Guhagar	5000
6	2007	Flood	Bihar: Muzaffarpur, Saharsa, Sitamarhi, Supaul, East Champaran, Patna, Darbhanga, West Champaran, Bhagalpur, Madhubani, Katihar, Sheohar, Samastipur, Khagaria, Nalanda, Madhepura, Gopalganj, Begusarai, Araria	1287
7	2013	Flood	Uttarakhand: Rudraprayag, Chamoli, Uttarkashi, Pithoragarh, Kedarnath, Dehradun, Rishikesh	5700
8	2014	Flood	Jammu and Kashmir: Srinagar, Anantnag, Baram ulla, Pulwama, Ganderbal, Kulgam, Budgam, Rajouri, Poonch, Reasi	4500

(continued)

Table 20.4 (continued)

S. No.	Year	Disaster	State/UTs/areas	Death toll
9	2015	Heat-waves	Andhra Pradesh, Telangana, Punjab, Jharkhand, Odisha and Bihar: Delhi, Titlagarh, Ongole, Daltonganj,	2248
10	2019	Flood	14 States: Kozhikode, Malappuram, Ernakulam, Wayanad, Thrissur, Idukki, Kannur, Palakkad, Central and South Gujarat, Bagalkot, Kasargod, Raichur, Vijayapura, Uttara Kannada, Yadgiri, Shivamogga, South Kannada, Chikkamagalur, Kodagu, Kolhapur, Satara, Sangli, Palghar, Thane, Dhar, Pune, Nilgiris district in Tamil Nadu, Barwani, Rayagada, Kalahandi, East and West Godavari districts in Andhra Pradesh, etc	2422
11	2020	Flood	West Bengal, Gujarat, Assam, Karnataka, Maharashtra, Madhya Pradesh, Kerala	1989
12	2021	Flood	Andhra Pradesh, Tamil Nadu, Uttarakhand, Kerala	1593
13	2022	Flood	Assam, Madhya Pradesh, Gujarat, Rajasthan, Bihar, Uttarakhand, Maharashtra, Kerala, Tamil Nadu, Karnataka	1098

Source NDMA, EM-DAT, Authors

I. Conforming to the national legal mandates—the Disaster Management Act 2005 and the NPDM (National Policy on Disaster Management) 2009
II. Focusing on achieving global goals framed for disaster management under Sendai Framework, Sustainable Development Goals (SDGs) and Conference of Parties (COP21) Paris Agreement on Climate Change
III. Prime Minister's Ten Point Agenda for DRR denoting present day national and local priorities
IV. Focusing on Principle of Social Inclusion
V. Mainstreaming DRR as a fundamental and comprehensive feature

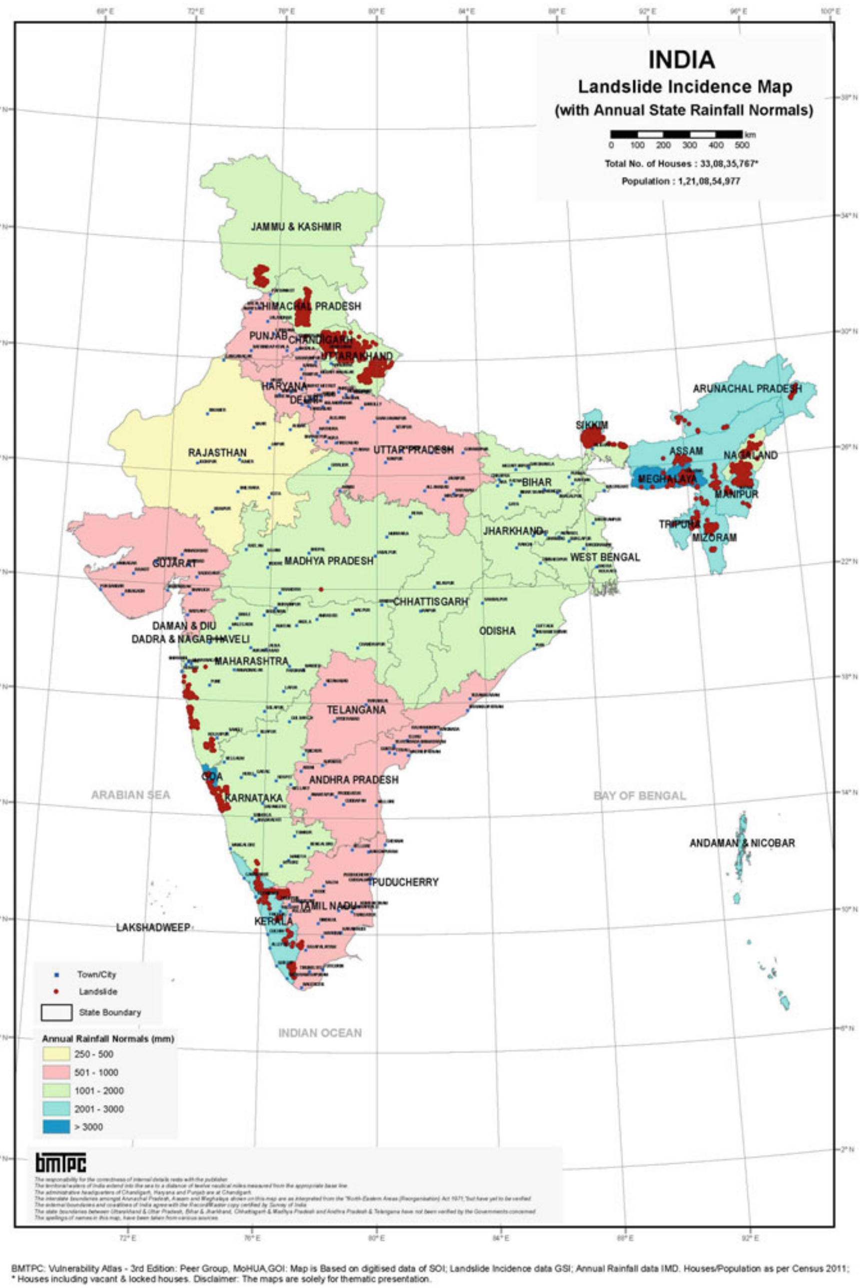

Fig. 20.7 Landslide incidence map of India. *Source* (BMTPC—Building Materials and Technology Promotion Council)

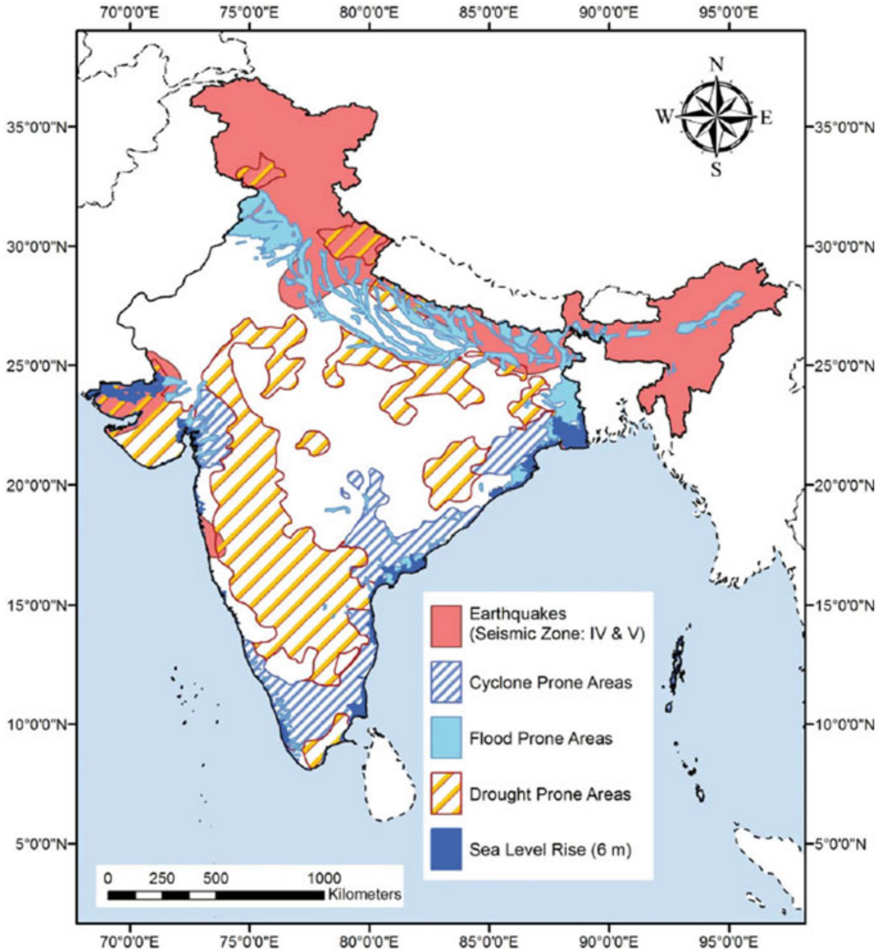

Fig. 20.8 Composite map of disaster prone areas in India. *Source* Chakraborty and Joshi (2016)

Prime Minister's Ten-Point Agenda for Disaster Risk Reduction

The Prime Minister, Shri Narendra Modi, put forward a Ten-Point Agenda in his inaugural speech at the Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR) 2016, which has also been included in the National Disaster Management Plan (NDMP). These ten points are as follows:

1. All development sectors must assimilate the disaster risk management principles
2. Risk coverage must include all, starting from poor households to SMEs (Small and Medium Enterprises) to multi-national corporations to nation states
3. Involvement of women's leadership in disaster risk management
4. Investing in risk mapping globally to improve global understanding of nature and disaster risks

5. Leverage technology to enhance the efficiency of disaster risk management efforts
6. Develop a network of universities to work on disaster-related issues
7. Utilize the opportunities provided by social media and mobile technologies for disaster risk reduction
8. Build on local capacity and initiative to enhance disaster risk reduction
9. Make use of every opportunity to learn from disasters and, to achieve that, there must be studies on the lessons after every disaster
10. Bring about greater cohesion in international response to disasters

Six areas are identified to be focused on for DRR in national policy for each hazard and the approach is in accordance with the Sendai Framework. These are listed as under:

1. Understanding Risk
2. Inter-Agency Coordination
3. Investing in DRR—Structural Measures
4. Investing in DRR—Non-Structural Measures
5. Capacity Development
6. Climate Change Risk Management

Gap Analysis

- Nowhere focus on research on indigenous field practices in National Disaster Management Plan (NDMP)
- No description or mention of flood risk percentage in district-wise vulnerability analysis by mapping agencies
- Absence of accountability of adequate budget for disaster-prone areas by respective state authorities

20.7 Indigenous Field Practices and Future Scopes

A research shows that various indigenous solutions practiced in the village Alappad of Kollam district Kerala by the community after they suffered severely from the 2004 Indian Ocean earthquake and tsunami have helped reducing disaster risks to a great extent. They have a seasonal calendar which forecasts disaster and helps to identify which months would bring those fishes and which ones would bring destruction. 'Karkidakam' according to the Malayalam calendar is a time period between mid-July to mid-August where the ancestors say is not good for fishing. Coastal residents also found some natural warning systems like unusual and loud chirping of birds in their nests, animals leaving their home and moving of sea to many kilometres in reverse direction few hours before tsunami. Also very interestingly according to the respondents of the Alappad panchayat, those areas which were having sea walls, mangrove plantation, casuarinas trees along the coasts, coral reef, etc. were

Table 20.5 Gap analysis in national policies and plans with respective suggestions

S. No.	Indicators of disaster risk reduction	Gaps identified in national policy	Suggestions for Indian policymakers
1	Mortality	No surety of vulnerable population in saving their lives	Focus on better and faster early warning systems using indigenous mechanisms
2	People affected	Lakhs of people are still affected despite having best technologies	Increase in restricted areas which are predicted to undergo frequent disaster events
3	Economic losses in GDP	Lack of financial back up plans in losses to various development sectors	Setting up of a government department for mandatory contribution of social responsibilities from each well-settled households yearly just like corporate social responsibilities (CSR) and keep a check on officials responsible by Central Government appointed teams
4	Loss of infrastructure and services	Absence of district-level hazard mapping	Inclusion of experts in mapping previous and predicted vulnerable areas with various GIS tools, simulation modelling techniques, inclusion of disaster proof or risk-resistant buildings and construction works
5	Implementation of policy framework at national and local levels	Bridging of gaps between state authorities and local authorities still left	Involvement of NGOs and co-workings with government officials for capacity building and training programmes in educational institutions and organizational programmes
6	Increase in international support for capacity building	Less number of research and studies over actual disaster events	Building up institutional networks with organisations or associations working for risk reduction in disaster-prone countries like Japan, Indonesia, etc. and publishing of having indigenous knowledge

(continued)

Table 20.5 (continued)

S. No.	Indicators of disaster risk reduction	Gaps identified in national policy	Suggestions for Indian policymakers
7	Access to early warning and multi-hazard risks' information system	Very little accesses to people living in coastal areas few metres away from sea	Opportunity for employment for one member in such families in quick response to forces trained under military officials, setting up of new alarming signal systems and communication systems

Source (NDMP 2019, Authors)

not affected by the disaster events as compared to areas which did not have them (Sunil et al. 2018) (Table 20.5).

In hilly and mountainous areas prone to earthquake, like in Jammu Kashmir, there are indigenous practices for building houses which use Taq system (timber laced masonry) and Dhajji-Dewari system (timber frame with infill walls) very prevalent in Kashmir. Taq system uses wooden horizontal runners which are inserted into the masonry walls and this helps it in keeping intact preventing it from any breaks or cracks during the earthquakes. Dhajji Dewari system is another easily built traditional construction system where small panels of timber cross member frames are used along with local materials and mud mortar. In landslide-prone zones, people prefer shrub plantations in terraced surface farming rather than planting large trees (Khan 2008).

There are some traditional methods and knowledge practised in the Dindori district of Madhya Pradesh in forecasting and prediction of disasters like droughts, heavy rains and storms, etc. such as flowering of bamboo, fruiting of Sal tree which indicates that drought will persist in that year, thinness of Munga fruits, big rain droplets which indicate cyclone, fruiting and ripening of Bhui fruit (*Careya arborea*) in the month of June, emergence of new leaves before cold season in Pipal (*Ficus religiosa*) and arrival of more fruits of B. lanzan (*Buchanania Lanzan*) which indicate good rainfall. In the agricultural lands of Bihar, which are prone to insect infestation, farmers protect their grain bags by using neem leaves (*Azadirachta indica*) and paddy fields from 'Phank' infestation by using spray of ash mixed with kerosene oil and adopt various other crop management systems such as livestock, soil health and crop watch practices (having local knowledge). Small land holder farmers have been identified as the first target for policies to increase production in mixed systems for effectively increasing carbon density and refilling depleted soil carbon reserves (Bhushan 2019).

As far as wind storms during summers in Rajasthan is concerned, local people use the Dhani system of house construction, where its circular nature also helps in resisting seismic shocks prevalent in the areas for instance, houses with similar style in Kutch in Gujarat faced least damage during the 2001 earthquake. In Barmer, even highly respectful people live in these houses called Dhanis as the traditional ones are more comfortable rather than modern technology houses which are unable to resist extreme high temperatures. There is community participation prevalent in the area and time-tested structural safety of the house exists with local materials like dried by-product of jowar crop used for roof construction with wooden struts for additional support (Sharma and Joshi 2008).

Bamboo root pressure traditional technique is used by the people of Assam where severe floods are seen eroding the topsoil. Here, bamboos are planted on the bunds or embankments of rivers where roots deepen upto 5 ft under the ground and help to prevent breaching of bunds and damage of roads and bridges, and thus connectivity of villages to cities is not obstructed. This also prevents river overflows and other serious damages. This is highly practiced in Nadeswar village where bamboo planting not only helps them with combating against floods but also helps them economically as a livelihood, which requires less investment and low maintenance cost (Stephen et al. 2008).

Another study in areas prone to landslides in Sri Lanka shows how social capital, 'Attam kramaya' working together, and transfer of local knowledge from elders who experienced disasters to communities, building live fencing using 'pawatta' (Adhatoda vasica), a certain type of plant, and building the retaining walls have helped reducing landslide risks. Etanwala and Mandaramnuwara communities in Sri Lanka are not connected to outside communities but are self-sufficient and have a strong knowledge sharing network which help them build vulnerability awareness, stewardship ethic, responsibility to environment and community and a mutual feeling of trust and safety (Dasanayaka and Matsuda 2022).

For restoration of soil carbon which is washed away due to heavy rains, enhancement of carbon sinks with the help of timber species by indigenous Mayan communities of Mexico in their agro-forestry systems has also played as an important part for mitigating the climate change. Rotating of agro-species in two year by rural indigenous communities help in sequestering 26–78 Mg carbon per ha in the soil. Hence, species native to the places having indigenous qualities to replenish carbon sink in agro-forestry as well as urban forestry can increase carbon stock from 1.5 to 3.5 tonne carbon per hectare per year (which means carbon stock of an area can be made to an optimum level by growing native plant species and lost vegetation and soil can be recovered)(Bhushan 2019; Chaurasia and Munoth 2022).

In some studies, it is found that in coastal communities where islands face cyclones and storms very often, people make use of local vegetation 'Suhay' which are bamboo rods, and 'Ai Tatan' which are wooden clamps used for construction of their disaster-resistant houses, in Philippines and Timor-Leste, respectively. In such places, transportation is interrupted for long time period and hence these communities use 'Krong Padee' in Indonesia and 'Guci' in Timor-Leste for storing their emergency food which include taro, cassava and yams, white spot giant arum (*Amorphophallus paeoniifolius*), sago and air potato (*Dioscorea bulbifera*) in such small and island southeast Asian countries. They also have traditional organization of fishermen 'Panglima Laot' where they grow and maintain mangrove and coastal forests to mitigate storm damages (Hiwasaki et al. 2014). These studies also show that bridging the gap between indigenous knowledge and scientific measures can be achieved via participating of local researchers in observation, recording and assessment of experiencing traditional knowledge at the site, validation by community, its analysis, and integration with scientific knowledge and its popularization with modules. Such observations are done on celestial bodies, direction of wind, certain behaviour in animals and leaves shedding in plants, and different traditional beliefs in respective cultures.

Traditional earthquake-resistant houses in Sumarta Islands which have various fault zones such as Mentawai Fault, Sumatran Fault, etc. have existed to even this date. Some house types include Rumah Adat, Omo Hada, Omo Sebua, Rumah Gadang, Rumoh, Rumah Tuo, Rumah Kaki Seribu, Rumah Wale Minahasa, etc., (Kumio et al. 2021). The people pass on the traditional knowledge like unusual sign from squirrels and chicken about the upcoming earthquakes to younger generation through story telling in school education, or folk songs which they sing in their respective village communities giving improvement in risk literacy, risk preparedness in cultural habits and take refined local measures to build back better.

Future scope in disaster management and risk reduction includes:

- Great opportunities in research and development as scholars and agencies can do more documentation and further area-specific studies for its prevention and control with indigenous measures for local population. Educational institutions may play a big role in conducting programmes and workshops where interactive sessions between students of disaster management field and policy experts may bridge the gap between knowledge or information and strategic actions or efforts put up, before occurrence of such natural hazards
- Generally policies focus on measures taken after a disaster has happened and are based on recovery and rehabilitation. But disaster-resistant construction practices are highly needed with those housing projects or developmental projects which are going to lie in seismic zones in future
- A person can serve as a medical expert, as a mock drill and training expert, as a professional in government departments or private consultancies as engineers, educators, scientists, environmental expert, law experts, disaster investigation officers, emergency specialists, management officers, security officer, etc.

20.8 Policy Recommendations

Some areas which still need much more focus in order to mitigate and manage disasters are listed below:

- Disaster management plan with focussed strategies for each vulnerable area district wise and increasing reach to victims for rehabilitation
- State government departments must hire experts and knowledgeable persons for risk analysis at certain time periods of the year and also ask public opinion polls to identify if they are lying in hazard risk areas

- Decreasing early recovery time from 18 months (as mentioned in NDMP 2019) to 6 months for faster recovery also reduces respective medium and long-term recovery periods or time frames
- State-wise identification of respective disasters yet occurred in history and setting up of corresponding departments with response strategy with respective specific hazards
- Bottom-up approach of disasters risk and vulnerability assessment based on surveys from local people and introducing their indigenous knowledge in research studies
- State institutional framework—additional branches where work of prediction, research, vulnerability analysis and mapping is done which is headed by centrally sponsored teams

There are some other recommendations by various authors and researchers tabulated below:

20.9 Conclusion

To deal with forces related to nature, one needs to gather knowledge about how nature works and quantify the impact it has on human beings based on historical evidences. Traditional and local knowledge which is based on the past experiences of the ancestors is transferred to next generation orally and, through demonstration, helps abundantly in understanding nature and co-existing of ecosystems, the frequency of hazards and what sustains and what gets destroyed in such calamities. This knowledge gets updated with each hazard faced by the local communities, and new ways of getting resistant to natural forces are invented without harming the environment which is passed on to their younger ones. But there are various places where people are unable to cope with certain disaster events, and they need researchers who can study and assess and bridge the gaps between local knowledge and scientific measures taken to reduce the risks faced by vulnerable population of disaster-prone areas (Table 20.6).

Many researches worldwide have shown that disaster risks cannot be reduced just with scientific equations, satellites and machines or equipments. An integration of indigenous knowledge with technical proficiency along with international cooperation and knowledge sharing committees will help in preplanning, managing, focussed administration and proper governance of disaster-related issues. Measures taken before a hazard prove to be more effective in reducing loss of life, property, livestock, agricultural losses, economic losses in GDP, etc. For instance, the Turkey-Syria earthquake which has taken more than thirty three thousand lives and still counting, was predicted three days before the disaster actually took place, by a researcher named Frank Hoogerbeets. The same researcher and seismologist has predicted next one which will be affecting India, Afghanistan and Pakistan. This

Table 20.6 Recommendations from reference authors

S. No.	Indicators to be focussed on for disaster risk reduction	References
1	Urban governance, resilient structure in a city, vulnerability assessment, informed citizens	Sharma et al. (2017)
2	Involvement of reputed civil society organisations (CSO) in pre-disaster till post-disaster measures	Thattai et al. (2017)
3	Understanding of disasters at experiential level and incorporating information from grass root level, avoiding rigid top–bottom framework	Ogra et al. (2021)
4	Advanced forecasting systems and early warning system with quick response and advanced planning with multidisciplinary approach	Rao and Mohan (2020)
5	Hybridization of scientific as well as local or traditional knowledge among local people and experts in hazard mapping with institutional safeguarding	Hadlos et al. (2022)
6	Data mining techniques for prediction and detection, creation of large database, use of social media for information distribution and early responses	Goswami et al. (2016)
7	Role of NGOs in capacity building, awareness programmes, proper fund allocation by State Disaster Management Authority, community participation based approach	Kumar and Pradhan (2022)
8	Adaptive capacity, sensitivity and exposure risk as three elements of vulnerability index and risk assessment	Chakraborty and Joshi (2016)

should be seriously taken into considerations by the responsible government departments and other geological suvey departments or organisations/technical institutions, as early warning signs and those areas which are coming under fault zones must be well prepared with all support systems already mentioned in the chapter.

A country like India suffers severely from various hydro-meteorological, geological, biological and accidental disasters more due to its high population. There is a need to focus on awareness generation, advanced preparedness, hazard risk assessment, vulnerability assessment, mock drills and community participation in training programmes, emphasizing on role of different stakeholders in reducing risks, database management and quantifying historical evidences, zoning, mapping and monitoring of disaster prone areas, using indigenous knowledge for quick responses, structural and non-structural measures comprising of disaster-resistant construction of infrastructure and services, strategic recovery, proper fund allocation and bottom-up approach in administration and governance. A lot of scopes are in research and development where different indigenous Indian communities may help local researchers to observe and analyse the environmental signals before such natural catastrophes and bridge gap between implementation of policy framework, approach and mitigation measures.

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Chapter 21
The Resilience of Indigenous Peoples in Facing Disaster Risks Due to Extreme Climate Change on Alor Regency, East Nusa Tenggara, Indonesia

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Abstract Climate change affects the lives of indigenous people in Alor Regency. The community felt the impact of the tropical cyclone Seroja that occurred on April 2–4, 2021, accompanied by very high extreme weather, strong winds, and flash floods. The disaster damaged houses and public facilities. The community's agricultural land was flooded, and many people died as a result of the disaster. Qualitative data were collected by interviewing the affected indigenous peoples in Alor District and stakeholders. Observations were also made to document the impact of the disaster. The data obtained were analyzed thematically, namely based on a predetermined theme. This chapter describes the condition of the community affected by the disaster, mitigation efforts, and the resilience of indigenous peoples. Two main findings become priorities for restoring the strength of the Alor community due to tropical cyclone Seroja, namely physical stability and socio-economic resilience. Physical strength is realized by building houses and public facilities damaged by floods. Socio-economic resilience is a priority because damaged agricultural land results in the loss of community livelihoods. This will have an impact on the weakening of food security in the region. The value that stands out from the local community in solving problems is mutual cooperation. Adapting to natural disasters requires a balanced process of environmental planning and management involving local indigenous peoples. Related parties outside the Alor community are also concerned because climate change is a problem for all the people of the earth.

Keywords Indigenous people · Climate change · Disaster risks · Resilience · Adaptation

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_21

21.1 Introduction

Natural conditions and the territory of Indonesia are disaster-prone areas, so disasters have become part of people's lives. Human behavior that is not good for nature can cause disasters. This can lead to global warming and a changing climate. In such conditions, disaster management is needed to prepare the community for disasters. This chapter begins with the preparedness of indigenous peoples in dealing with disasters due to climate change on Alor Island, East Nusa Tenggara.

The world environment is changing rapidly due to climate change. The disaster in Alor Regency will provide a unique perspective that must be considered when understanding the differences in indigenous peoples after experiencing floods and landslides due to climate change. The experience of indigenous peoples in the Alor Regency makes them resilient in the face of change (Berkes et al. 2021). Disasters can remind us of the importance of maintaining the balance of nature.

Indonesia is a country that has a dry season and a rainy season with the characteristics of extreme changes in weather and wind direction. Due to climate change, tropical cyclone Seroja hit Alor Regency on April 2–4, 2021. Symptoms that appear are very high extreme weather and strong winds that cause damage to several residents' houses, submerged community agricultural land, and flash floods. In addition to injury, it also takes lives.

As a result of Cyclone Seroja, natural conditions in Alor Regency pose hydrometeorological threats such as floods and landslides. Flooding is an event where water inundates land due to overflowing water in rivers. Because the contours of the land in the Alor Regency are hilly, it is flooding that causes erosion. Landslides are natural disasters when soil or rock slides down a slope or cliff. Landslides and floods occurred in Alor Regency due to high rainfall. This erosion disaster is detrimental to humans, both loss of life and property damage because it occurs suddenly and cannot be predicted.

Most of the disasters in Indonesia are hydrometeorological disasters, namely disasters caused by atmospheric phenomena, including hydrometeorological disasters, landslides, droughts, hurricanes, forest fires, and extreme weather. The impact of natural disasters in the Alor Regency is huge on people's lives. Community preparedness is needed to anticipate the effects of natural disasters. The increasing intensity of disasters, regardless of the environmental influences of global and regional strategies in the form of global warming, causes an increase in temperature, climate change, no sea level rises, and ecological changes that significantly influence the chances of natural disasters.

This chapter explores the resilience of the indigenous people of Alor Regency in adapting to the conditions they experience. Describe the adaptations they make to the situation they face. The research questions that will be answered in this chapter are: (1) what is the condition of the people of Alor Regency who are affected by climate change?; (2) what efforts are made by indigenous peoples in Alor Regency in future disaster mitigation?; how is the resilience of the people of Alor Regency in adapting to the climate change situation they face?

The purpose of writing this chapter is to describe the resilience of indigenous peoples in facing disaster risks due to climate change by describing three main points, namely: (1) analysis of the conditions of communities affected by climate change; (2) disaster mitigation efforts for the indigenous people of Alor in the future; and (3) the resilience of the indigenous people of Alor Regency in adapting to climate change situations. Recommend that, disaster risk can be minimized. Suggest that, the disasters experienced can be a learning process to create community resilience to disasters caused by climate change.

21.2 Rationale of the Study

Climate change can threaten human life because it can cause natural disasters, such as abrasion, rising sea levels, hurricanes, droughts, and floods. Alor Regency is one of those affected by disasters caused by a changing climate.

21.2.1 Climate Change

Human waste and greenhouses have changed the world's climate, including in Alor Regency. As a result, climate change risks cannot be separated but integrated into more extensive efforts to reduce risks (Aalst et al. 2006). The changing climate affects the ecosystems and people of the world. These changes can endanger human life and community resilience and disrupt development. Reducing the risk must be done immediately to avoid more significant danger. The adaptation process is critical to minitroubles the changes caused. Adaptation is needed to ensure the success of mitigation. Indigenous peoples in Alor Regency can adapt by preparing themselves to make changes. To limit the impact of climate change, we must reduce it significantly.

Climate change affects global food security by reducing global food crop production. Without adaptation measures, the production of key crops such as rice and corn grown by the Alor community is damaged. Climate change will also exacerbate human health problems and cause health problems in various regions due to irregular seasons (Filho et al. 2022). The adaptation process is critical to do to minimize the risks caused. Adaptation is needed to ensure the success of mitigation. Indigenous peoples in Alor Regency can adapt by preparing themselves to make changes. To limit the impact of climate change, we must reduce it significantly (Winsemius et al. 2018).

21.2.2 Disaster Risk

The consequences of climate warming will be proportional to the required adaptation (Raza et al. 2019). High sea levels will impact coastal and low-lying communities, causing flooding, coastal submergence and erosion, and the sinking of small islands. This will have an extraordinary impact on an archipelagic country like Indonesia. Climate change also affects terrestrial and marine species' geographic ranges and migration patterns. Some species will become extinct. Ocean warming poses a significant threat to the marine environment, especially in polar regions and coral reef ecosystems. Indonesia, a mega biodiversity country, has a complete land and ocean ecosystem. Ecosystem-based adaptation is also one of the priority agendas for controlling climate change.

Human activities that damage the climate are directly responsible for the extreme natural disasters in Alor Regency. Events that cause individual extreme or non-extreme climate change have severe effects on the overall human and ecological environment. Global warming due to human behavior that damages the environment will impact the emergence of disasters for humans (Lavell et al. 2012). A changing climate is a particular threat to humans living in low-lying coastal settlements. Mitigation, migration, and resettlement modification will be needed to reduce the risks associated with a changing climate in Alor Regency (Mcgranahan et al. 2007).

A changing climate reduces local and global food security. Flooded agricultural land can cause a decrease in food crop production (Purakayastha et al. 2019). Rice and maize production is expected to decline if adaptation measures are not implemented. Climate change is expected to hurt economic growth (Baarsch et al. 2019). It is proven that in the Alor archipelago, floods and hurricanes caused damage to agricultural land so that people could not harvest. This creates vulnerability to poverty and even exposure to exposure licts.

21.2.3 Indigenous People's Resilience

Climate change in Indonesia has rapidly increased the intensity of disasters in recent years. The importance of disaster risk reduction by communities should be emphasized because of its essential role in building resilience (Wang et al. 2019). Strength is coping, adapting, and transferring norms in a changing environment (Ford et al. 2020). Learn from the states of Australia that climate change contributes to increasing the vulnerability of indigenous peoples. State programs must respect indigenous peoples. If you does not respect local wisdom, it is vulnerable to occur in the future (Howitt et al. 2012).

The preparation, risk assessment, and recovery process in dealing with disasters must be carried out in a partnership that respects each other and upholds justice. So, disaster risk management programs must consider the local wisdom of indigenous peoples. One study conducted on a predominantly farming community in north-eastern Ghana found that increased knowledge of farmers about climate change and building extension workers' capacity to share climate change information as appropriate adaptation measures are critical to successful adaptation (Tambo 2016). An effective public communication campaign's objectives, strategies, and approaches can significantly impact knowledge, attitudes, perceptions, and behavior regarding climate change adaptation (Okaka 2009).

21.3 Materials and Methods

This study describes the response of indigenous peoples in Alor Regency, East Nusa Tenggara, to extreme climate change resulting in the Seroja tropical cyclone. This description covers the events of the approach of green social workers by presenting indigenous peoples as the main actors. Qualitative data were obtained through interviews and focused discussions on communities affected by the disaster. The informants in this study were 24 people related to disasters in Alor Regency, including affected communities, community leaders, NGOs, local governments, and the central government.

The interview and observation process took place from April 26 to 29, 2021. The interview duration ranged from 60 to 90 min, covering topics such as the experience and role of the interviewee. On a national scale, discusses the disaster management program that was launched; Bappenas discusses disaster planning and budgeting; the Alor District Social Service addresses the role of the local government in providing social assistance for food, psychosocial, and death assistance; and affected communities discuss the events they experienced and how to deal with the situation.

The data collection process includes interviews (Prentice 2017), focus group discussions (FGD) (Garrison et al. 1999), observations (Greatorex 2014), and documentation studies (Jones and McCoy 2019). The Social Service Office hosted focus group discussions in disaster-affected locations to gather information related to the following topics: (a) disaster events that occurred, (b) how to defend themselves from disasters, (c) parties involved in disaster management. Further, documentation studies were conducted to learn from the results of this program evaluation. Reports, books, scientific journals, and other documents are also some of the sources we use.

This study collects data using thematic analysis (Sundler et al. 2019), presenting the data collected according to predetermined themes, in particular about the role of indigenous peoples in tackling disasters. This study has several limitations, including the limited time to observe disaster-affected areas. In addition, the situation described above does not fully represent the situation in Indonesia as a whole (Fig. 21.1).

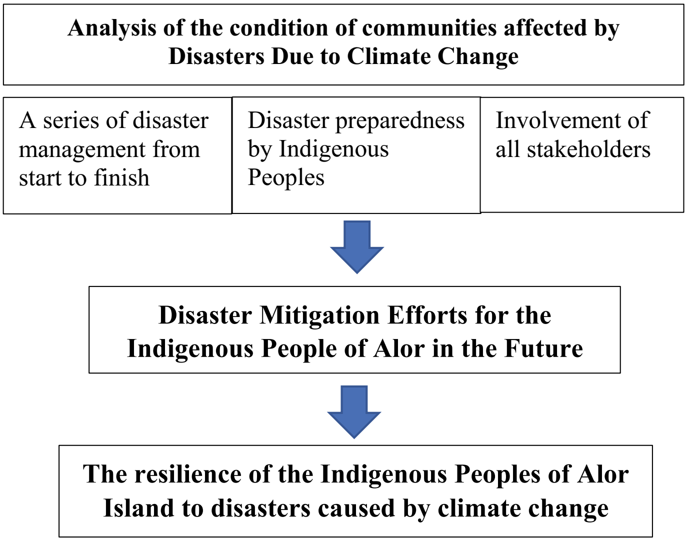

Fig. 21.1 Research framework

21.4 Results and Discussion

Alor Regency consists mainly of mountainous highlands surrounded by valleys and ravines. This is to obtain communication facilities and vehicle traffic flow, both land and sea.

21.4.1 Condition of Communities Affected by Disasters

The Alor Regency area has an altitude between 6 and 1700 m above sea level. The condition of the Alor Regency area is primarily mountainous and hilly, with a slope of above 40%, a pace of 183.993.83 ha, and *n* area with a gradient of 15–40%, as much as 67.691.44 hectares. The type of soil content in the Alor Regency generally consists of lithosol soil and other volcanic rocks. This condition causes Alor Regency to become an area prone to landslides.

Handling During a Disaster and After a Disaster

Tropical cyclone Seroja hit almost the entire area of East Nusa Tenggara. Alor Regency was one of those affected by the Seroja storm. Hurricane Seroja in Alor Regency occurred from April 2–4, 2021, with very high extreme weather characteristics and strong winds. The disaster destroyed people's houses and flooded

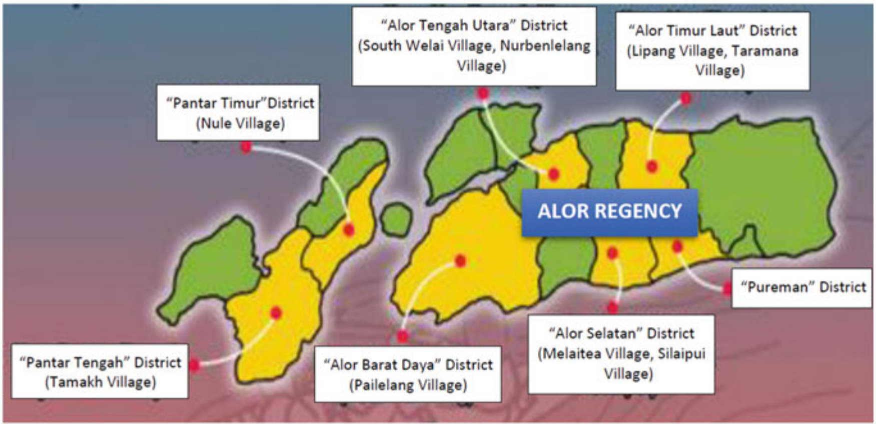

Fig. 21.2 Flood map due to extreme weather in Alor Regency

community-owned farmland. The disaster also caused many people to die. The affected victims were 39,980 families/155,412 people, consisting of 29 dead, 12 lost, 25 injured, and 550 people displaced.

Natural disasters due to severe climate change impact seven sub-districts in Alor Regency (Fig. 21.2). The main road connecting Kalabahi to Maritaing has been damaged as many as 74 points. Benlelang Bridge and Taramana Bridge were heavily damaged. Seven hundred sixty-six houses were heavily damaged, 525 homes were moderately damaged, and 1053 homes were slightly damaged. A total of 264 public facilities were heavily damaged. This disaster also damaged the drinking water infrastructure of 36 points. Other damage deemed vital was two government offices and a power plant which caused power outages.

This natural disaster has a considerable risk because it occurs at night when people are fast asleep, so people do not have time to save themselves. The tragedy happened when the Alor community was approaching the rice harvest, as one informant said (Fig. 21.3):

> As a result of this disaster, gardens and fields were destroyed. At that time, the rice had just turned yellow and was ready to be harvested, but because of the flood, people could not enjoy their agricultural produce.

The state of the affected communities who lost their rice fields, fields, and even fallen trees caused people's livelihoods to be lost. Furthermore, their food reserves are also threatened by the loss of their rice fields and fields. This must get attention because if left unchecked, it will lead to social disaster.

Alor Regency faces food security problems because the rice fields and fields that are their source of life are flooded. This condition can cause new social issues due to limited resources, namely poverty and crime. Their affected houses and farms are difficult to rehabilitate because they are covered in stones and sand and are located in disaster-prone areas. As one resident said:

Fig. 21.3 Condition of the house affected by the disaster

> Currently, we live with neighbors, while the house's current location is no longer suitable for habitation. So we need land to move to a place that is safe and free from flooding.

Overcoming this requires innovative solutions from the Alor Regency's indigenous people. These innovations include local education programs, traditional agricultural systems, and local wisdom in managing environmental balance. Such innovations must consider local social and economic development issues (Máté et al. 2020).

In addition to the physical losses mentioned above, the disaster on Alor Island was also felt psychologically. The impact of disasters on children and adults varies from short to long-term emotional effects that can still be seen include fear, anxiety, sadness, feelings of emptiness, and trauma. As stated by the following informant:

> Every time there was a small rain, we would feel scared and could not sleep because of the trauma of the floods we had experienced.

In some people, this feeling will improve over time. But, on the other hand, the emotional impact of a disaster can last longer in the form of trauma and adjustment problems in personal, interpersonal, social, and economic life after a disaster. Symptoms of emotional disturbances are a source of suffering and can affect the ability of disaster survivors to organize their lives again. If we do not respond immediately, it will cause the survivors, families, and communities to not function properly in life. Those with severe trauma require particular therapy to eliminate it. The role of family and neighbors is enormous so that social functioning can return to normal.

Disaster Management by Indigenous Peoples

Natural disasters have occurred and cannot be avoided, but they can be mitigated by disaster management. A resilient household must be created for the indigenous people of Alor Island who encounter a disaster. Building a solid home is not only about one family but also related to the environment and culture. One of the cultures that exist in the Alor community to create a strong household is cooperation and tolerance. They help each other to establish a shelter for the local community. They help each other repair damaged public facilities regardless of background. As said by one of the informants:

> We all help each other what we can; our energy is used to search for missing victims buried in the sand. We also set up a post for evacuation. Some are with the family for those who still have a family. We feel like we are brothers here.

Togetherness among indigenous peoples cannot be separated from their traditional leadership role. Alor Island is still very thick with traditions. The part of traditional leaders is very influential compared to government leadership. It is these informal ties that move the fastest in dealing with disasters.

At the time of the incident, several command posts were opened, especially in disaster areas that claimed many lives. There are about 47 families in one evacuation post, estimated at around 150 people, while the children in one post are about 50. Most residents' activities while evacuating were still confusing because they had lost their homes. In fact, at first, they ignored the health protocols because the place was limited and all emergencies, but after the officers arrived, the masks were distributed, and the health protocols were observed.

Residents affected by natural disasters choose to move to safer relatives' homes. The number of refugees is still being recorded because there are currently no refugee camps. Residents were scattered to take refuge in close family homes. However, residents need certainty to return to their homes as before. Such conditions require assistance to build their houses as soon as possible. Some want to rebuild their houses, but groups of residents plan to relocate because their original residence is no longer safe. Some residents have donated their land but are still having problems with legality because their heirs will sue at a later date. In addition, before relocation, research is needed to ensure that the place is safe from natural disasters.

Family relationships that exist in the life of the people of Alor can unite the community beyond the boundaries of religion, team, and social status that exist in society. A strong brotherly relationship is essential for the Alor people to live in harmony despite the diversity of religions. People in Alor believe that they are one family. Before getting to know faith, they believed in a belief that taught the norms of living together in the village, namely maintaining family values as Alor people. When conflicts with religious issues occur a lot, this does not happen amid the life of the Alor people because the Alor people always say that:

> Religion is not a problem for us; Alor people are brothers and come from the same ancestor and remain Alor people regardless of religion.

There are four pearls of local wisdom of the Alor people in protecting the environment. First is the attitude of moral responsibility toward nature by always obeying the rules, traditions, and customs. Second is the attitude of solidarity toward nature that the Alor people have to protect their ancestors and natural ecosystems. Third, love and care for the earth by becoming a member of Green World. Fourth is the attitude of not disturbing the life of nature.

Involvement of All Stakeholders

Social groups in Alor Regency are the determinants of success in overcoming disasters, so that such groups must be strengthened by increasing their capacity with assistance from government agencies and related parties (Karlsson and Hovelsrud 2015). Although indigenous peoples have an essential role, the roles of various parties are needed because this plan is a national disaster. Related parties in the disaster management process in Alor Regency include: indigenous peoples, especially those affected; local government; federal government; non-governmental organizations; corporations; mass media; and the scientific community.

Indigenous Peoples of Alor Regency. Local communities are directly affected in the event of a disaster. So, the local community is the main stakeholder in the management of tropical cyclone Seroja; this group should be strengthened because, after a disaster, it is essential for an early warning system centered on local communities. Their complaints when a disaster occurs are input into the design of the adaptation system. This information is used to determine the level of risk in an area. Affected communities must be aware of the hazards and potentials they face. They must be able to take action when there is a disaster by reducing the risk of damage or loss. The location of the indigenous peoples is of the utmost importance; For example, the people of Alor must be educated and alerted to potential landslide disasters so that they can be used as an early warning system for wind and landslide disasters.

Local government. This institution must be good at dealing with the threats faced by indigenous peoples in Alor Regency. Therefore, local governments must actively design and maintain an early warning system with the community. So, local governments must engage indigenous peoples in ways that improve their safety and reduce the risk of losing the resources on which communities depend. The provincial government also acts as an intermediary between the affected districts and outside parties who want to help, including the national government. The regional coordinator is the Alor Regency Regional Disaster Management Agency (BPBD).

National governments. Tropical Cyclone Seroja disaster is included in the category of state disaster, so the central government is also responsible. The central government plays a role in providing budgets through local governments and is obliged to monitor the use of these budgets. The central government is also responsible for making policies that regulate the mechanism for assisting other countries. After a disaster, they are also responsible for the systems needed to adapt to a disaster-prone environment. The central government should also design an early warning system and conduct emergency response preparations by involving local communities. The central government must ensure that emergency response and early warning are for the most vulnerable populations, such as in the district of Alor. The Central Government is also responsible for climate change campaigns to the broader community. The disaster experienced by the people of Alor Regency is the impact of global human behavior. So, it is hoped that all Indonesian and the world's people will be responsible.

Non-government organizations (NGOs). Organizations in the community are very influential in dealing with the tropical cyclone disaster in Alor, for example, youth organizations, community organizations, and religious organizations. The disaster in Alor Regency is a national disaster, so the organization's role is not only at the local level, but there are also regional and international organizations. Most of the support provided was technical support, providing food and clothing for refugees. Support is also provided in the form of trauma management for children. This organization has a role in making people aware of being actively involved in dealing with disasters. They also advocate ensuring that a changing climate is a priority for government policymakers.

The private sector assists in technical handling, including the provision of food, clothing, and medicine. The private sector is also essential because it is usually better equipped to provide tangible solutions. This sector will help when their company comes into contact with the company. This sector also has a budget for disaster management or community development as corporate social responsibility (CSR). The private sector has great potential to help provide skills' services for community cadres through technical skills and knowledge sharing.

The media is critical in increasing public awareness about disasters and disseminating the news so that it is known to the broader community. The media educate indigenous peoples and the wider community about climate change to prevent it. The media can be an essential channel between agencies dealing with these issues and the general public. The media also plays a role in collecting public funds to be channeled directly to disaster-affected communities.

The scientific community can assist the government and the community in assessing events in Alor Regency. The scientific community involved in this disaster included the University of Nusa Cendana. This scientific community also acts as a researcher who can develop an early warning system by providing specific scientific and technical input. They play a role in creating a systematic design that is easy to understand. The scientific community can also assess disaster risk to be used for future vigilance. In addition, it can also collect scientific data based on events with rational methods.

21.4.2 Disaster Mitigation Efforts for the Indigenous People of Alor in the Future

The climate change phenomenon forces the local Alor community to develop comprehensive measures to adapt to the hazards. Reducing vulnerability and increasing resilience are the needs of indigenous peoples (Khailani and Perera 2013). After a natural disaster occurs, it will raise awareness among the local people of Alor Island that protecting the environment is essential. As one of the following residents said, this awareness must be presented for vigilance in the future.

> In the future, we must maintain the balance of the environment; we must not cut down trees on the banks of the river because the rainwater is not held back when it rains heavily, and floods occur as we feel today.

Awareness of climate change is an essential element that must be owned by local communities on the island of Alor. Natural disasters due to climate change occur not only once; there is a time scale that will repeat itself. This can be determined by identifying multi-year historical trends. “Local adaptation knowledge is divided into four categories: land and water management, physical infrastructure, livelihood strategies, and social institutions” (Lebel 2012).

The knowledge system of indigenous peoples in the Alor Regency differs from the formal learning system in general. The catastrophic events they experienced were precious lessons for the next life. Many are dynamic, drawing information from previous events. Previous learning methods are no longer relevant to dealing with new possibilities. Identify the weaknesses and strengths of local wisdom as the basis for determining policies.

Indigenous peoples form a disaster management center. Alor Regency has a disaster management center in each sub-district. The local indigenous community established a disaster management center as a refuge for refugees and an information center. The village disaster management center also distributes aid to disaster victims (Fig. 21.4).

This post also provides shared kitchen services that provide food assistance for disaster victims. Such positions are considered effective in disaster management. Not only is Indonesia developing, but posts like that are also being developed in Bangladesh. The disaster management committee formed by the local community is the most critical organization in disaster management in the region (Alam and Ray-Bennett 2021).

Efforts to mitigate natural disasters due to climate change in Alor Regency must be prioritized. Floods and landslides due to climate change must be addressed. Realizing mitigation efforts against natural disasters requires a balanced planning and management process between the environment and humans. This aims to ensure its sustainability in the future. One resident said that the affected village needed to be relocated because it was feared that a similar disaster would occur. However, research will be conducted before relocation to ensure the area is safe from natural disasters.

Disasters in the Alor region have severe impacts on humans and ecosystems. So, we have to reduce disaster risk and always be ready for disaster. However, in this case,

Fig. 21.4 Disaster management center at the sub-district level

public awareness and the ability of policymakers to integrate adaptation and disaster risk reduction are still limited, so that the incident in Alor Regency is a valuable lesson so that we are always vigilant. Local community knowledge is essential to reduce disaster risk.

Community participation in disaster management efforts is essential. Policymaking at the regional, national, and international levels should involve indigenous peoples because they are a vulnerable group affected by disasters caused by climate change. The community also has the potential to create and implement customary rules based on local wisdom so that these communities become resilient and adaptive to a sustainable life (Busayo and Kalumba 2021). Adaptability to climate change among different levels of stakeholders is a crucial ingredient to achieving the goal. Local governments should manage disaster management with local power structures so that disaster management due to climate change can take root deep in society and culture (Wolensky and Wolensky 1990).

21.4.3 The Resilience of the Indigenous Peoples of Alor Island to Disasters Caused by Climate Change

The trauma experienced by indigenous peoples on Alor Island will foster resilience in overcoming future problems. In the discussion forum with the community, they thought hard to find the causes of the disaster and tried to prevent it from happening again in the future. Resilience is individual and related to family, community, and culture (Fast and Collin-Vézina 2020).

Floods and evacuations due to flooding experienced by the Alor community can increase vulnerability and impact the resilience of indigenous peoples (Khalafzai et al. 2021). Floods due to seasonal changes in Alor Regency often impact community infrastructure, agriculture as a traditional livelihood, and the local economy, adding to residents' anxiety. The experience of facing flood risk hurts their well-being during and after evacuation. The short-term result is a person's physical vulnerability, and the long-term impact is that some people experience disability.

The human capacity to face, overcome, and overcome adversity is defined as resilience (Grotberg 1997). The ability of a system to cope with disturbances or the capacity to adapt to environmental stresses and changes is referred to as resilience. Resilience is dealing with troubles and challenges that can worsen their lives. (Ayers and Dodman 2010). The community must be able to face disturbances or pressures by adapting to increase socio-economic resilience. According to the above definition, stability has four essential components: adaptation, response, self-organization, and learning.

Resilience has several levels, the lowest of which is the individual, who can apply strength by learning how to deal with disturbances; the middle class, namely social communities or people who have close kinship relationships so that they can work together to deal with disasters together; and the highest level is government intervention in making policies to help people deal with disturbances that occur in residential areas (Obrist et al. 2010).

Socio-Economic Resilience

Vulnerability due to flooding in Alor Island significantly affects their economic resilience. Communities in the Alor Archipelago are economically vulnerable because of their livelihood as farmers. Exposure is closely related to the strength of a society (Shah et al. 2018). The vulnerability of the people of Alor Regency disrupts low food security. About 7 ha of agricultural land were flooded, as shown in Fig. 21.5. Rice fields as rice producers have strategic value for food security in Alor Island. This can threaten the community's food security because it will take a long time to plant again before planting, the embankment must be repaired, and agricultural land must be rehabilitated first.

The environmental characteristics of Alor Regency make community agriculture vulnerable to climate change. Climate change causes the cycle of the rainy season and dry season to become erratic, which puts smallholder agriculture at risk of crop failure. Seasonal changes that often occur suddenly and are extreme, either in droughts or excessive rains that lead to flooding, also increase the risk of agricultural crop failure. Heavy rains come when the harvest has not yet been carried out. On the other hand, drought occurs when the land needs water for plant growth. The latest flood disaster is when the community's agricultural land is ready to harvest.

Fig. 21.5 Seven hectares of rice fields in Malaipea Village, South Alor District, are threatened by flooding

Climate change is a multidimensional threat whose impact has risked the existence of this green planet. An increase in the temperature of natural and anthropogenic factors causes an increase in natural disasters. Climate change has severe and far-reaching consequences for the environment, agriculture, economy, and society (Shubhi Patel et al. 2021). Planning, prevention, avoidance, mitigation actions, and reaction to threats are all components of resilience. In the short term, community resilience is a strategy for dealing with disasters and overcoming vulnerabilities, so people can survive in disaster-affected areas. Changes in community conditions in Alor Regency require having the resilience to deal with them. Economic conditions will influence the ability of the community to adapt to disasters. Because economic activity and social life are intertwined, society and the economy are essential components of resilience. The changing climate significantly impacts agriculture and the economy in Alor Regency.

The community's ability to deal with external pressures and disturbances caused by social, political, and environmental changes is social resilience. Meanwhile, the economic sector's strength is the economy's ability to recover from financial difficulties and withstand pressure. All members of society can cultivate resilience. "Women contribute significantly to three main areas of community resilience, namely social resilience, economic resilience, and ecological resilience" (Singh et al. 2022).

The factors that affect socio-economic resilience are the amount of income owned by the community, the type of business ownership in the future, the amount of savings owned by the community to deal with disasters, loan assistance to microfinance institutions to help the economy of the poor, the existence of social organizations that care environment so that social services and other activities are often held, access to education and health to assist the level of education and health of the economically disadvantaged community, and the existence of government policies to help the community reduce the impact of the disaster caused. So, "climate change is related to the acceleration of sustainable development" (Swart et al. 2003).

Adapting to Climate Change

Resilience is the ability to deal with every disaster from each individual and community so that the disaster can be a lesson to be better prepared to face disaster if it happens again. Community resilience is not just about dealing with disasters and overcoming vulnerabilities, so people can survive in disaster-affected environments. Resilience is related to the adaptations and preparations before a disaster (Lei et al. 2014). The resilience of local communities in the Alor Regency is associated with the early warning system (Ulrichs et al. 2019).

There are two forms of adaptation and social adaptation (Sarkodie and Strezov 2019). Physical adaptation is all the physical efforts of individuals or groups in dealing with disasters in their environment. Social adaptation is social relations and social characteristics in terms of adjustment. (Tam et al. 2021). Social adaptation is significant because humans are social creatures who need each other.

Physical adaptation has five forms: maintenance by using building maintenance, rehabilitation by making repairs without neglecting the original building, renovation by making changes to some parts of the construction, reconstruction by rebuilding new facilities after destroying old facilities, and restoration or restoration of buildings. Each individual will adapt and choose a place to live according to their needs and economic conditions. The main requirements for low-income people to select a place to live are close to the location of work, land ownership status, availability of social facilities, and the creation of comfort. Meanwhile, people who do not have low incomes will prioritize comfort, availability of social facilities, and proximity to job opportunities. The people of Alor Regency experiencing social protection problems (Davies et al. 2009) must be shaped to adapt to the future (Davies et al. 2009).

Based on the impact that the indigenous people of Alor Regency have felt, the community's resilience must be increased by various adaptation strategies. The first step is to define the types of impacts caused by climate change in Alor Regency. The second is to determine the desired community resilience, and the third is to determine the adaptation strategy to reduce the impact of climate change. The methods of the indigenous people of Alor Regency in minimizing the effects of climate change are as follows (Table 21.1):

The values that stand out from the adaptation strategy are mutual cooperation which in the local language of the Alor people is called "Gemohing." The culture of gemohing is behavior to help people overcome work difficulties. They work while rhyming and singing traditional songs. Gemohing is a local wisdom that becomes the personality and character of the people of Alor Regency, so that gemohing is also applied by the community in dealing with flooding problems due to climate change. Gemohing is the behavior of a person working together to achieve a desired result. Gemohing gets the job done, and the results are distributed fairly. Gemohing is a

Table 21.1 Strategy of the indigenous peoples of Alor Regency in adapting to climate change

No	Adaptation type	Vulnerabilities experienced by communities due to climate change	The adaptation strategy of the indigenous peoples
1	Physical adaptation	The existence of flash floods in Alor Regency caused people to lose their homes which became comfortable places to live and shelter	Build temporary disaster posts by working together and planning to build a permanent residence by choosing a disaster-free location. Landowners donate their land to build community housing
2		Public facilities such as community health centers and places of worship are buried in sand and stones	The community works together to clean and repair damaged public facilities
3	Socio-economic	Agricultural land is damaged or lost due to flash floods causing socio-economic and food security to be disrupted because most indigenous peoples work as farmers	Rehabilitation of agricultural land and repair of irrigation canals. I am anticipating the threat of crop failure with food barns to store food reserves
4		Food insecurity causes social problems such as poverty and crime	The culture of sharing food and helping each other can prevent social problems from arising in Alor Regency
5	Psychological adaptation	The community is grieving because family members died and were lost in the flood	The community helps each other to find the missing victims regardless of ethnicity, race, and religion. Local and central governments provide death compensation to families whose family members die
6		The community experiences trauma, especially for vulnerable groups, namely women, the elderly, and children	Recovery of psychological disorders through psychosocial support and trauma healing, especially for vulnerable groups, namely women, the elderly, and children

(continued)

Table 21.1 (continued)

No	Adaptation type	Vulnerabilities experienced by communities due to climate change	The adaptation strategy of the indigenous peoples
7	Cultural adaptation to protect the environment	The forest environment and agricultural land have been damaged a lot to bring back awareness about the culture of indigenous peoples who always maintain the balance of nature	The community started planting trees and reinstating customary law as fines for those who destroy nature

Source Research result, (2021)

form of social solidarity in the life of the local community, which is formed from the community itself.

The benefit of mutual cooperation in disaster management is that it can lighten the workload. The more people who work in a job, the easier it will be for each individual. In addition, mutual cooperation makes work faster and easier to complete. So that the work becomes more effective and efficient, mutual cooperation can foster a voluntary attitude, help, togetherness, and kinship between each other. People who want a partnership will care more about the people around them. Fellow individuals will be willing to help each other and help one another. The spirit of mutual cooperation in different lives is to build good social relationships. A harmonious environment will form a healthy community environment. This social relationship can be made if the community carries out mutual cooperation activities.

Alor Regency has local wisdom in mitigating floods and landslides. Local wisdom is ideas that arise from the thinking of the local community that is wise, full of wisdom, and good worth, which is implanted and followed by community members. Local wisdom contains special provisions covering norms, beliefs, ethics, and customs. This local knowledge has usually been practiced for generations from generation to age. Local people use traditional knowledge to adapt and survive in the existing environment. This is also the basis for disaster mitigation actions by local communities.

Flood and landslide disaster mitigation in Alor Regency is a series of efforts to reduce disaster risk through physical development, awareness, and capacity building in dealing with disaster threats. Climate change requires people to be aware of the arrival of natural disasters that can befall their area at any time. One of the causes of this climate change is the high rainfall intensity. Our ancestors have traditionally applied natural and environmental management knowledge to disaster mitigation action. Government policies should consider local wisdom in disaster mitigation. The combination of modernization and local insight can be a practical step to minimize the impact of disasters in Indonesia.

21.5 Limitations of the Study

This research is limited only to answering research problems. This study cannot be generalized, considering that the characteristics of each disaster are always different. However, this study's results can be used to strengthen local communities resilience in dealing with disasters. Thus, local communities that have other characteristics must prepare an assessment of the condition of the community. This study has limitations on the time of observation which impacts the study's results. So, the research results cannot be used at different times. The reliability of this research is challenging to be used as a standard of measurement because of the inherently unique and unstable social situation in society.

21.6 Recommendations

Natural disasters, such as on Alor Island, cannot be avoided, but the risk of disasters can be reduced. Based on the analysis of disasters caused by climate change, among others, (1) disasters occur frequently. Still, they are often ignored, so local communities must be constantly vigilant to monitor disaster risks. (2) The social strength of the local community must be maintained and even strengthened because they are the first to assist when a disaster occurs. (3) The role of local leadership in disaster management is to maintain the balance of nature. (4) Some places require relocation because of the already inhabited locations of our waterways when it rains. (5) Spatial planning for disaster-prone areas is the key to adapting to disasters caused by climate change.

Disaster mitigation in Alor Regency is carried out to reduce risks to indigenous peoples. This activity is to increase the knowledge of indigenous peoples in dealing with and reducing disaster risk in the future. Some of the activities carried out in Alor District include: (1) identifying risks in disasters that have occurred; (2) development planning involving the participation of indigenous peoples; (3) public awareness of disasters; (4) carrying out disaster management, both physical and non-physical; (5) identification of hazard sources in disasters; (6) proper management of natural resources, and (7) the use of high technology in building an early warning system.

The Alor Regency is vulnerable to tropical solid cyclones and flash floods. Identification and analysis based on several aspects indicate that disaster resilience in the Alor Islands tends to be low. Most of their residences and agricultural sites are located in flood-prone watersheds. Strength can be increased by raising awareness of climate change from local communities so that this knowledge can form the basis for action to be vigilant. So far, anticipation and activities are still limited to evacuation and shelter preparations. The public must understand the influence of the global climate on the disasters they experience. Thus, the people of Alor are also made aware of campaigning for the worldwide community. To increase the resilience of local communities, unique protection systems should be established for communities affected by climate change. This will provide certainty for local communities in the Alor Islands.

21.7 Conclusions

Climate change causes Cyclone Seroja in Alor Regency to affect people's lives significantly. The increasing temperature of the earth causes various aspects of changes in nature and human life, as experienced by indigenous peoples in Alor Regency. Analysis of the condition of indigenous peoples in Alor Regency affected by climate change is a lesson in adapting to living conditions in the future. Studying the chronology of events, their causes, and how to overcome them are analyzed to relate events to one another. So that the results of an analysis can be used to adapt and reduce disaster risk in the future, analysis involving indigenous peoples will shape the resilience of the people of Alor Regency to be strong.

Floods and landslides in Alor Regency threaten and disrupt the lives of indigenous people. This disaster resulted in the loss of human lives, loss of property, damage to agricultural land, and psychological impact. Disaster mitigation to reduce risk is a series of capacity building, awareness, and physical development in overcoming disaster threats. Green technology is one of the efforts that need to be developed in the local community of Alor Island to adapt and mitigate global warming.

Through disaster analysis and mitigation efforts, it is hoped that resilience will emerge in the indigenous people of the Alor Regency. Various kinds of community resilience must be prepared to face the next life because floods and landslides cause vulnerability. The strength of indigenous peoples in the Alor Regency includes socio-economic and adaptation to disasters caused by climate change. Local and central governments must cooperate in providing social security for communities affected by climate change because many have lost their livelihoods.

Government policies regarding disaster management caused by climate change must consider local wisdom. These values have been maintained for generations by the people of the Alor Regency. Therefore, the Seroja tropical cyclone disaster can be a source of learning for all of us. Local wisdom that exists in Indonesia is a wealth that must be maintained in this modernization era because the combination of modernization and local wisdom may be a practical step to minimize the impact of disasters in Indonesia.

Acknowledgements We thank the Center for Social Welfare Research and Development, which has supported this research in 2021.

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Chapter 22
Unearthing the Local Wisdom of Disaster Mitigation Based on Geoarchaeological Records in the Mainland of Sumatra, Indonesia

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Abstract The nature and culture of Indonesia have long attracted many interests. The geological landscape on "the ring of fire" has been the Dutch's observation since long ago. Despite their blessings and virtues, the drawbacks of the silent threats should be considered. Several cases in archaeology have shown the interlink between blessings and their threats, but this topic is still recherché in publications. The tsunami of Aceh in 2004 finally strokes the urge to investigate the major cause and how to prevent and minimize continuous endangerment in the future. This chapter unearths the local wisdom of disaster mitigation found in mainland Sumatra, the challenge, and how to preserve them as local wisdom through the geoarchaeological approach. Stratigraphic analysis of the presence of volcanic product and the tsunami's sediments in the archaeological excavation and the presence of artificial features on the site grounds is the main focus. The investigation was also enriched by their historical background and other previous studies to give their overall context about mitigation. The findings highlighted three acts of mitigation from the people of Sumatra. First, they mostly coped with the threats by moving back-and-forth before and after the disaster. Second, they built moated or earthworks to prevent the flood, and third, they built stilts' house to lessen the earthquake effects. These acts of mitigation should be relayed through generations. Pierre Bourdieu's insight on empowering cultural

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G. K. Panda et al. (eds.), *Indigenous Knowledge and Disaster Risk Reduction*, Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_22

capital through enduring, converting, and institutionalizing is the alternate way that can be done.

Keywords Sumatra · Indonesia · Local wisdom · *Geoarchaeology* · Pierre Bourdieu · Cultural capital

22.1 Introduction

Indonesia is circled by the ring of fire and is prone to many natural disasters of earthquakes, volcanics' eruption, landslides, flooding, etc. The study of disaster mitigations is commonly found but despite geoarchaeological records. Reid after the Aceh tsunami in 2004 concerned about the history of seismology in Indonesia seems to be neglected by scholars. Reid questioned the severity of the nineteenth century inhabited in Indonesia as might be something related to past disasters (Reid 2015). Aceh's deadliest tsunami which reached thousands of victims was a warning sign that past research on disaster should be taken more seriously.

Sumatra has been chosen for this study due to two reasons. It is where the Great Sumatra Fault traversed the land from Aceh to Tanggamus Lampung, and this is the land where archaeological findings related to disaster mitigation were found more than any other land in Indonesia.

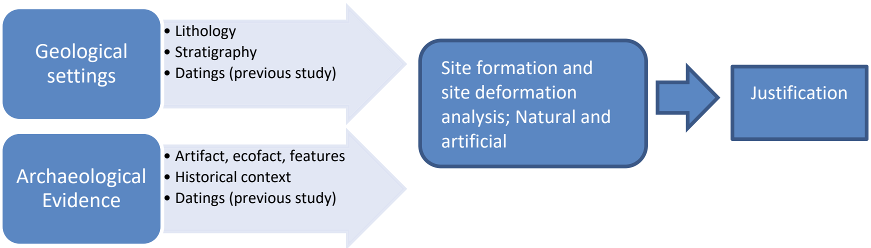
The first recorded Sumatra earthquake and tsunami of 8.8 magnitude were taken from the Dutch era from the notes from Visser in 1992, Wichman (unknown year), and Newcomb and McCann in 1861 and 1987 stroke west Sumatra, and in range disasters in 1907, 1936, 1964, 1967, 1976, and 1983 stroke the northern part of Sumatra in Simeulue, Banda Aceh, Lhokseumawe, and Kuta Cane (Supartoyo and Putranto 2014).

Aceh's tsunami in 2004 has triggered several papers published. The topics are varied from reanalyzing Aceh's tsunami (Tejakkusuma 2005), remapping the risks and its mitigation (Latief 2012), the method of mitigation (Muhari et al. 2010), to the health risks in disaster situations (Widayatun and Fatoni 2013). Other topics also include discourse about preparedness, efficacy, and disaster literacy (Suhardin 2021).

Local wisdom is another emerging topic seriously carried out from the anthropological side. This discourse strongly investigates the mitigation based on local wisdom, folklores, values, customs, proverbs, architecture, and land settings preserved in the communities such as seen in West Sumatra (Rozy 2017). Another comprehensive paper is to urge the combination of the interdisciplinary study of geoarchaeology and geomythology for tracing back the past disastrous event in Indonesia which has 500–1000 years of periodic events (Yulianto 2020). In this case, the artifacts could be hard to find due to another changing year and environment. Geology could help them by tracing in more spanning time as well as mythology could complement them through their passing codes and beliefs within generations (Yulianto 2020).

22.2 Research Question, Methods, and Objectives of the Study

The research question revealed in this chapter is how far the people of Sumatra had implemented their knowledge and wisdom on disaster mitigation, what are they, what is the challenge, and how to preserve them for a better future. This study presents geoarchaeological data in the mainland of Sumatra which resembles past mitigations enriched with the discussion, drawbacks, and strategies of how to preserve them based on geoarchaeological research and Pierre Bourdieu's cultural capital insight. The geoarchaeological method used in this chapter is focusing on the layer of the tsunami's sediments in the north of Sumatera (4.1), archaeological survey and geological observations of land organization in the wetland of the middle Sumatra (4.2), and the observations of moated sites, the presence of column base, and the presence of volcanic sediments in the south Sumatra (4.3). Each of the method requires a strong historical background of the site formation and site deformation process (see chart). Several data collection such as geological map, stratigraphic references, and its comparison is urged to seek to define and justify the presumed past disastrous event.



This chapter is also enriched with the previous study and updates the recent progress related to the subjects of disaster mitigation and its challenges. Interviews are only given to a few people mostly the local villagers, farmers, peasants, and the head of the village. The question is about how long they have been there? In what year they experienced the disaster? How to prevent them? And did they know the name and the functions of the artifact or feature around them? This chapter is enclosed with an alternate way of how empowering the past knowledge on mitigation through Pierre Bourdieu's insight through enduring, converting, and institutionalizing which hope could optimize the efforts on preserving the knowledge for the next generations.

The aim and objective study is to obtain the overall view and integrated pattern of the varied activities of disaster mitigation in Sumatra. Though it is not an easy way to pursue the geoarchaeological signs toward disaster mitigation, the efforts on gaining interpretations of its artifacts within their geological environment and their features are worth trying.

22.3 The Geological Settings of Sumatra

Sumatra is the famous island in the Indonesian archipelago and the fifth largest island in the world, with an area of approximately 474.000 km^2. The island runs across the equator for around 1650 km from northwest to southeast and can be 100–400 km broad (Fig. 22.1). Sumatra Island is in Indonesia's western archipelago. The Bay of Bengal borders it to the north, the Malacca Strait to the east, the Sunda Strait to the south, and the Indian Ocean to the west. There are several wetlands in the east of the island, including Asahan (North Sumatra), Siak River (Riau), Kampar, Inderagiri (West Sumatra, Riau), Batang Hari (West Sumatra, Jambi), Musi, Ogan, Lematang, Komering (South Sumatra), Way Sekampung, Way Tulangbawang, Way Seputih, and Way Mesuji (Lampung). Meanwhile, numerous rivers, including Batang Tarusan (West Sumatra) and Ketahun, flow into the west shore of the island of Sumatra (Bengkulu). The Bukit Barisan Mountain range, which spans from northwest to southeast across Sumatra, is in the western section of the island. There are dozens of mountains along the Bukit Barisan, including Geureudong (Aceh), Sinabung (North Sumatra), Marapi and Talang (West Sumatra), Mount Dempo (South Sumatra), Mount Kaba (Bengkulu), and Kerinci (West Sumatra, Jambi). There are various volcanic lakes on the island of Sumatra, including Laut Tawar Lake (Aceh), Toba Lake (North Sumatra), Singkarak Lake, Maninjau Lake, Atas Lake, Bawah Lake, Talang Lake (West Sumatra), Kerinci Lake (Jambi), and Lake Ranau (Lampung and South Sumatra). These mountains are often Quaternary or Recent volcanoes that rise 2000 m above sea level (Barber and Crow 2003; Barber et al. 2005; Zulkarnain 2016). The mountain range in Bukit Barisan is a landscape formed by the Great Sumatran Fault (GSF) (Natawidjaya and Triyoso 2007) (Fig. 22.1).

Sumatra is one of the disaster-prone areas in Indonesia. Based on historical records, Sumatra had experienced a destructive earthquakes several times. From 1822 to 2010, there have been at least 18 times of powerful and destructive earthquakes in Sumatra and some of which caused the tsunami. The long history of destructive earthquakes in Sumatra includes the earthquake in Padang was happened in the year 1822, 1835, 1981, 1991, 2005, and 2009. Earthquake in Singkarak in 1943, Pasaman in 1977, West Lampung in 1908, 1933, 1994, Agam in 2003, Tanah Datar in 2007, Mentawai in 1861, 2010, Aceh in 2004, Bengkulu in 2007, and Sori-Sori in 1904 (Hurukawa et al. 2014; Reid 2015).

On December 26, 2004, the big Aceh-Andaman earthquake and its horrific effects placed the Sumatran area and its active tectonics into the spotlight. The earthquake struck on December 26, 2004, with a magnitude of 9.1. Tectonic plate movement at a depth of 53 km. The earthquake also caused a tsunami, which resulted in further deaths and devastation. Sumatra's plate tectonic setting has likely been the same for tens of millions of years, and catastrophic geologic events have likely occurred often.

The immaturity of our understanding of large earthquakes and other forms of natural hazards contributed to the 2004 earthquake's surprising location. However, time is perhaps best understood in terms of the inevitability of the rare occurrences that define the trajectory of geologic evolution (McCaffrey 2008).

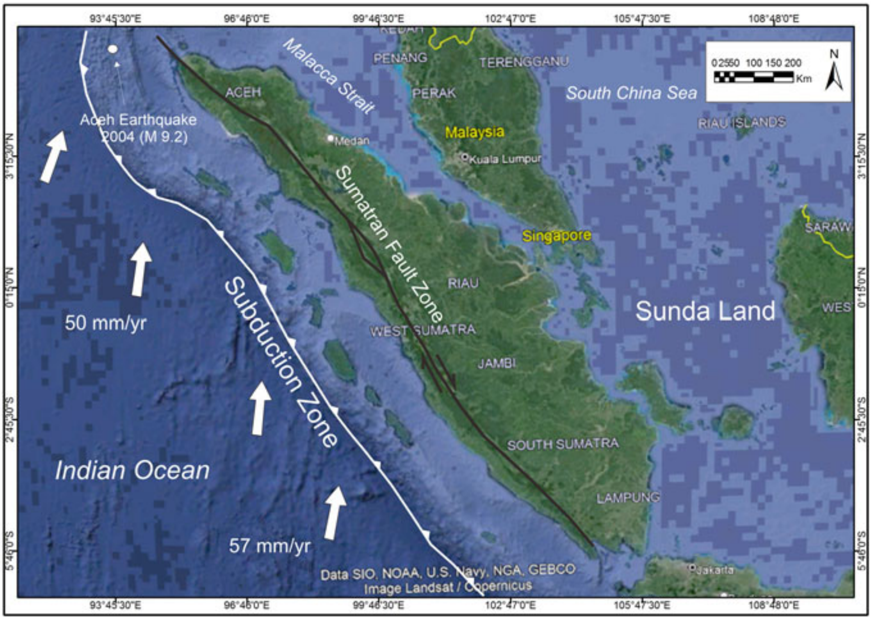


Fig. 22.1 Tectonic Settings of Sumatra (Redrawn by Ananta Purwoarminta)

22.4 The Archaeological Mitigation Evidence in the Mainland Sumatra

As previously mentioned, geoarchaeological mitigation research in mainland Sumatra is about to begin. Many interesting sites are unrevealed yet and few local narrations are still dispersed and not being passed rigorously through generations, highlighting the difficulties of gaining the major pattern of social mitigation vigorously. However, there are some clues of mitigation practice in Sumatra that we could sought as the starting point to analyze the common patterns they have shown. Research and data collection from three main clusters in north Sumatra (Aceh), middle (Palembang), and south (Lampung) have found some indications of the past disaster mitigations which related to respond the geohazard including tsunami, earthquakes, floods, and volcanic eruptions. Table 22.1 shows the list of the archaeological evidence of mitigations found (Fig. 22.2). The details of the varied form of mitigation are described in Sects. 4.1, 4.2, and 4.3.

Table 22.1 Archaeological sites and the mitigation

Region	Threats	Sites	Mitigation form
Aceh (Northern sumatra)	Tsunami	Mabitce cave	Settlement cave
		Ek Leunthie cave	Settlement cave
Palembang (Middle sumatra)	Wetland	Talang Tuo inscription	Food security for wetland
		Banyu Biru	Wetland settlement
	Flood (Musi river)	Taman Purbakala Kerajaan Sriwijaya	Kingdom Sriwijaya Trenches
	Earthquake	Baghi Pagaralam	Stilt house
Lampung (Southern sumatra)	Earthquake	Hujung Kampung Tuha	Column base/stilt house
		Negeri Ratu	Column base/stilt house
		Kehidupan	Column base/stilt house
		Batu Raja	Column base/stilt house
	Flood	Keramat Gemol	Moated sites/Earthworks
		Bakung Udik	Moated sites/Earthworks
		Keramat Bandar	Moated sites/Earthworks
		Tanjung Langit	Moated sites/Earthworks
		Keramat Teluk	Moated sites/Earthworks
		Talang Keramat	Moated sites/Earthworks
		Benteng Sabut	Moated sites/Earthworks
		Gedig	Moated sites/Earthworks
		Periki	Moated sites/Earthworks
		Meris	Moated sites/Earthworks
		Cicilik	Moated sites/Earthworks
		Hantatai	Leaving and back-and-forth

(continued)

Table 22.1 (continued)

Region	Threats	Sites	Mitigation form
		Tanjung Jati	Leaving and back-and-forth
		Bandar Negeri Suoh	Leaving and back-and-forth
		Mulang Maya	Leaving and back-and-forth
		Olok Kulayan	Leaving and back-and-forth
		Umbul Cukhup	Leaving and back-and-forth
		Umbul Tupa	Leaving and back-and-forth
		Gunung Doh	Leaving and back-and-forth
	Eruption (Mount Krakatau); Tuff layers	Pekon Tuha Majasaka	Leaving and back-and-forth
		Benteng Belanjung	Leaving and back-and-forth
		Kampung Kahai	Leaving and back-and-forth

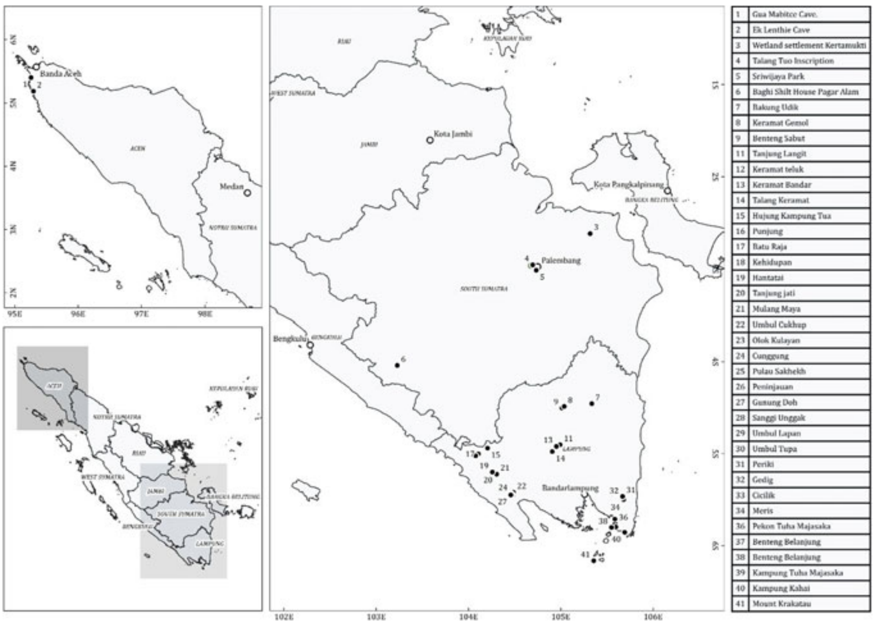


Fig. 22.2 Dispersal map of the archaeological sites on mitigation (mapped by Taufiqurrahman Setiawan 2022)

22.4.1 Northern Sumatra

Aceh in the northern Sumatra is the first focus regarding with the threat of tsunami hazard. Tsunami was the first threat that might cause the inhabitant of Mabitce and Ek Leuntie Cave in Aceh Besar Regency, abandoned. The Mabitce Cave has an L-shaped inner passage with a room height of 17.4 m and a passage width between 10 and 11.5 m. (Setiawan et al. 2020). The excavation of Mabitce Cave opened five excavation boxes that found archaeological evidence from the upper to lower layers. This cave has not yet been dating, but this area is thought which has a relation with the influence of the Hoabinhian culture from 12.000 to 5000 BP. In the excavation of Mabitce, it was found that the sediment cave reached 180 cm and there were at least ten stratigraphic layers. In addition to the findings of archaeological data, one of the interesting data found was the existence of a stratigraphic layer which was thought to be a tsunami stratigraphic layer. This assumption is also influenced by information related to the impact of the December 26, 2004, which is Aceh tsunami in the Leupung area which was quite large. The results of Paris et al.'s research (2009) stated that it had resulted in the retreat of the coastline in the Leupung area ranging from 60 to 150 m with a wave height of 10–20 m (Paris et al. 2009).

The existence of the cave on the lower slope of a cliff with a slope of almost 900 makes this location a natural barrier that becomes the end zone of tsunami waves. This condition then allows sediments carried by tsunami waves to be deposited in the crevices in the cliff, including Mabitce Cave. The tsunami layer at Mabitce Cave is dominated by the deposition of clam shells and sediments transported by water. The shells were identified as *Brottia sp.,* which has a strong riverine habitat. This raises questions about the past environment in front of Mabitce Cave. Was there a strong river flow in front of the cave in the past? This still requires further proof by doing some excavation /drilling in the environment in front of Mabitce Cave (Fig. 22.3). However, if linked to the retreat of the coastline due to the influence of the tsunami and post-tsunami environmental changes, this is very likely.

In addition to the tsunami that occurred in 2004, the west coast of Aceh has experienced the disaster in the last 7400 years ago. This was revealed by Rubin et al. (2017) in *"The highly variable recurrence of the tsunami in the 7400 years before the 2004 Indian Ocean tsunami"* which is the result of research at Ek Leuntie Cave in Lhoong, Aceh Besar. Research results at the site show that there have been 11 ancient tsunamis since 7400–2900 BP with an average interval of 450 years. For the period after 2000 BP, there have been several tsunamis as well, but they cannot be identified because the layers have been disturbed (*unconformity*).

The effects of tsunamis not only eliminate the objects they hit but can also change their geomorphology. Such changes are because when a tsunami occurs, a considerable amount of sediment can be transported. Large tsunamis are major geomorphic crises, as they imply extensive erosion, sediment transport, and deposition within minutes and over hundreds of kilometers of coast. The geomorphological impact of tsunamis is evidenced by coastal erosion (some beaches almost disappear), the destruction of sand barriers protecting lagoons or at river mouths, numerous cliff

Fig. 22.3 Mabitce cave and its tsunami deposition site. (*Source* North Sumatra Archaeological Centre 2019; Illustration by Taufiqurrahman Setiawan 2022)

erosions, erosion of riverbank beds, and large impact traces on slopes. The tsunami erosion footprint resulted in the retreat of the coastline by hundreds of meters (Paris et al 2009, 61).

The tsunami chronology found in the research at Ek Leuntie Cave (Fig. 22.4) has illustrated the existence of an occupancy-hiatus-occupancy phase and so on, especially at residential sites around the west coast of Aceh. Tsunamis can eliminate objects, including people, and can break the cultural cycle that exists at that location. As the cycle is broken, the existing culture at the affected site can be transformed into a new culture by the influx of new inhabitants in the area. How do they saved themselves is still unknown as well as how do they prevent themselves from the upcoming tsunami. The archaeological mitigation records of these caves are still unresolved completely.

In connection with the Aceh earthquake and tsunami that occurred in 2004, it was found that there were very few casualties in the Simeuleu Island region, which was closer to the epicenter. It is quite interesting how disaster mitigation is found in this Simeuleu community. The local wisdom of the people of Simeulue Island in reading the natural phenomenon of the coast has saved thousands of people. Early warning through *semong* "shouting" warning (low tide and must run to the hills), which is obtained from generation to generation, is learned from the disaster events several decades ago. Semong for the people of Simeulue Island has always been socialized as a legendary story by local community leaders so that this term becomes attached and cultured in the hearts of every resident. This term saved almost all of them even though they were geographically located very close to the epicenter of the earthquake that triggered the tsunami. This diverse local knowledge, with its traditional terms and methods, should be seen as a potential in disaster mitigation planning based

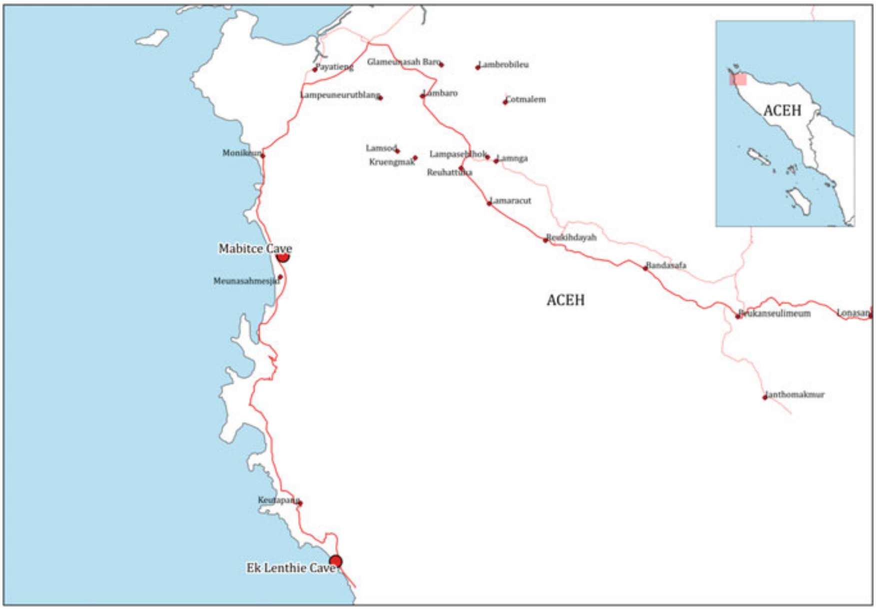


Fig. 22.4 Location of Mabitce Cave and Ek Leunthie Cave. (*Source* North Sumatra Archaeological Centre 2019; Mapped by Taufiqurrahman Setiawan 2022)

on local wisdom. Would these *semong* was the knowledge they have got from their previous experience in the last 7400 years ago?

22.4.2 Middle Sumatra

The topography of middle Sumatra (now becoming South Sumatra Province) has many variations ranging from highlands to lowlands. Palembang is the center of province where was the center place of the Srivijaya Kingdom in the seventh century. The plateau in the South Sumatra region is generally located in the western part, which is the Bukit Barisan Mountain range and borders of Bengkulu Province. The more to the east, the topography is increasingly flattened until it ends in the easternmost part, the east coast of South Sumatra which consists of many swamps and beaches, where the vegetation is strongly influenced by sea tides (Rangkuti 2007).

The act of disaster mitigation in the middle Sumatera mostly related to the Srivijaya Kingdom. There are three indications that might could be functioned for mitigating the hazards (Fig. 22.5a–c). First is dealing with the Srivijaya era in the seventh century. The Talang Tuo inscription which mentioned the establishments of Taman Sri Jayanasa for land regulation and food security for the peoples because most

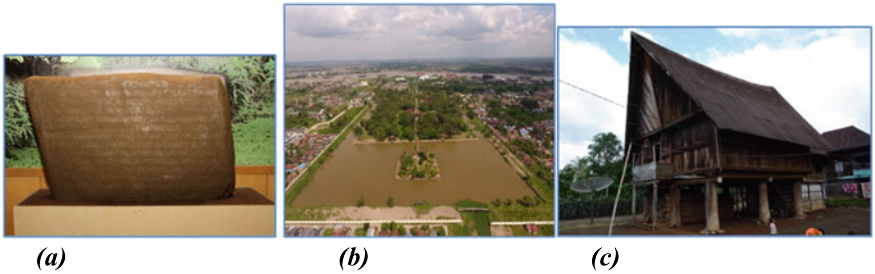


Fig. 22.5 **(a–c)** The Talang Tuo Inscription (**a**), Taman Purbakala Kerajaan Sriwijaya (**b**), and Baghi house (**c**). [*Source* South Sumatra Archaeological Centre 2007 (**a**–**b**); Palembang Archaeological Centre, 2007 (**c**)]

of covered land of Sriwijaya is wetland. Second, the site of Taman Purbakala Kerajaan Sriwijaya (TPKS) or Sriwijaya Kingdom Archaeological Park in Karang Anyar, Palembang City, is known where the king built the trenches to control the Musi River to form the centers' settlements along the Musi watershed. The trench or ditches were created to meet the water needs and flood control around the site (Utomo 2007). Other structural buildings that can still be seen today are the water buildings in the form of ditches and artificial ponds (Reid 2011).

The last evidence is a stilt wooden house called Baghi house. As any other house commonly found in Sumatera, this type of wooden house and building is also widely used by most of the people who inhabit in the middle Sumatera (South Sumatera Province) and widely found on the river banks to overcome the tides and the water raised (Siswanto 2009). In Pagaralam highland, this stilt house called "*bagh*i" can withstand the earthquake (Fitry and Siswanto 2020).

Archaeological research in the east coast area in middle (South Sumatra) and Jambi in 1980 accidentally found pottery fragments and building poles in the rice fields. Apart from the information of residents, archaeological findings around the east coast are also widely known from the peatland fire disaster. This disaster resulted from the opening of peatlands that were previously filled with plants and shrubs. The findings of building poles found around the old rivers are thought to be former house buildings and the port. The pillars of the house are generally made of *nibung,* a local kind of wood that is indeed widely grown in the region. The existence of houses with stilt wooden houses in this area is the same as those in Palembang City to overcome floods caused by a tidal river (Fig. 22.6a–b).

22.4.3 Southern Sumatra

The mitigation in southern Sumatra (Lampung region) has been discussed in 2019, 2020, and 2021 (Rusyanti et al. 2021a, b, 2020b). The geoarchaeological evidence in Lampung has shown four patterns of mitigation act: (1) the column base in the

(a) *(b)*

Fig. 22.6 **a–b** Nibung woods as the traces of ancient settlements (**a**) and potsherds fragment from the west coast archaeological sites (**b**). [Palembang Archaeological Centre, 2007]

highland to prevent the earthquakes, (2) the movements sites in Suoh and Tanggamus to prevent the eruptions and floods, (3) the moated sites in the lowlands to prevent the floods, and (4) the movement of ancient settlement near Mount Krakatau in Kalianda (Fig. 22.7).

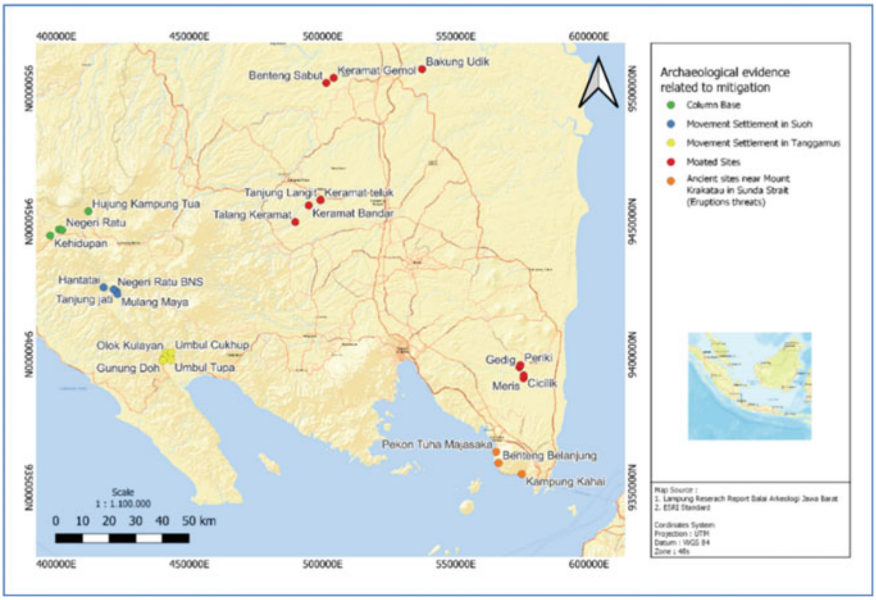


Fig. 22.7 Archaeological evidence related to mitigation in Lampung. (*Source* West Java Archaeological Centre 2020; mapped by Azhar Rachman 2022)

The Column Base in the Highland

The column base is finally attached to the previously unknown stones scattered in the Way Rubok archaeological sites. The scattered stone was formerly noticed in 2011 explorations continued until 2012, 2013, 2014, and 2018 (Rusyanti et al. 2018). There are five sites with column bases found: Negeri Ratu, Punjung, Batu Raja, Kehidupan, and Hujung Kampung Tuha. The length is 24–40 cm and the width is 15–25. The holes are 7–11depth and 5–10 diameters. The stone was made from tuff and andesites, blocks shapes with and without holes, and bulged. The textures are porous and lightweight with yellow and white colors.

It takes two years to finally examine them as a thoughtful act of mitigation that might have been used by the people of highland Liwa in the past. This thought was revealed after comparing the column base of Liwa with the column base from the village of Hujung and Kenali in West Lampung which has the same basic forms. The dating of column base is contextual and correlates with the ceramics from the fourteenth to the twentieth century. The sites were geologically controlled by the fault, supporting the assumptions that the column base might be part of their traditional house made with the *kalindang* techniques where the constructions of woods are tied knot each other just like Austronesian houses. This construction is believed to strengthen the house from ground shaking (Rusyanti 2021). The modest construction of reusing the stones are found easily in Liwa's archaeological sites until 2018. The stones are thought increased due to agricultural extensification (Fig. 22.8).

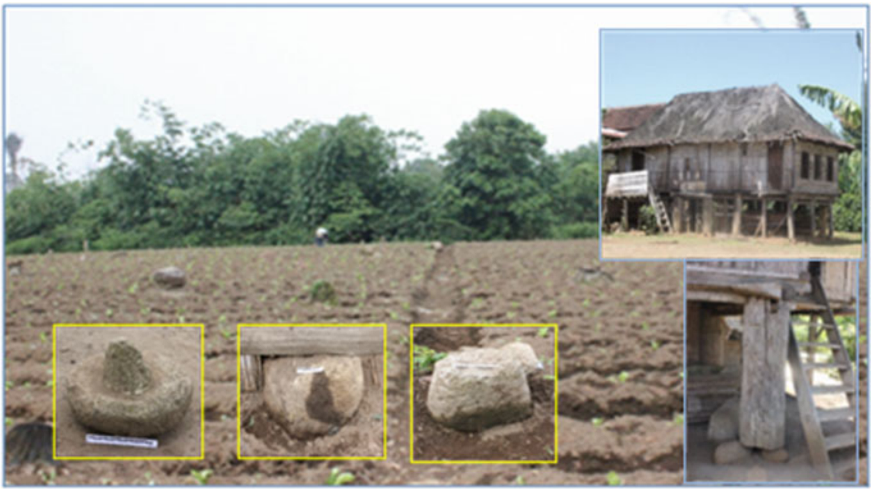


Fig. 22.8 Column base in Negeri Ratu sites and Hujung Kampung Tuha stilts' house (Rusyanti et al. 2014)

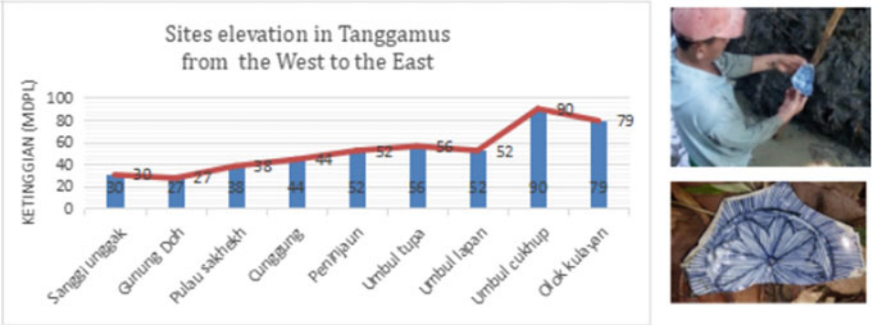


Fig. 22.9 Settlement movement's in Tanggamus and Qing Ceramics Guandong ware (19–20th CE from Pulau Sakhekh (Rusyanti et al. 2021a updated graph)

The Movements' Settlements in Suoh and Tanggamus

The indications of ancient movements as the act of mitigation were seen in two regions: Suoh and Tanggamus both near the mainstream of the Way Semangka watershed. Suoh's exploration in 2018 found ceramics of the nineteenth century in the Negeri Ratu which now have been abandoned and become rice fields. The migration of the people according to the local archives was caused by the 1933 earthquake and eruptions and floods which made them dispersed from Suoh to the South in Tanggamus and surroundings. The 1933 earthquake has been written by Berlage and Stehn (1934) devastated the villages. In Tanggamus, the movements were seen through the patterns of elevations of the toponyms which believed as the new place estranged from the river from the west to the east (hill) and sometimes they were back-and-forth. The left evidence was ancient ceramics fragments kept in the *peratin* house (village headman) (Rusyanti et al. 2018, 2021a) (Fig. 22.9).

The Moated Sites in the Lowland

Moated refers to the earthwork encircling the sites. The presence of moated sites alongside the river of Lampung has been recorded since 1994–2018 explorations. The length, width, and depth are varied from 1 to 800 m, 2 to 20 m, and 1 to 4 m. Some of them are dried and some become swamp and watery sometimes based on the seasonal changes. It was not an easy way to examine the function of these moats since deeper research has not yet been taken seriously until now.

Twenty-five moated sites have been identified from the previous reports in the lowland of Lampung: 15 in the river of Way Seputih and Sekampung and 10 sites in the river of Way Mesuji and Tulangbawang. The moated sites correlate with the ceramics from the tenth to the twentieth century, Islamic tombs, and scratch stones from the megalith's tradition. Desk studies from several papers and reports have found that the elevation of the moats is equal to the river levels to 5 m below. The

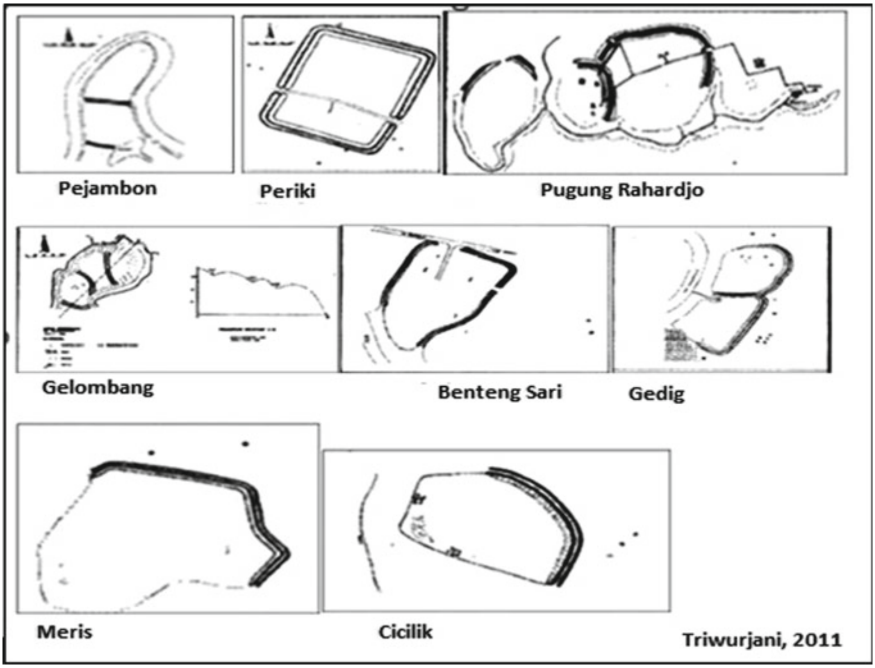


Fig. 22.10 The 8th moated trace in Way Sekampung [taken by, and used with permission from, Triwurjani]

moats have varied in shape length, depth, and width from 0.5 to 1 km left. Only eight (8) moat sketches left from 2002 and not being research anymore (Fig. 22.10). Many of the moated features have been no more and dwindled mostly caused by the changing of land function and probably flooding, since 80% lowland is considered as a floodplain. Therefore, the moats are thought to have been built as the fortresses (Rusyanti et al. 2020a, 2021b). In Benteng Sabut, the moat is also being functioned as fishery or ponds or *lebak lebung* (Saptono 2010).

The Movement of Ancient Sites Near Mount Krakatau

Mount Krakatau in the Sunda Strait is the most memorable of the deadliest eruption in 1883. According to R. D. M Verbeek, 36.000 people reportedly become the victims. Tom Simkin and Richard S. Fiske in their publication in 1983 "Krakatau Eruption 1883: the Volcanic Eruption and Its Effects" mention that the eruptions have caused the changing climate in Europe, Japan, and the USA (Tantri 2014). Banten and the southern part of Lampung were the worst damaged, but folklores and local narratives are only a few reported this, rather than the foreign reports. Iim Imadudin and Heru Erwantoro tried to discuss the other side of the story based on the local perception who perceived them as the punishment colonialism from God and triggers religious beliefs and spirits. *Haul Kalembak* was belief as the ritual to commemorate the eruptions (mnemonic device), but since 2006, the rites were no longer acted on anymore even though they can be a reminder as well as disaster mitigation efforts (Imadudin and Erwantoro 2020).

Archaeological research concerning these eruptions and tsunamis of the Krakatau is still silent. Although there are found some indications of the settlement movements, the ancient settlement of Kampung Tuha Maja Saka, Benteng Belajung, and Kahai in the southern part of Lampung is believed to move by certain causes unknown but not by the eruptions and the tsunami which reached 15 m while these settlements is in 30 m height (Saptono 2020). Although still debatable, these three ancient settlements and the cause of moving are still open to discuss further since the excavation shows the presence of tuff layers (5–10 cm) in the middle of the artifact depositions which could be the evidence that the pyroclastic material still *reached* them anyway in a certain time. The artifact depositions (potsherds and ceramics) mentioned were above and below the tuff layer. This means that the places were actively and repeatedly inhabited and repeatedly faced the hazards. Sutikno Bronto mentioned that the eruptions of this volcano (Krakatau and Anak Krakatau) did not happen at once. It happened repeatedly in 416, 1883, 1927, 1963, 1992–1996 (Bronto 2000). Due to this repetitious, these settlements might back and forth as well as seen in Suoh and Tanggamus. The movements of back-and-forth could be the act of rescuing themselves as well as the act of mitigation to prevent other threats from coming.

22.5 Insight and Strategies of Geoarchaeological Mitigation Evidence in Sumatra

Mitigation, as we perceived it as any effort to prevent the loss caused by a disastrous event, in the archaeological context, it should be viewed in intertwined ways both the action *before* the event and the action *caused* by the events which then lead them to take some action. In Sumatra, the movement of back-and-forth is likely the most modest way to mitigate the hazards before they learned to make a better construction or building to prevent them, and that evidence is still very little that we have known about and should be further examined. Therefore, there is still a wide challenge waiting to be further explored with suitable strategies.

22.5.1 Geoarchaeological Insight and Strategies

The movement and the back-and-forth caused by the earthquake and/or tsunami or anything should be supported by information obtained from the community interviews and excavations. Many valuable objects, such as jewelry, gold objects, Chinese ceramics, pottery, weaving tools, weapons, glass bottles, etc., are found in the locations. If the community at that time deliberately left the location to move to another location, these valuable objects would be taken with them. Therefore, the deposition of these objects at the site (in situ) is matters. It could define the result of a sudden or instantaneous event or not. The results of the excavation of the stratigraphic layers and the soil conditions such as peat soil mixed with black sand and coral fragments and/or tuff and its archaeological findings also should be taking account its contextuality as well as how to dispose the artifact within its geological settings which sometimes juxtaposed and intertwined.

The trickiest research also happened when dealing with the examination of the moated function, where most of them has vanished and the supported artifacts has gone due to floods or land cultivation. One of the important acts on mitigation that should be preserved is the evidence of the column base that relates to a wooden house construction. The construction of buildings that are bound together between one building and another and have flexible wooden construction provides strength to be able to withstand earthquake shocks. But, this evidence also begins vanished due to the exchange taste of modern houses and the expensive of wood as the main construction.

The contribution of geosciences to archaeological research could assist in reconstructing palaeoenvironments where the sites found. The choice of sites' location cannot be separated from environmental conditions. The natural resources to survive could be the base for choosing a place to stay. Nevertheless, natural disasters could threat to most in Indonesia such as landslides, earthquakes, tsunami, volcanic eruptions, and floods. In the past, migration or population movement due to natural disasters is very likely occur. The migration process could evidence by archaeological data and historical records or inscriptions including in Sumatra. These archaeological data are in coastal caves where was hit by tsunami event. Then, archaeological sites in the Sumatra active fault area of Lampung is often experiencing earthquakes. The lowlands of central Sumatra are frequently flooded. In the future, geoarchaeological research in Sumatra must be able to reveal the reasons how to choose the sites location, what natural resources are available in there, and what is the natural factors trigger the past lives become extinct or migrate. In addition, the future of geoarchaeological research is expected to answer the cause of past migration and the glory life based on geosciences approach.

22.5.2 Bourdieu's Insight on Cultural Capital

Local wisdom is another emerging topic seriously carried out from the anthropological side and now becomes an interesting topics together with geoarchaeology and geomythology for tracing back the past disastrous event in Indonesia such as the traditional beliefs of the *Smong* (Aceh) and *Teteu* (Mentawai) (Yulianto 2020). But again, the effort on disseminating the oral history is not an easy way as well as the challenge on preserving the wooden house which is not well and thoroughly implemented nowadays. When the oral history and knowledge of past mitigation are not well passing through generations, the threats on natural disaster will still be a great housework. One of the strategies on empowering the importance of preserving the past knowledge on mitigation is through adopting the basic principles of cultural capital from Bourdieu.

Experiences on disaster have shaped the *habitus* of the community in responding the risks, materialized through their artifacts, and passing them through the tell-tale and oral history. We perceived them as the *cultural capital*. Cultural capital was introduced by Bourdieu (1986). Initially, cultural capital was used to explain the relationship of educational qualifications to socio-economic conditions. This capital manifests itself in three forms, namely (a) the form of the embodied state, that is, as an enduring disposition of the individual's mind and body; (b) in objective circumstances, when cultural capital is converted into cultural goods, such as drawings, books, dictionaries, instruments, machines; and (c) in an institutionalized state, when the cultural capital contained is recognized in the form of academic credentials (Fig. 22.11).

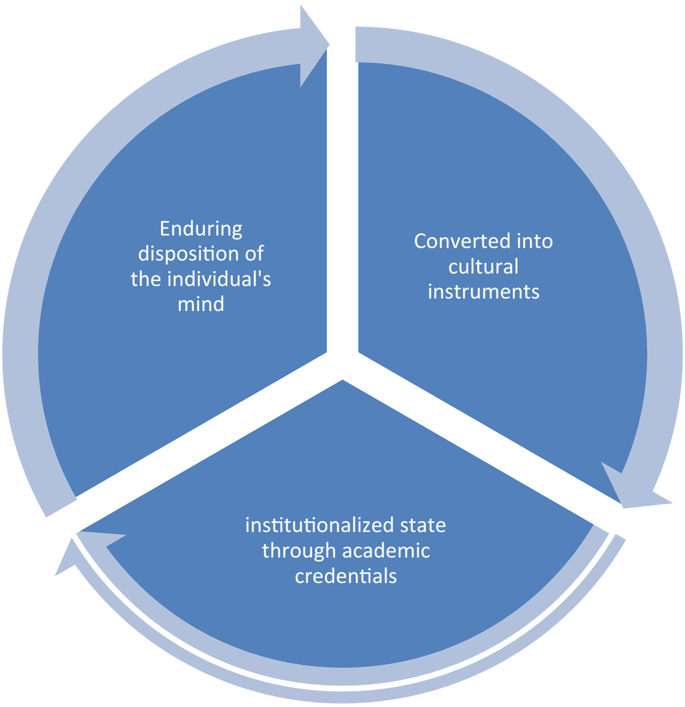


Fig. 22.11 The three basic cultural capital for empowering the act on mitigation [Adapt from Bourdieu, 1986]

In the context of disaster mitigation, cultural capital is explained as knowledge to adapt to the natural environment by applying traditional practices through various experiences (Ameir et al. 2020). Traditional practices are manifested in traditional local knowledge. This knowledge is a network of knowledge, beliefs, and traditions that aims to preserve, communicate, and contextualize indigenous relationships with cultures and landscapes over time. Traditional local knowledge can be oral narratives, cosmological, time calculation modes, symbolic and decorative communication, to special technological techniques (Bruchac 2020).

Archaeological sites on the island of Sumatra show evidence that traditional local knowledge has developed in the region. One form of this knowledge is efforts in disaster risk mitigation. The frequency of earthquakes that shook Sumatra encouraged the use of special technology in the design and construction. One form of such technology is the use of column bases as the foundation of building poles. Column bases are found in the remains of ancient settlements (Rusyanti 2021). The image of the hollow building is also inscribed on the brick relief (ninth–fourteenth centuries AD) found in the Muara Jambi Site complex (Tjoa-Bonatz et al. 2009). The use of stone patches as a foundation gives the advantage of dampening vibrations and the durability of wooden poles from moisture and disturbance of soil insects. Therefore, this foundation technology is very suitable for use in earthquake-prone areas such as on the island of Sumatra (Imani et al. 2021).

Architectural sketches inscribed on bricks in the Muara Jambi Site Complex depict a wooden building, built on poles with elevated floors, and using pole and beam techniques. Descriptions of the building are still commonly found in traditional architecture that is still developing today (Tjoa-Bonatz et al. 2009). People in Sumatra have a variety of architecture rooted in old traditions, such as houses sometimes in West Sumatra. *Rumah Gadang* is an architecture that applies a form of local wisdom related to disaster mitigation. The construction of the building uses to be completed with the principles of ties, pedestals, pegs, linked pedestals, and related joints (Imani et al. 2021). Poles with elevated floors have minimized the risk of flood disasters (Rozy 2017).

Berkes (1993) defines traditional ecological knowledge as a collection of knowledge and beliefs passed down from generation to generation through cultural transmission regarding the relationship of living beings (including humans) with each other and with the environment. This knowledge also means the attributes of a society that has historical continuity in the practice of using resources. This traditional ecological knowledge develops in non-industrial or technologically simple societies and is in the environment of local communities. Glevarac (2022) proposes the expansion of the idea of cultural capital with reference to knowledge or practical competence in situations of need.

Berkes (1993) type of ecological knowledge that can be developed in non-industrial and local society is suited to the Sumatran people who have ecological knowledge passing through just like the use of the wooden house and column bases. This ecological knowledge should be well preserved and searched for more and applied them by using Bourdieu's basic principles of cultural capital; parents *dispositioned* the ecological knowledge and threats, i.e., fault hazards to their children *enduringly*, they teach them *convert the knowledge* into *cultural instruments,* i.e., making a suitable house accordingly, and the government stately *instituted* them through several regulations and obligations as an academic credentials.

Aksa (2020) views that traditional local knowledge must be able to be spread and understood by the wider community. One way is by converting knowledge that is tacit knowledge into explicit knowledge so that it can be scientifically validated. Archaeological sites on the island of Sumatra store a lot of historical information on disasters and their mitigations. The information and knowledge behind the data must be found through the scientific stage. Thus, the information and knowledge that are "hidden" behind archaeological sites can become explicit knowledge. Academically, explicit knowledge gained from the scientific stage will be acceptable to many circles. Finally, traditional local knowledge originally only developed in local communities can be inherited and guided by all other communities.

22.6 Conclusion

The geological conditions of Sumatra, which are in an active tectonic area, result in this area having a level of vulnerability to earthquake and tsunami disasters. In addition, the existence of the Sumatra fault results in a high potential for earthquake disasters. Natural disaster data in Sumatra show a long history of disasters, especially earthquakes. Sumatra has a long history of disasters, earthquakes, tsunamis, and volcanic eruptions. Archaeological evidence has identified the act of mitigation mostly in three ways: moving back-and-forth, building ditch or trenches, and making the stilts of wooden houses. Another piece of evidence should be unearthed along with the oral history and best managed through the three basic principles of cultural capital for their sustainability: deposition, converting, and institutionalizing. This study becomes beneficial for tracking back the geoarchaeological identifications of past mitigations and disaster records in Sumatra and developing them for further research.

Acknowledgement This paper is a synthesis of several studies conducted in the Sumatra region. All authors are key contributors according to their respective research areas and expertise. Thank you to Triwurjani, Nanang Saptono, Endang Widyastuti, Y. Hardikusmana, and Amir for some discussions about Lampung.

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Chapter 23
Assessment of Community-Based Risk (CBR) and Indigenous Knowledge on Climate Change Adaptation: An Overview

Mohammad Afsar Alam and Vipan Kumar

Abstract Using traditional knowledge is crucial for coping with climate change. According to AR5, the IPCC's latest assessment report, researchers studying climate change must consider several perspectives and disciplinary frameworks. The present study has been attempted to bridge the gap between the existing and emerging research on indigenous knowledge in IPCC assessments around the globe. This study is based on secondary data and qualitative analysis. For this study, a case study research methodology is used. The study's overarching goal is to learn how indigenous peoples' expertise in adapting to climate change is disseminated in different parts of the globe. In this chapter, we look at the evidence supporting indigenous knowledge-based adaptation to climate change. In this study, a community risk assessment has been made to assess the increasing threats and indigenous knowledge on climate change adaptation at global level that encompasses two entirely different communities of the world, i.e., Fulani Herder of Western Ghana and Tacana Community of Bolivia. The findings reveal knowledge clusters and adaptability through planning and practice and behavioral measurements in tropical and drylands areas. Fulani and Tacana communities still live primitive ways of life and hence getting information from them is difficult, which I believe is the biggest research gap. For the IPCC AR6 assessment of indigenous knowledge, this work serves as a foundation for future research. Besides, it may prove a milestone for the planners and policymakers for planning such regions of primitive people throughout the globe.

Keywords Climate change · Community risk assessment · Indigenous knowledge · IPCC and Knowledge system

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23.1 Introduction

Everyone knows that poor people are more susceptible to the destructive forces of weather events. This study reviews that how indigenous knowledge perceives the impact of climate change and climate change adaptation on various marginalized communities at global level. In fact, climate change adaptation and persistent poverty interact with one another. Albeit there has been an increasing recognition that poverty is not a fixed condition, but rather it is generated by a complex web of circumstances, such as social, economic, political, environmental, climatic, individual, communal, and historical aspects. There are several direct and indirect paths through which climatic variability and change may increase poverty, especially in less developed nations and areas, yet climate change is seldom seen as a solitary cause of poverty (Alam 2022).

Climate change and unpredictability threaten livestock industry development and might dampen global and Ghanaian demand for livestock and livestock products. Given that one billion of the world's poor rely on the cattle industry for their livelihood, this danger necessitates immediate action. It also substantially contributes to global food security since animal products account for around 13% of the average worldwide calorie intake and 28% of the protein consumed internationally (Falvey 2015). These numbers are anticipated to climb since the demand for animal products is predicted to double by 2050 (Rojas-Downing et al. 2017). Cattle production is an important contributor to rural prosperity in developing countries. Despite this, worries about the effects of climate change on water availability, livestock diseases, biodiversity, and the quality of feed crops and forages are growing (Abdurehman and Ameha 2018). Climate change adaptation planning (CCAP) in Africa and elsewhere needs research that maps the climate-related hazards influencing the cattle business.

Undoubtedly, the beginning of the twenty-first century marked the warmest time on record for the complete instrumental temperature record of the planet, indicating that the climate is changing. The cattle sector, animals, and crucial natural resources including food, fiber from trees, clean water, and the aesthetic value of landscapes are all seriously threatened by climate change.

Researchers who have examined the Sahel and other dry parts of Africa have discovered that several species are dying there due to decades-long patterns showing significant increases in mean annual temperature (Kahsay and Hansen 2016; Amjath-Babu et al. 2016; Gonzalez et al. 2012; Osbahr et al. 2011).

Global environmental, social, and economic problems are all made worse by climate change. Scientists believe that the world's attention has been focused on climate change in recent years because of the unprecedented persistence of anomalously low rainfall (Tarhule and Lamb; Mengistu 2011) and the low economic capacity of the affected countries to address the devastating impacts of climate change (Shahid 2010). The ecological deterioration, animal herd decimation, widespread food shortages, mass migration, and huge loss of human life in Africa are all linked to severe climatic variability such as drought (Tarhule and Lamb 2003).

These effects of climate change are also felt throughout Asia. Around 89% of the world's population was impacted by catastrophes, 57% of the world's total fatalities were caused by disasters, and 44% of the world's economic damage occurred in this area between 1975 and 2006 (Asian Development Bank 2010). There are significant environmental and social problems that the area must overcome to preserve its precious natural resources. Degradation of land and ecosystems in Asia poses a challenge to the continent's ability to provide enough food for its population. Moreover, the air and water quality in this area are worsening, and the region's already severe environmental issues are becoming much worse as a result of the ongoing rise in consumption and the corresponding rise in waste (UNFCCC 2007). Additionally, the area is very vulnerable to natural disasters like the 2004 Indian Ocean Tsunami and the 2007 super storm Sidr in Bangladesh, which set new records for both its area of destruction and the speed of its winds (Shahid 2011).

To put it simply, Bangladesh is one of the world's most climate-vulnerable nations. Bangladesh is at risk from natural disasters including floods, rising sea levels, tropical cyclones, storm surges, etc., due to the country's low elevation, copious rivers, and maritime climate. Repeated disasters threaten both current progress and potential future growth. Agriculture, livestock, and forest resources, human settlement, human health, and biodiversity are among the sectors that are severely susceptible now and may be at grave danger in the future (Seal and Baten 2011). Bangladesh's economic growth is hindered by these vulnerabilities since the country lacks the resources to adjust to the socially, technologically, and fiscally damaging effects of climate change (UNFCCC 2007; Shahid 2010).

This research makes use of community risk assessment to plot where Fulani Herders in North-Western Ghana are most at danger from climate change in the wake of mounting concerns about climate change and development in Africa. This chapter only focused on two case studies: Ghana and Bolivia because these two are from entirely different parts of the world where especially in these two communities the use of technology is still at its infancy stage, and hence, they depend on their indigenous knowledge to cope up with climate change adaptation.

Despite their obvious dependence on the environment, herder communities are often excluded from studies on climate change. One such case study focused on the Kpongu Fulani Herder Community in Wa Municipality has been taken into consideration for this study. The design made use of participatory rural assessment technologies for data collection and analysis. Extended dry seasons and dry spells, decreasing water bodies, the formation of iron pans on topsoil, stunted growth of grass species, thinner grass stalks, and lower grass concentration are all indicators that climate change is already having an effect. These factors have contributed to a lack of pasture and water, longer journeys as herded cattle forage for sustenance in the scorching sun, and other negative outcomes. According to these findings, the local environment has a drying tendency and a de-concentration in vegetation, especially grass species. Herders' understanding of climate change is essential. Communities that depend on cattle herding and other forms of livestock husbandry are urged in the study to pay attention to climate change adaptation planning and policy by making sure their residents have access to enough water and food (Napogbong et al. 2021).

Fulani and Tacana communities still live primitive ways of life and hence getting information from them is difficult, which I believe is the biggest research gap.

Some of the significant objectives of this study includes.

1. Natural resource management and decision making,
2. Regional risk management planning, interventions, and policy recommendations, and.
3. Overall understanding of climatic and environmental change.

23.2 Materials and Methods

In this study, a case study research methodology has been used. Case studies are in-depth analyses of a small number of variables with a few units with the goal of painting the most complete picture of a circumstance, phenomena, or event. In this context, a unit can be an individual, a team, or a neighborhood. Greater comprehension of the interplay between a particular context and the phenomenon under research is gained via a thorough examination of a particular unit (Bryman 2001). This study is based on four datasets gathered using different methods:

(a) Quasi-organized home interviews (datasets 1 and 3),
(b) Meteorological information (dataset 2), and
(c) The voice recorded methodology (dataset 4; Wang and Burris 1997).

Cattle herding in the Kpongu community of western Ghana and the Tacana community of Bolivia was selected as case study because this research design allowed for an in-depth investigation of the phenomena of adaptations to climate change and the contextual factors that were relevant to it.

23.3 Indigenous Knowledge and Community Threat Assessment (CTA) Activities

23.3.1 Community of Fulani Herders in Western Ghana

As opposed to the advanced scientific understanding of the natural world that is commonly referred to as "modern" knowledge, "indigenous knowledge" refers to the systems of knowledge developed by communities with extensive histories of interaction with their natural environs. Decisions regarding essential aspects of everyday life may be made more effectively in rural communities when they draw on indigenous knowledge (Ajibade 2003). Its significance extends well beyond the context of the society in which it emerges; for example, it may be used by researchers to improve circumstances in rural regions. This view places local communities at the center of the discussion around climate change adaptation planning, placing them in charge of making decisions and carrying out actions related to managing the risks posed by climate change. Relying on indigenous knowledge has several advantages, including the ability to provide site-specific and contextual evidence of adaptation to climate change and the development of actionable, cost-effective, participative, and long-lasting plans for coping with the consequences of climate change. It stands in stark contrast to global data on climate change supplied by GCMs, ANFIS, ANN, FG, SS, and LGP methods (Makondo and Thomas 2018). Integration of indigenous knowledge systems with context-specificity into other scientific evidence bases of knowledge has been proposed as a means to more effectively and sustainably execute adaptation to climate change. The CBR assessment framework has shown to be a useful participatory strategy when it comes to including locals and making use of indigenous knowledge in adaptation and climate change mitigation planning. Hazards, vulnerabilities, capabilities, and individual risk perceptions are all evaluated within this framework. Numerous CBR studies corroborate this, demonstrating how the method engages communities in mitigating climate risk (African Development Bank 2010; Bruce et al.2006; Chambers 1994). Bottom-up risk assessment is useful in these circumstances because it allows local knowledge and experience to be taken into account. These are organized and directed by people in the community with the express goal of recognizing and fostering the local capabilities at play there. Climate change risk assessments are often the first step in the process, followed by the identification of specific concerns and threats to economic activity caused by climate change (Warrick 2011). The CBR assessment framework is in line with the study's qualitative approach to methodology when contrasted to GCMs, which employ quantitative data produced by computers to interpret the climate and anticipate climate change on a global or regional scale. Taking this tack allows for more complex evaluations of how geographical, socioeconomic, and climatic factors interact within specific regions. When compared to methods like the Holistic Risk-Based Environmental Decision-Making model, CBR seems to place a stronger focus on and commitment to the local community (Arquette et al. 2002). The methodologies used in this framework enabled extensive use and analysis of herders' first-hand knowledge of the region's chronic climate change, the threats this provides to cattle herding and other livelihoods activities, and the adaption tactics used by the Kpongu Community.

From establishing the framework for climate change adaptation to identifying risks and developing a strategy for implementing mitigation measures, Fig. 23.1 illustrates the steps required to carry out a community-based risk assessment approach.

Since risk assessment can be applied to a wide range of climate-related outcomes, including those with high and low likelihood of occurrence, it may be a useful tool for adapting to the negative impacts of climate change (Bruce et al. 2006). Once one stage is completed, the following one becomes logically possible, or the process may be concluded if the threat of climate change is removed. This is an iterative procedure; when new data become available, previous steps may be reassessed.

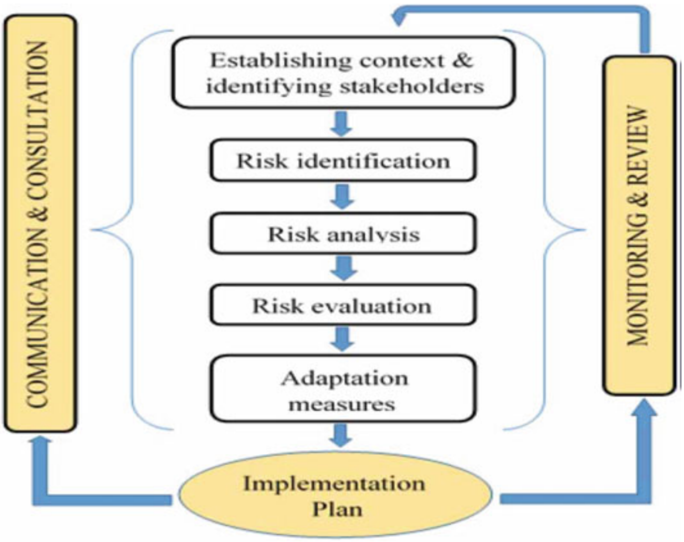

Fig. 23.1 Community threat assessment activities. *Source* This text has been modified from Bruce et al. (2011), p. 26, and Napogbong et al. (2021) Indigenous knowledge and community-based risk assessment of climate change within the Fulani Herder Community of Kpongu, North-Western Ghana

23.3.2 The Study Area

The community of Kpongu is located in the southwestern part of Wa Municipality. There are five different Zonal Councils in the city, and one of them is called Kpongu. Kpongu may be found around 7 km south of Wa, the city's central business district. Wa is one of the eleven district/municipal assemblies that make up Ghana's Upper West Region. Despite making up a negligible portion of the municipality's overall land area (234.74 km^2), Kpongu has created useful relationships with neighboring settlements.

Kpongu may be found around 7 km south of Wa, the city's central business district. Its latitude and longitude are 2° 35′ minutes north of and 10° 0′ minute west of the equator, respectively. Long-term climate data from 2006 to 2017 show that the area gets its annual rainfall of 1000 to 1400 mm in a unimodal distribution, mostly between the months of May and October. Rainfall and temperature trends from 2006 to 2017, as recorded by the Wa Meteorological Agency, show, for instance, a general tendency toward a continuous increase in heat and a decrease in the number of wet days.

Thus, people who were willing to talk about their long-term interactions with climate change could be found and recruited. Fulani herders are locals descended from a nomadic population with extensive experience in the pastoral industry. The Fulani are one-third of the population and the largest nomadic people group in the world. The Fulani are a large Sahelian people group that has dispersed over the

West African region, particularly in Nigeria and Guinea. Although the exact number of Fulani people in Ghana is unknown, it was previously claimed that there were more than 14,000 of them (Bukari and Schareika 2015). Unliterate and sometimes reclusive, the Fulanis of Kpongu live on the outskirts of the neighborhood. However, their lack of a formal education does not diminish their resourcefulness or ignorance of their native knowledge and pastoralist experiences. Their comments reveal a comprehensive awareness of pastoralism and the riches of nature around, combining indigenous knowledge and mainstream thinking. Their primary source of income is raising animals, especially cattle. They were formerly nomadic people who were constantly on the road with their family and animals. They now live according to the whims of the weather and are getting more sedentary. They live off the profits from their stockbreeding activities, which include the raising of cattle for the livestock markets and the collection of milk from cows to be sold, bartered, or exchanged. They do both animal breeding and food crop planting during the rainy season so that they may meet the needs of their family while remaining sedentary.

23.3.3 Data Analysis

The data were analyzed using the framework method to theme analysis. Risk perception, preparedness, readiness, and the results of hazard and vulnerability analyses are the four interconnected components of the analytical framework used for this study, which is called CBR. With this approach, people are at the heart of all decisions and actions taken to mitigate climate change risks. Considering this, the analytical process kicked off simultaneously with the development of data-gathering techniques, and the questions were then arranged in accordance with the framework's four dimensions. In order to accurately transcribe the responses and narratives, it was necessary to read each one many times and make mental notes of any similarities or differences that were significant to the research question. The primary themes that emerged from the comments were also noted in the margins of each page. The concepts were then given a second look after this first research and organized into thematic networks. The next step was producing qualitative analysis by meticulously scrutinizing what participants had to say about these themes and what it meant in light of the study question and constructing the data segments that represented each subject from digital copies of the transcripts.

23.3.4 Results

The findings indicate a substantial correlation between the Fulani herder community's indigenous knowledge of climate change and their long-term, generational experiences with its effects. Five primary climate change indicators are at the center of their stories and expertise. A few of these changes are mentioned below:

(1) The dry season and dry spells are becoming longer,
(2) Dry spells are getting longer,
(3) Water bodies are getting smaller,
(4) Iron pans are forming on topsoil, and
(5) Grass species are not growing or dispersing as they may be.

Extinction of Wetter Periods and Lengthening of Dry Seasons

The Fulani ranchers of Kpongu have noted longer dry seasons and dry spells, and they believe this is due to a change in the environment. Since the dry season is detrimental to pastoral activities, herders are curious about its beginning, what happens throughout it, and when it ends.

The herders agreed that the dry season, which typically lasted from November to March, had shrunk to two months during the last three decades. There will now be a seven-month time span, beginning in October and running through April. The herders know it is the dry season when the winds from the east are strong, the leaves fall off the trees, it is cooler in the mornings, the grasses dry up (making it easier for bushfires to start), and there is less water available for the animals.

Shrinking Sizes of Water Bodies

Many herders, especially the elderly, have noticed that the amount of their water bodies has been decreasing over time. This gives the ranchers another experience and a means of identifying and measuring climate change. According to the herdsmen's stories, the water bodies are often entirely dried up during the dry season in addition to losing a substantial quantity of water when it is dry.

Development of Iron Pans on the Topsoil

Some ranchers have seen an increase in the usage of iron pans as a result of the changing environment. The topsoil becomes hard and resembles an iron pan because of a kind of clay that is rich in iron but very lacking in humus. Grass growth, which ranchers rely on to feed their cows, is impeded by the harsh soil conditions. The increased prevalence of these iron pans on ground that was formerly covered in humus is a symptom of climate change, according to the herders.

Undersized Growth, Lower Stalk Diameters, and Fewer Grasses

A new piece of information has been added to the Fulani herders' growing body of data on the effects of climate change on their way of life. They argue that the length or height of the grasses also has a role in feed availability for cattle, in addition to the cyclical nature of feed availability (rainy and dry seasons) and the amount of rain. As for how they have witnessed the consequences of climate change and climatic variability, they have noted that watching the growth of different kinds of grass has been one way.

Across many conversations with them, ranchers echoed a common sentiment: the grasses on which their herds depended had grown less. On the other hand, some farmers worry that their livestock are not growing as well since they do not have to exert themselves to reach the tall grasses and weeds. A herdsman mentioned the shortness of the grasses in a focus group discussion.

Three broad indicators and patterns of climatic change and fluctuation that are closely tied to the Fulani people's manner of life and style of life were divulged via their traditional knowledge. Soil, vegetation, temperature, precipitation, and other environmental factors all have a role in shaping the symptoms and sensations that people have (Fig. 23.2).

Firstly, there are signals based on precipitation and temperature, such as the observation of longer dry seasons, longer dry spells, high and increasing temperatures, and shrinking surface water body sizes. The following discussion is on how herders become aware of and respond to early symptoms of climate change.

The data demonstrate that dry seasons are becoming longer, dry spells are getting longer and more frequent, and temperatures are increasing to unbearable levels for humans and livestock. The average duration of the dry season has increased from five to seven months between 2006 and 2017. Cattle use water that has been collected in dams and dugouts from rainwater runoff. Dry spells have become more often and have lasted longer throughout the rainy season, leading to a significant drop in

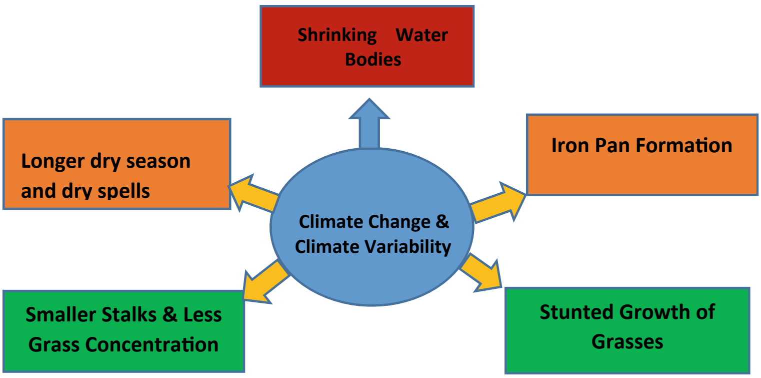

Fig. 23.2 Schematic diagram showing the signs of climate variability and change

the quantity of water stored in the area's dams and dugouts. This is consistent with previous studies' findings of persistent increases in annual mean temperature in arid regions of China and sub-Saharan Africa (Wang et al. 2019; Qasem et al. 2019; Kahsay and Hansen 2016; Amjath-Babu et al. 2016; Gonzalez et al. 2012; Osbahr et al. 2011).

23.4 Indigenous Knowledge and Community Threat Assessment (CTA) Activities

23.4.1 Tacana of Bolivia

Indigenous people in at-risk areas are disproportionately affected by climate change and its predicted negative ecological and social repercussions (Savo et al. 2016; Bose 2017). People that rely on the land for their survival, such as Indigenous communities, may be more susceptible to the effects of climate change. This might be due to the great degree of dependence they have on natural resources, as well as the unfavorable economic, social, and political conditions in their home regions (Belfer et al. 2017; Savo et al. 2016; Wildcat 2013; Ford 2012). Given that 41% of Bolivians are members of one of the 36 recognized Indigenous tribes and that 85% of food of Bolivia is generated by subsistence farmers and small holders, this is especially pertinent for the Plurinational State of Bolivia (FAO 2015).

Bolivia, like the rest of the globe, is seeing an increase in the frequency of floods, droughts, and bushfires due to climate change (Marengo and Espinoza 2016; Cai et al. 2014; Seiler et al. 2013). Indigenous communities' ability to adjust to environmental shifts may be conditioned by the meanings they assign to such shifts (Boillat and Berkes 2013). Understanding the impacts of climate change on lowland Indigenous communities who depend on subsistence agriculture and forest cover for their livelihood is crucial for identifying viable adaptation options (Seppälä 2009).

This research is a part of a wider project looking at the effects of climate change on the economy and society of three Indigenous Tacana communities in Bolivia. These communities depend heavily on the nearby forest for their survival. The goal of this chapter is to provide light on how residents of these three areas see climate change and how they have coped with excessive rainfall. Decisions in this area should take into consideration how traditional knowledge is mobilized in response to global environmental change, as well as the experiences and viewpoints of small-scale groups (Pyhälä et al. 2016). Academic discussions, legislative responses, and mustering practical support may all be improved with a better grasp of how people are already adjusting to the effects of climate change. Better two-way communication between stakeholders may also result from a more comprehensive understanding of how local families are experiencing climate change, which in turn will aid in the development of effective policy responses.

Accordingly, we set out to investigate the following hypotheses:

1. How do the Tacana's observations of weather shifts compare to hard data from meteorologists?
2. What are the Tacana's traditional signs for predicting the weather, and do these methods still have any weight?
3. Which economic centers, according to Tacanas, saw the most damage from natural disasters?
4. Which livelihood capitals, in the eyes of the Tacanas, were most helpful in enduring the severe weather?

As Petzold et al. pointed out, there is a dearth of basic research on traditional knowledge in South America, and thus, their study will help fill that need adaptation to climate change (2020). Very little is known about how climate change is affecting the people of Bolivia who rely on the country's forests for their livelihood. They are concerned with preparing for the effects of climate change and implementing methods for doing so (Ruiz-Mallén et al. 2015, 2017). This research is the first to analyze the short-term reactions to severe weather events in Bolivia to give evidence of the real coping mechanisms of forest-dependent families with regard to climate change. Pyhälä et al. (2016) conducted a comprehensive literature analysis on local perceptions of global environmental change and found that the research gave no explanation of methodology on the meaning of "local" and the reported perception about individual or communal viewpoint is not clear. Despite evidence suggesting that taking into account differences in perception, knowledge, and practices between and within social groups is crucial for sustainable management, the possibility of such differences going without addressed in the literature on worldwide changes in the environment until recently has been largely overlooked (Ghimire et al. 2004). By concentrating on individual families' reactions to climate change, our research clearly recognizes the importance of intra-community variability in livelihood options.

23.4.2 Conceptual Framework of Traditional Ecological Knowledge (TEK)

Using the social-ecological systems (SES) paradigm, this research sought to understand how residents of three Tacana communities affected by a devastating weather event viewed climate change. A socio-ecological systems (SES) framework is a way of thinking about how various parts of human society and the natural environment are interconnected and mutually influential on one another (Folke 1998). Local natural resource management decisions may be influenced by familiarity with traditional ecological knowledge (TEK), understanding of how climates are changing, and experiences with extreme rainfall (Pyhälä et al. 2016). Both immediate responses and long-term strategies for climate change adaptation were affected (Mekonnen et al. 2018; Alam et al. 2017).

Locals' first-hand reports of such changes may be helpful if there are few weather stations, little or no historical data, or discrepancies between expected and observed climatic trends. Household reactions to climate change may depend on how people perceive the phenomenon (Harvey et al. 2014; Djoudi et al. 2013; Adger 2010; McDaniels et al. 1996). Farmers may alter planting and harvesting schedules and the types of seeds used in reaction to what they perceive to be shifting weather patterns (Verschuuren et al. 2014; Harvey et al. 2014).

Local weather impressions may be supplemented, validated, or contradicted by the viewpoints of academics or policymakers from elsewhere. Under or overinvestment in adaptive responses is possible if there are divergent points of view, such as a discrepancy between locally felt risk and danger estimates based on observations of meteorological information (Williamson et al. 2012). Incorporating indigenous perspectives on climate and climatic change into scientific research has gained traction in recent years (Petzold et al. 2020). More and more people are realizing that the best way to comprehend climate change and potential adaption techniques is to combine local observations with Western scientific studies. Understanding, triangulation, and evaluation may all benefit from evidence gleaned from a variety of knowledge systems. Additionally, fresh data and insights may be gained via cross-fertilization, which may enhance the ability to comprehend causal links in the SES dynamics (Tengö et al. 2014). More and more studies and discussions are focusing on Indigenous and local knowledge and its significance in dealing with and adapting to climate change (Petzold et al. 2020). The phrases traditional local knowledge (TLK) and indigenous ecological knowledge are combined (IEK) in this study according to Berkes' (1993) definition of TLK as "the cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship between living beings (including humans) and their environment." IEK encompasses both traditional and non-traditional holders' traditional knowledge, whereas TLK is limited to Indigenous knowledge keepers. To a considerable extent, Indigenous peoples' knowledge is meant by "IEK" in this research.

Indigenous ecological knowledge (IEK) is an essential notion for comprehending the complex ecological practices of traditional, resource-dependent communities. In this way, communities and other IEK holders may better prepare for and recover from the effects of potentially devastating natural disasters (Alves and Barboza 2018; Bose 2017; Nishida et al. 2006a, b).

Many human societies have relied on astronomical observations and biotic markers, such as animals, plants, algae, and fungus, to anticipate future climate events since prehistoric times (Alves and Barboza 2018; Orlove et al. 2002). One of the earliest and most common ways that humans engage with animals is via the use of animal observation as a climate ethno-zoo indicator (Alves and Barboza 2018; Parrotta and Agnoletti 2012). To deal with global environmental change, local forest-based communities also create adaptation strategies based on TEK (FernándezLlamazares et al. 2015). However, there is mounting evidence that biocultural variety is dwindling as a result of the loss of TEK associated with agricultural methods, calendars, and bioindicators (Garteizgogeascoa et al. 2020; Kronik and Verner 2010; Loh and Harmon 2014). Threats to TEK's adaptability include decreased transmission of knowledge between generations (Aswani et al. 2018), the loss of indicator species due to habitat destruction or migration (Alves and Barboza 2018), and rapid societal and environmental shifts (FernándezLlamazares et al. 2015). The necessity to record TEK and acknowledge its part in climate change adaptation methods is argued for by Alves and Barboza (2018) and Bose (2017). Threatening Indigenous adaptive ability is the steady loss of TEK, as well as customary behaviors and social structures. Interdisciplinary and participatory research may play a crucial role in reversing this trend (Williamson et al. 2012).

The exposure and susceptibility of a livelihood to certain trends, shocks, or seasonality characterize its position as vulnerable or as insecure. This study employs the Sustainable Livelihoods Approach (SLA; Scoones 1998) because it provides a framework for analyzing the livelihood's setting and its assets in light of the 2014 Bolivian severe weather event. To live sustainably means you can weather adversity and bounce back stronger than before without depleting the natural capital and resilience of future generations (Chambers and Conway 1992). Both the availability and the degree to which one is reliant on intangible capitals (such as social capitals and human capitals) determine how much of a priority they are for ensuring one's survival and flourishing. Financial capital includes cash, savings, economic assets; social capital includes networks, social claims, social relations, affiliations, and associations; natural capital includes the stocks of natural resources; and human capital includes leadership potential, health, knowledge, skills, and the ability to work (Scoones 1998). Using SLA, we will demonstrate the effects on forest households' livelihood capitals and how those resources were utilized in the face of a catastrophic event.

23.4.3 The Area of Study

This research was done in Tacana community of the northern Bolivian Amazonian plain. There are 621 households in 20 communities that own title to 389,303 acres of mostly wooded property as part of the TCO (Tierras Comunitarias de Origen) Tacana I (Fig. 23.1). Nearby Madidi National Park is where you will find TCO Tacana I (CIPTA and CIMTA 2014; WCS 2017). Santa Rosa de Maravilla ($n = 12$, 100% of the town), San Silvestre ($n = 8$, 89%), and Buena Vista ($n = 29$, 46%) were all included in our sample of 49 houses. There are members of the Tacana people who identify with all three of these Indigenous groups. Immigrants are welcome in a community so long as they agree to abide by its norms. From now on, anybody who lives in an Indigenous community is just the Tacana. Based on these criteria, the communities were chosen in close consultation with the CIPTA steering group. This study is based on a sample size of 49 houses simply because of getting varieties of information from the 20 communities of Tacana.

Both the proximity to woods and the variety of economic activity present are important factors (accessible by motorbike).

Community leaders and study subjects gave their agreement after being given all relevant information. TCO Tacana I mostly consists of riverine forests, wet Amazonian rainforest, and humid foothill forests (Ribera 1992). Most land is used for either annual crop farming or perennial crop farming (cacao), for animal production (pasture or silvi-pasture), or for forestry (CIPTA and CIMTA 2014). In contrast, in the last three decades, floods and other forms of extreme weather have grown more frequent (Gloor et al. 2015; Ovando et al. 2016). Three hundred and forty thousand people were affected by the worst flood in Bolivia's history in the northern lowland region in 2014. This had a major effect on the TCO (Ovando et al. 2016; Bauer et al. 2018). At the closest weather station at Rurrenabaque, 380% more water was pouring down the Beni River than is typical (Espinoza et al. 2014).

23.4.4 Collection and Analyzing of Data

Here, we present four datasets gathered using different methods:

(a) Quasi-organized home interviews (datasets 1 and 3),
(b) Meteorological information (dataset 2), and
(c) The voice recorded methodology (dataset 4; Wang and Burris 1997).

The first set of data is qualitative in nature, and it was gathered in 2013 using quasi-organized home interviews that included 3 open questions referring to respondents' former climate change awareness of their assessments of the consequences of this change, and the ramifications of this change.

The second set of data is comprised of annual precipitation and temperature readings from 1946 to 1958 taken from the nearest meteorological station at Rurrenabaque (11–70 km from the communities). Data for the whole year were compiled, including the average temperature, the coldest and warmest temperatures, the number of wet days, and the total amount of precipitation.

2013 semi-structured interviews for conventional indicators included two free-from questions and make up Dataset 3 (Table 23.1). There were no canned responses, but if someone did not provide us enough information, we probed more about if there had been any changes to the clouds, animal presence/behavior, or plant life. A Spanish term, creencias, was utilized to probe for clues. Subsequently, we performed qualitative text analysis (Mayring 2000) to identify regional climate markers. We separated them into five groups: atmospheric, astronomical, zoological, botanical, and anthropological. Descriptive analysis was used once again to determine frequency distribution for dataset 3.

Dataset 4 contains 2015 photovoice submissions from 44 different families. Cameras were sent to households so that the members may record their responses and use the photographs as proof to respond these questions:

1. Which crucial facets of people's livelihoods were impacted by the 2014 floods and heavy precipitation?

Table 23.1 The 43 (38 unique) weather indicators reported by Tacana community as Phyto, zoo, atmospheric, astronomic and human

Types	Indicators of weather	Human indicators stated by number (N) of Tacana households
Rain predictors		
Phyto	The Ambaibo tree is characterized by its inverted leaves.	16
Phyto	The Ambaibo tree's leaves do not sway; they instead flip.	1
Zoo	The prevalence of insects such as mosquitoes, stingless bees, little black moths, and wasps.	10 7
Zoo	The local birds (Guaracachi) perform its nocturnal song.	3
Zoo	In the swamp, the frogs sing.	2
Zoo	Massive, swarming, and viciously biting hunting ants.	2
Zoo	Evidence of hunting tarantulas appearing.	2
Zoo	To quack, flap their wings, or run is a common duck behavior.	1
Zoo	Local bird species used as a weather indicator.	1
Zoo	Chubi (local unidentified bird species) can be heard singing.	1
Zoo	Paitechi (local unidentified bird species) sing.	1
Zoo	Racua lizard sings	1
Zoo	Snakes make an appearance.	1
Zoo	The gallop of a horse.	1
Zoo	Monkeys make beautiful music.	1
Zoo	Toucans beautifully sing	7
Atmo	Overcasting of dark clouds	1
Atmo	Appearance of ground clouds.	3
Astro	Formation of ring pattern around the sun.	1
Astro	It looks like the sun is going to set soon.	1
Astro	Strong wind and sunshine.	1
Astro	The color of the sun changes to a yellowish hue	1
Thunderstorm predictors		
Zoo	Toucans used to sing.	1

(continued)

Table 23.1 (continued)

Types	Indicators of weather	Human indicators stated by number (N) of Tacana households
Atmo	Appearance of white clouds.	1
Astro	Sun that is composed of three different colors.	1
Hum	A machete in the yard would not cause too much damage to the house.	1
Hum	Stones are thrown at the roots of some trees to lighten the load during storms.	1
Sur predictors		
Zoo	Monkeys respond with song.	1
Zoo	Guaracachi perform its nocturnal song.	1
Atmo	Northward clouds.	1
Bad weather predictors		
Phyto	Falling of giant trees in the forest.	3
Phyto	When it vents and plants move, rain will fall the fourth day.	1
Phyto	A woodland leaf moves.	1
Zoo	The wolf, also known as a borochi, howls loudly.	1
Zoo	Bear (Tremarctos ornatus or Jucumari) up in the mountain yells at night.	1
Atmo	Wind three days north or south, never east or west.	6
Atmo	Rain is forecast if the wind is coming from the north.	1
Astro	The Moon is encircled by water.	2
Astro	An outside rim can be seen on the Moon.	2
Hum	Physical discomfort	1
Good weather predictors		
Zoo	Forest-dwelling cicadas sing the sun's arrival.	2
Zoo	Soaring eagle	1
Drought predictor		
Phyto	Forest is dry	1

Note:
Atmo: Atmospheric indicators (clouds)
Astro: Astronomical indicators (sun, moon and wind)
Phyto: Vegetative indicators (plants, trees & forest)
Zoo: Animal indicators (birds, monkeys, bears, wolf, Guaracachi, snakes, horses etc.)

2. In 2014, what parts of your livelihood were most helpful in overcoming the event's effects?

The approach accounts for the fact that when given a camera, individuals will take pictures that, to them, indicate important processes, trends, or developments.

For further clarification of datasets 1, 2, 3, 4. (Refer to the Appendix given at the end after the reference).

 # By looking into the above atmospheric, astronomical, animal, plant and human activities, Tacana community predicts the weather conditions through indigenous knowledge.

For further clarification of Table 1. (Refer to the Appendix given at the end after the reference)

23.4.5 Typical Meteorological Signs

Table 23.1 shows the conventional indications gleaned from dataset 2. To forecast weather events, Tacana families utilize a total of 43 (38 different) clues from the atmosphere, the stars, the animals, the plants, and even themselves. Many of the astronomical and botanical markers are based on outside evidence. There are supposedly two markers (putting a machete in the yard and striking tree roots) that can help you avoid costly repairs after a storm. No one indication provides a look farther out than a few days, and all of them are short term. Some 42% of those surveyed expressed doubts about the relevance of climate indicators considering recent shifts in zoo-indicators and weather unpredictability. Human observers noted an uptick in the number of insects and mosquitoes, as well as a noticeable rise in the number of migratory animals. Participants reported hearing fewer birds singing and seeing fewer animals in the areas around their communities. The decline of macaw populations was singled out. Environmental factors such as hunting, deforestation, and monoculture farming were cited as the reason for the overall loss in the variety and number of wildlife and plants. The overlaps between general forecasters of adverse weather and specific predictors of rain, wind, sur, and thunderstorms are shown in Table 23.1.

23.4.6 Reports from the Ground and Meteorological Information

While just around 60% of families understood the term "climate change," almost everyone in the study noticed a shift in the way the weather usually behaves. A comparison of meteorological observations, such as the rise in temperature and the number of wet days each year, with the observations of local families demonstrates a correlation between the two. Insights into seasonal changes, rainfall habits, and sur (Bird Songs) patterns were gleaned from the anecdotal reports of Tacana locals, which were not reflected in the official weather reports. The latter is important because it affects how and when people engage in their means of subsistence, such as farming, hunting, and lumbering (Figs. 23.3 and 23.4).

As has been observed in earlier studies of Bolivia (Meldrum et al. 2018; Boillat and Berkes 2013) and the Amazon (Gloor et al. 2015), the volatility and unpredictability of the wet and dry seasons have a direct impact on agricultural activity. Same results were discovered in a study reporting the findings of the Tsimane, a neighboring Indigenous tribe in lowland Bolivia.

Fig. 23.3 Pictures from the field: Tacana locals

Fig 23.4 Pictures from the field: Tacana locals

Without access to contemporary information technology or long-term weather records from a nearby weather station, isolated people must frequently depend on their own perceptions, observations, and associated traditional knowledge when making judgments concerning the use of natural resources for human survival. It may be helpful to combine meteorological data with weather-related perceptions when creating risk management plans, especially in areas with a sparse network of weather stations. To potentially increase regional data quality, global climate data should be provided in a more localized context.

Information gleaned from local perceptions and the meteorological dataset was found to be highly congruent in this study, indicating that they complement one another. The results from the two sources of information may differ, but that does not make either of them less reliable. Instead, acknowledging and valuing both can enhance knowledge innovation (Tengö et al. 2014) and synthesis (Klein et al. 2014), which benefits from healthy discussion (Klein et al. 2014; Sterling et al. 2017). More resilient, particular, and successful local adaptation plans to climate change may be developed with Tacana perspectives on shifting weather occurrences integrated into the process (Makondo and Thomas 2018).

The fact that 90% of Tacana households have noticed a decline in their standard of living due to climate variability highlights the need for such comprehensive plans. Evidence shows that climate change is increasing the prevalence of vector-borne diseases like Dengue and Chikungunya in Bolivia and worldwide (Moya Quiroga Gomez et al. 2018; Githeko et al. 2000). Poor healthcare coverage in the villages, in particular during the rainy season, compounds inhabitants' precarity as a result of the weather. The perspective of the Tacanas is consistent with previous research from different places in Bolivia (Meldrum et al. 2018; Riva et al. 2013) highlighting the difficulties that climatic unpredictability and extreme weather events have on subsistence farmers. Responses to resource depletion can be triggered by extreme weather (IPCC 2012). Raising everyone's level of awareness is the first step toward improving the adaptive capacity of forest livelihoods, which is crucial if we were to prevent long-term negative effects for livelihoods and the Amazon ecosystem.

23.4.7 Typical Weather Indicators and the Environmental Change

In 1989, Wentzel mentioned the Tacana worldview as "profoundly animistic with a wide pantheon of mountain, woodland, water, animal and plant spirits," and noted that "knowledge about natural occurrences" was central to Tacana way of life (CIPTA and UMSS 2010). Three different Tacana groups have provided a non-exhaustive list of 38 traditional weather indicators that attest to their ongoing awareness of and intricate engagement with the natural world. Studies comparing TEK from different cultures, such as those conducted among the Tacana people of lowland Bolivia, are uncommon. Similarities between the galactic halo and the calls of the Bolivian red howler monkey (Alouatta sara) and Toco Toucan (Ramphastos toco), the turning of the leaves of the Ambaibo tree (Cecropia menbranacea) as predictors of rainfall, the calls of cicadas, and so on, all demonstrate the utility of TEK indicators and the value of long-term observations of the local environment (Cicadidae spp).

Years of observations have gone into developing a wide range of indications for predicting various weather scenarios; these have been augmented with knowledge, belief, and practice that have been passed down all through the generations (Huntington et al. 2005). The short time frame is probably connected to its use in agriculture and hunting. People who were interviewed cast doubt on their credibility, nevertheless. Many Tacana families still rely on astronomical weather indicators, although others have questioned the relevance of zoo-indicators in modern times. The diversity of birds, the creatures most frequently seen for weather forecasting, is particularly stated to have declined. Climate change, habitat loss, and human activities like hunting all put pressure on plant and animal behavior in various ways. As a result, the usefulness of weather indicators has been questioned, and it is possible that they no longer function as intended or appear antiquated (Melka et al. 2013).

Even in places where modern meteorological forecasting technologies are not widely accessible, traditional forecasting plays a significant role in local livelihood choices and activities (at the time of the research, none of the communities had a phone network, and radio broadcasting was only partly available due to a lack of electricity). While scientific knowledge remains relatively stable over time, traditional knowledge evolves and improves when it is exposed to fresh data and different viewpoints (Fernández-Llamazares et al. 2015). Similarly, to what was reported for the neighboring Tsimanes in Fernández-Llamazares et al., the adaptive capacity of the Tacanas' SES may be hampered if climate changes are happening faster than TEK can adjust (2015). There has been a loss in the accuracy and preservation of indigenous people's weather knowledge in lowland Bolivia and the Andes (Valdivia et al. 2013; Kronik and Verner 2010), the Artic (Weatherhead et al. 2010), and Tanzania.

McNamara and Buggy (2017) and Fernández-Llamazares et al. (2015) present evidence that TEK may provide substantial insights for the adaptability and resilience of communities that rely on natural resources. The Tacana Peoples' Sustainable Development Strategy and Territorial Management Plan 2015–2025, supported by Wildlife Conservation Society, is renowned for its dedication to preserving Tacana language, culture, and history. Nonetheless, the Tacana people's capacity to make a living and adapt to shifting climates and a decline in their knowledge of the ecosystem as a whole can be negatively impacted by these factors acting in tandem. Consequently, a key concern is sustaining the TCO Tacana's heavy emphasis on TEK, and another is expanding our understanding of local indicators and the changes they have undergone. Tacana may only be able to implement long-term, sustainable, and inclusive adaptation and mitigation strategies if they get a more nuanced knowledge of environmental change at the local level. It may be possible to support participatory climate change communication with Tacana families and the development of inclusive, successful, and site-specific conservation efforts for important species as well as coping and adaptation strategies by bringing local perception of shifting indicators and scientific studies on climate and environmental change.

23.5 Conclusion and Recommendations

Native communities in vulnerable areas are likely to bear the brunt of climate change's negative consequences (Bose 2017). But their personal stories are rarely heard in scholarly discussions on climate change adaptation (Soubry et al. 2020). In an effort to shed light on climate change in the Bolivian Amazon, this study interviewed members of forest households in Indigenous Tacana villages to learn about their thoughts on the topic and their actions taken during a recent heavy rainstorm. This study lays the groundwork for future interdisciplinary research on Amazonian Indigenous communities depending on forests and the effects of environmental and climatic change on their well-being.

After conducting this research, we came to four conclusions: (1) It demonstrated how Indigenous knowledge holders' and western science results of studies analyzing the effects of climate change on human communities are mutually enriching due to the unique perspectives each brings to the Table 23.2 The investigation uncovered 38 distinct traditional weather-related indications that demonstrate the Tacana's profound connection to their natural surroundings. But the deteriorating reliability of TEK, such as the weather indicators, along with shifting climatic patterns, can have a negative impact on the Tacana people's capacity to predict weather shifts, which in turn can have a negative impact on their ability to earn a living. (3) Photovoice results indicated that most households saw natural capital, particularly their crop field, as the most significant portion of their livelihood that was impacted by the extreme weather event, and (4) Tacana families depended heavily on social capital such as networking and bonding to help them get the outside and inside help they needed to get through a natural disaster.

The Tacana SES may be able to improve its adaptability if members work together to establish site-specific monitoring and conservation programs for endangered key indicator species. Strategies for dealing with and adapting to climate change are developed with consideration for the significance of natural and social capital to the Tacana people's capacity to generate sustainable livelihoods. Beliefs and experiences that impact behavior and livelihood choices have implications for natural resource management and decision making.

Our research shows that local perception, traditional ecological knowledge, and scientific understanding are all strengthened by incorporating multiple sources of evidence. Follow-up communication with local or Indigenous people based on science is facilitated by such coproduction of knowledge. Consequently, these data may direct local and regional risk management planning, interventions, and policy recommendations, as well as improve our overall understanding of climatic and environmental change. It can help counterbalance the decline in traditional ecological knowledge while also significantly bolstering the efficacy and resilience of such efforts. More efficient syntheses and lasting effects on the ground can result from management and policymaking from a distance that takes into account and recognizes local perspectives and norms (Soubry et al. 2020; Sterling et al. 2017; Daniel et al. 2012). Such integrated and synthesized knowledge can help strengthen communities and ecosystems (Sterling et al. 2017; Chia et al. 2015; Erikson et al. 2011). Thus, it is strongly recommended that the TEK must be preserved and further improved so that it could run parallelly with the modern means of meteorological weather forecasting.

Appendix

Table A.1 Summary of responses related to changes in atmospheric, astronomic, zoo-, phyto- and human indicators stated by number (N) of Tacana households.

Weather Indicator	N
Atmospheric indicators (clouds)	
In the past, there were big clouds, and we would know it would rain, but now we cannot predict it anymore.	2
Now, the sky is almost always cloudy.	3
Astronomic indicators (sun)	
In the past, when there was intense sun, and the wind was blowing hard, you knew it would rain—today you never know.	1
Zoo-indicators	
Animals seem to have gone far, replaced by more insects and mosquitos because of deforestation, machinery, and monocultures.	6
Fewer animals than in the past, need to walk far to hunt.	5
Fewer birds sing these days (fewer parrots, macaws)	3
Today a lot more mosquitos	3
Rain predicting mosquitos and flies are more aggressive.	1
No more butterflies	1
Cacao is infected with ants.	1
Nowadays, the weather does not even respect the cicadas.	1
Jaguar approaches the village.	1
In the past, birds were sacred and respected; today they are hunt.	1
In the past, animals killed people, today it is the opposite.	1
Birds and insectivorous animals like the armadillo are disappearing, which are harmful to people's crops. Citrus fruits are becoming scarce, there are no longer any fruit trees, and if there are any, they are full of worms, and they conclude that there are no longer any consumers of insects like birds, and that is why they attack crops more than before.	1
Phyto-indicators	
Plants dry out more often.	1
These days, platane leaves become yellow and white.	1
Plants are yellow and have fungi.	1
It feels warmer, and that changes the smell of the forest.	1
The smell of some plants in the forest has gone.	1
Plants flower earlier or later	1

(continued)

(continued)

Weather Indicator	**N**
Many colours in the forest have gone.	1
Human indicators	
Weather is unpredictable.	1
Traditional knowledge is lost	1

See Table A.2.

Table A.2 Summary of the datasets 1, 2, 3, and 4, including year of collection, number of households, and methods used to obtain and analyze information on the local perceptions of changing weather patterns, weather indicators, and coping strategies used by the Tacana

Dataset	Year of collection	No. of households	Data source and analysis	Questions
Dataset 1	2013	49	Semi-structured interviews and qualitative content analysis	Q1: Have you ever heard of climate change? Q2: Have you noticed any changes in weather patterns in recent years? If yes, what changed? Q3: Do these changes have consequences for your household?
Dataset 2	2018	49	SENAHMI and descriptive analysis	- Annual average temperature - Annual min/max temperature - Number of annual rainy days—Annual cumulative precipitation
Dataset 3	2013	45	Semi-structured interviews and qualitative content analysis	Q1: Do you know any traditional indicators to predict the weather? If so, which ones? Q2: Did they change in recent years?
Dataset 4	2015	44	Photovoice method, oral explanatory information, and qualitative content analysis	Q1: Which important aspects of the livelihood of your household were affected by the extreme weather event? Q2: What has helped your household to cope with the impact of the extreme weather event?

SENAHMI = National Meteorological and Hydrological Service

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Chapter 24
Indigenous Strategies to Building Climate-Resilient Communities: A Case Study of Majuli Island and Chehni Kothi Village

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Abstract Climate change is raising the occurrence and severity of terrible weather and climate consequences that impact all nations globally. However, due to their geographical position and dependence on climate-sensitive natural resources, emerging and poorer nations are more vulnerable to climate-related calamities. Several towns have started locally built environment programs to mitigate the negative consequences of climate change. This technique, which takes into consideration the local environment and climate, has taken many years to develop. If climate change is to be reduced, adaptation measures must be bold, collaborative, and strategic. There are tried-and-true solutions for proactively improving climate resilience that is accessible today. When it comes to adjusting to the effects of climate change, indigenous groups are at the lead of the movement. According to our findings, several groups have developed very complex adaptation strategies. Through community-led risk assessments, planning, and disaster recovery, we may be able to use specific regional climate adaptation strategies in disaster reconstruction, self-determination, and growing adaptive capacity, community members have motivated and educated themselves and others. In addition, conditions were created that are conducive to the creation and implementation of novel sustainable building design and construction practices. This study project tries to unearth these indigenous disaster-resilient techniques by focusing on the modern flood-prone communities of Majuli and the steep terrain and regional identity preservation of Chehni Kothi Village. According to our findings, some communities have refined their adaptation strategies.

Keywords Climate change · Community resilience · Vernacular strategies · Disaster-resilient · Traditional settlement

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Disaster Risk Reduction, https://doi.org/10.1007/978-3-031-26143-5_24

Fig. 24.1 Indigenous people protecting the forests. (*Source* https://bit.ly/2uhwoDn) REUTERS/Finbarr O'Reilly

24.1 Introduction

Flooding, drought, waterlogging, earthquake, cyclones, and soil erosion are just a few of the climatic disasters that have afflicted humanity from the beginning of time and have had terrible implications for vulnerable people's living conditions and finances. The fact that the most vulnerable people are continually addressing the implications of variations in climate change is not unprecedented. Communities that contribute to the climate change initiatives are frequently worst struck by its consequences, but they are often the most adaptable because indigenous knowledge has been passed down through the centuries. Indigenous knowledge is a set of skills and understandings that native peoples of a certain place have acquired and utilized for millennia to handle the unique problems they have encountered to survive and make sense of their environment. Indigenous knowledge has recently been the topic of great debate. Research with indigenous populations and their analogs is the only approach to increasing indigenous knowledge's cooperation with contemporary practices. This is because combining indigenous knowledge with modern knowledge has a lot of potential to reduce the risk of disasters Fig. 24.1

24.2 Indigenous Communities Around the Globe

Those people who had lived in their territories before invasion and colonization had the perception that they were distinct from the dominant social groups that existed in their country at the time. They are committed to preserving, developing, and transmitting to subsequent generations their unique cultural identities and homelands in a manner that is congruent with local cultural values, community-based organizations, and authorized structures to ensure the continued existence of their people (Martinez-Cobo 1984).

Some people live on each continent and believe they are the true indigenous people of their own countries. According to recent World Bank surveys, there may be up to 476 million people who do not belong to any admixed community. Indigenous communities have a profound understanding of their surroundings and climate as a result of their long-standing connection to the land, which has been passed down through the generations. As a direct consequence of this connection, indigenous communities have developed highly complex practices that are specifically tailored to the conditions in which they live. Indigenous peoples can provide for their own needs because they work together with the natural world to preserve and protect the environment (World Bank 2014). They have developed their unique way of thinking, along with their language and a set of building practices that are perfectly in tune with the environment in which they live. They are aware of how to decrease the harmful effects of the climate change as well as other natural calamities by using traditional knowledge in conjunction with adaptation and mitigation strategies. Figure 24.2 from the International Monetary Fund or the Banque Mondiale Indigenous peoples' traditional ownership of the land on which they live is not recognized by a significant number of government organizations, which leaves indigenous communities open to the possibility of being exploited. Even though certain nations, most notably New Zealand and Australia, along with several nations in South America, recognize the indigenous tribes' customary ownership of the quarter of land on which they have historically dwelt, this is in no way enough.

There is a chance that indigenous communities and valuable cultural treasures will be lost if the government and private companies continue to forcefully remove indigenous people from their lands. Even though there are indigenous peoples on

Fig. 24.2 A global map of indigenous peoples. (*Source* National Geographic; https://to.pbs.org/3TnmUjE)

Fig. 24.3 Statistics of indigenous people living in different countries. (*Source* https://bit.ly/3DSFGtl)

every continent, China has the most aboriginal people in terms of raw numbers and some of the best-known indigenous groups around the globe. China also has noted leading number of people living in traditional indigenous communities. About 125 million individuals, or 8.9% of China's total population, are members of one of China's officially recognized ethnic groups, such as Tibetans, Uyghurs, or Zhuang. There are 8.6% of indigenous people (Adivasi) living in Republic of India with compare of total population, which compares nearby more than 15 million indigenous people living in the Philippines, 15 million indigenous people living in Vietnam, 13 million indigenous people living in Kenya, and over 12 million indigenous people living in Mexico (10 percent) Fig. 24.3.

24.2.1 Threats to the Indigenous Community

Climate change is the most significant threat to humanity, yet it is not uniformly distributed. If it had been spread equitably among individuals and communities, everyone would have taken action to prevent climate change, seen it as a significant danger to their survival, and done everything in their ability to stop it. The reality is

Fig. 24.4 Impact of deforestation on tribal communities. (*Source* https://brook.gs/3ht9mFM)

just the reverse since climate change has a direct impact on the communities at the bottom of the human pyramid Fig. 24.4.

Rising temperatures are linked to diseases like dengue fever and other vector-borne and water-borne infections, both of which have devastating effects. Drought and desertification are major contributors to forestry blazes (Fire) and damage. Excessive precipitation, consider negative for grass field, plantlets, and other harvests; increasing rivers, as snow and glaciers melt in the mountains and the sea ice melts in the summer; a rise in the number of new bug species; increased longevity; that damage indigenous peoples' land and property rise, an increasing number of indigenous people are becoming environmental refugees.

Indigenous peoples are the Earth's custodians of biodiversity and cultural variety, despite having only 5% of the world's inhabitants, controlling 25% of global land field effectively. Also, acreage is close to places with 80% of the global biodiversity and 40% of all continental secluded regions and ecologically undamaged surroundings. So, indigenous groups perform a massive part in attempts to safeguard and keep the earth's eco-diversity in safe hands.

Contrary to President Jair Bolsonaro's assertions, deforestation in the Amazon rainforest rose by 22% in one year, hitting its lowest level since 2006. Data from Brazil's PRODES satellites indicated deforestation around approximately 13,230 km^2 of the planet's tropical forest, and region 17 times greater than the city of New York. From August 2020 until July 2021, the government supplies deforestation data. Even though Bolsonaro has tried to show that his government is committed to saving the Amazon, the damage is getting worse. An extreme-right ex-general has

Fig. 24.5 Deforestation a toll on Indigenous people. (*Source* https://bit.ly/3UGsqil)

pushed for mining and cultivation in rainforests. Brazil's government vowed to stop unlawful deforestation by 2028 at COP26, the UN climate summit in Glasgow. This goal would require considerable annual reductions in deforestation Fig. 24.5.

24.3 Indigenous Community in India

In India, there are 705 "scheduled tribes." The scheduled tribes of central India are often described as scheduled Tribal (Adivasis), which signifies the meaning of "Locally inhabitant Indigenous Groups." Various by-laws and legal conditions in India, such as the 5th constitutional schedule for India and the 6th List for various districts in the northeast, identify "Indigenous Communities" constitutional rights to land-dwelling and self-governance system, albeit their implementation is far from existing model. After its independence, Republic of India endorsed the (UN Decl.) on the Constitutional rights of "Indigenous Groups" on the proviso that every Indian be considered an "Indigenous individual." Therefore, neither UNDRIP nor the idea of "Indigenous Peoples" applies to India, International Work Group for Indigenous Affairs (Chakma et. al. 2021).

Indigenous populations found a sense of security in India throughout the Middle Ages, whether in the far northeast or the desert of Rajasthan in the south. This was true regardless of where they were in India. A scheduled tribe, or Adivasi in the native language, is a group that the Indian government has officially recognized as having legal rights and protections. In 1971, the scheduled tribes constituted 38,015,162 of India's total population or around 7% of the country's overall population of 547,949,809. Despite a 135 million rise in the overall number of people on the planet, the share of the population living in cities is thought to have remained stable over the previous decade. The tribespeople are dispersed over the subcontinent. However, they make up the northeastern India, approximately 88% in Meghalaya and Nagaland, and approximately 70% in Arunachal Pradesh. On the other hand, likewise Madhya Pradesh, Bihar, and Orissa are home to almost half of India's indigenous tribal population. Over 8 million of India's 1.3 billion people dwell in Madhya Pradesh (20%), 5 million in Bihar (80.75%), and approximately 7 million in Orissa (10%) (Das 2014) Fig. 24.6.

The "Gonds" (population: 4,000,000) of Central India (Madhya Pradesh, Maharashtra, and Andhra Pradesh), the "Bhils" (population: 4,000,000) of Western Indian region especially in (Rajasthan and Gujarat), and the "Sentals tribe" (population: 3,000,000) of Eastern Indian region (Bihar, Orissa, and West Bengal) are all significant ethnic groups. The Andamanese are the world's smallest people group, with only 19 members (Das 2014).

24.4 Natural Disaster in India and Their Impact

As the unique geo-climatical and socioeconomic attributes exist, India has been especially susceptible to a broad variety of disasters. Natural disasters such as floods, scarcities, storms, seismic activity, landslides, and forest fires are possible. Natural disasters pose a significant danger to 27 of the states and 36 of the territories. More than 40 million acres are responsive to flood destruction; over 5700 km of coastline are exposed to storms and tsunamis; 68.6% of cultivating land is prone to drought, and mountainous areas are susceptible to landslips and floods. Natural and man-made catastrophes are both possible. Disasters, both natural and man-made, and climate change are already having a severe impact on traditional and indigenous societies. Even though these populations have already acquired sophisticated adaptation techniques, their ability to adjust to new threats may probably be severely impeded (NIDM 2011).

A high-level Committee on Disaster Control Administration (DMC) has recognized several different kinds of natural calamities. In 2005, the tsunami was added to this list Table 24.1 and Fig. 24.7.

24.4.1 Community-Led Environmental Movements

The tribal Indigenous community (Adivasi Farmers) in Uttarakhand's Garhwal Himalayas abandoned commercial logging in the 1970s and 1980s after decades of heavy penetration caused significant deforestation, erosion, and flooding. This

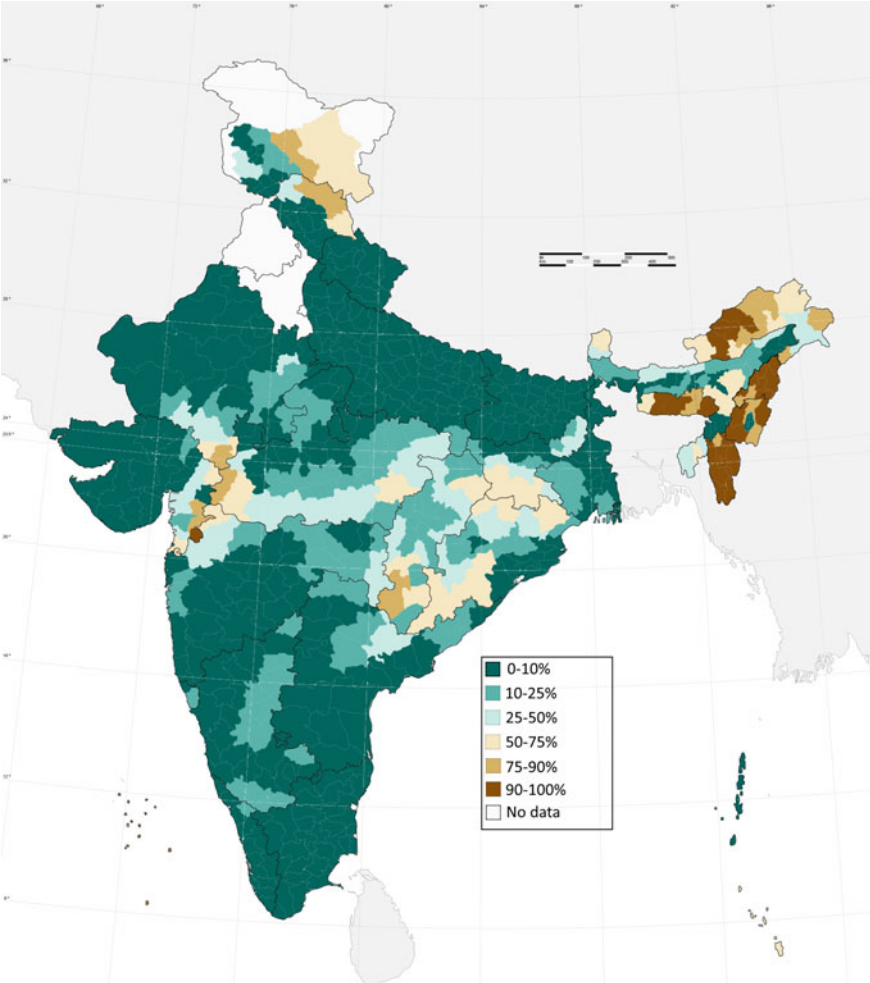

Fig. 24.6 Scheduled tribes as a percentage of the population of each Indian district in 2011. (*Source*: https://i.redd.it/drrxw0xnjzgx.png)

Table 24.1 Type of natural disasters and calamities in India

Type of disasters, prevalent in India	
Water disasters	Floods, cyclones storms and typhoons, cloud burst, heatwave and cold wave, snow lacks, sea ruin, thunder lightning, and tsunami
Environmental disasters	Landslips/slide and mudflows, seismic activity, dam failure/dam bursts, and mines disasters
Industrial disasters	Chemical and industrial calamities and nuclear disasters

(*Source* NIDM)

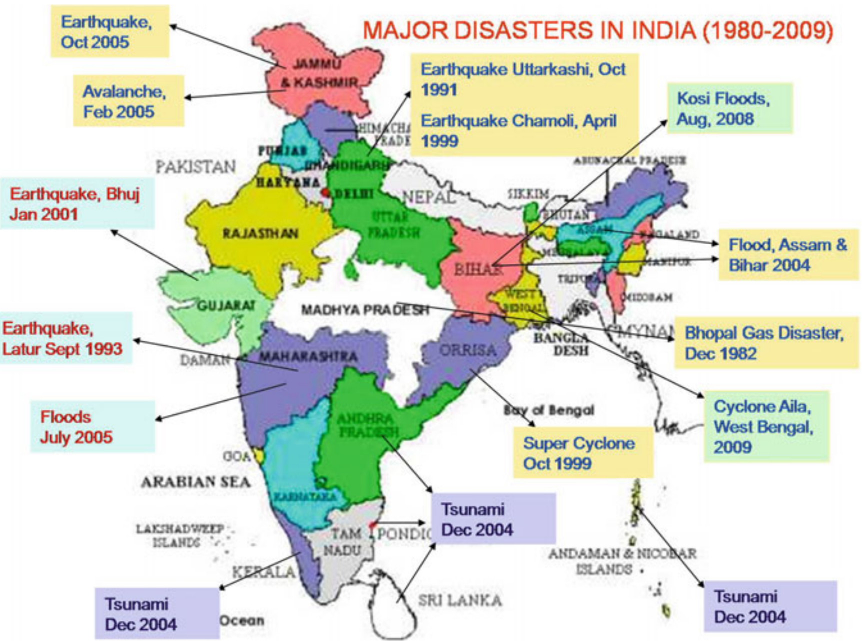

Fig. 24.7 Major disasters in India. (*Source* www.aidmi.org)

marked the start of India's environmental movements. Farmers' wives from around the area rallied in support of the campaign after seeing firsthand how deforestation would impair their ability to obtain essential supplies such as firewood and water (Diptarka Ghosh 2020) Fig. 24.8.

"Jungle Bachao Andolan"—Protests and growing tensions occurred in tribal areas of the Indian states of Bihar, Odisha, state of Madhya Pradesh, Maharashtra, also in Andhra Pradesh during the 1970s. In South Bihar, a dispute arose in 1979 when the government, as part of a World Bank-backed effort, started replacing "Sal" trees with teak trees. Because the "Sal" was holy to the indigenous people of the Singhbhum area, they launched a campaign to chop down teak trees under the slogan "Sal is ours; teak belongs to the exploiters," and over sixty tribal members were slain in the ensuing clash with police to save the trees. The advertisement stressed the usefulness of "Sal" (a tree that gives fodder, nuts, and fuelwood to forest communities) as opposed to commercial species like teak and eucalyptus, which are worthless for the fire and feed requirements of local peasants (Diptarka Ghosh 2020).

"The Appiko Movement" began as a nonviolent grassroots movement to protect Karnataka's, Kalse Woods. The Chipko Movement inspired it. The uprising was sparked by the government's plans to clear natural forests with eucalyptus and teak monocultures. On September 8, 1983, more than 70 people from the Salkani hamlet in

Fig. 24.8 Chipko Andolan (*Source* https://bit.ly/3hrRlYG)

Uttara Kannada started embracing trees in Kalse forests. South India's first environmental movement was Appiko (in Kannada). In response to this peaceful campaign, forest officials made it easier to cut down trees in the Western Ghats, (Diptarka Ghosh 2020) Fig. 24.9.

24.4.2 Impact and Implications

The environmental movements that have taken place for the last several decades have increased and extended our understanding of the significance of environmental challenges (Diptarka Ghosh 2020). The public has been persuaded to support these nonviolent resistance activities as a result of the steady stream of news headlines that warn of imminent ecological calamities that would be caused by deforestation, global warming, climate change, desertification, and floods. As a direct outcome of the deterioration of the ecosystem and the depletion of natural resources, land and forest disputes are only going to get more heated.

Fig. 24.9 Legacy of environmental movements (Paryavaran Andolan) in India

24.5 Strategy, Agendas, and Global Support

24.5.1 United Nations (UN)

Consider the UN Declaration on "Indigenous Communities" to be an essential component of developing and implementing climate mitigation, adaptation, and finance 24 policies. Ensure that indigenous and tribal people, especially indigenous women, are involved in all phases and components of the planning for such endeavors (UN Declaration 2021). Therefore, strategies centered and emphasis on "UNDIC" the Constitutional privileges of Natives-Indigenous Communities must be adopted. Misappropriation of indigenous vernacular knowledge must be prevented, and indigenous people must be acknowledged as equal partners and genuine keepers of cultural knowledge (UN Declaration, ii 2021). Facilitate sector-specific programs that address gender, values, and economic realities to improve the adaptation and relief capacities of "Indigenous communities." Conduct in-depth gender analyses to discover if and to what degree indigenous environmental knowledge is skewed toward men or women (Guha 2021).

24.5.2 UNESCO

UNESCO's several commissions include education, science, society, culture, and the media. The organization's policies, programs, and design systems benefit and have a tremendous influence on indigenous peoples all over the globe. The 2030 plan's goal to "leave behind " gives additional incentive to ensure "Indigenous communities" views are understood and their issues are addressed, considering the UN General Assembly's 2007 withdrawal of the UN Decl. As privilege of Natives-Indigenous

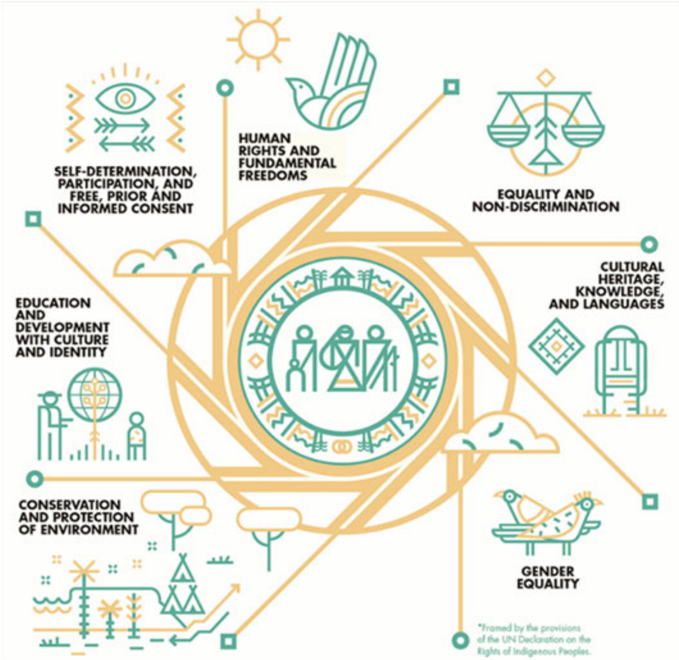

Fig. 24.10 Indigenous peoples' engagement policies overviews. *Source* https://en.unesco.org/indigenous-peoples/policy

Groups and many publications of the UNDP Guidelines on Natives-Indigenous Groups Issues, it is becoming urgent for UN agencies such as UNESCO to consider how to guide on engaging with indigenous groups. As a result, UNESCO's policy on dealing with indigenous people aims to lay out a house-wide traditional approach that will guide all of UNESCO's program sectors in their involvement with indigenous communities and allied organizations (UNDG, UNESCO 2008) Fig. 24.10.

24.5.3 Impact of UNESCO Policies

A UNESCO Priority on "Indigenous Peoples' Engagement" according to policies—Indigenous peoples are largely acknowledged as the custodians of the vast majority of the world's biological, cultural, and linguistic variety; nonetheless, they continue to be overrepresented among the world's lowest socioeconomic strata. UNESCO engages with indigenous peoples to solve the various issues they confront, following the 2030 Agenda's aim of leaving no one behind. In October 2017, the UNESCO Executive Board established a program on contacts with Natives-Indigenous groups, which currently serves as base for the organization's environmental and social protection criteria. The UNGA endorsed the Declaration on the privilege of "Natives-Indigenous Groups" in 2007. This report guide discusses the policies and UNESCO-specific efforts that led to its approval. In the year of 2017, indigenous groups from all seven indigenous areas are involved in the preparation of "2019 as Global Year of Indigenous Languages". The Indigenous and Traditional Peoples' World Heritage Forum was founded. The Conference for the Protection of "Cultural Heritage in Intangible category" has officially recognized Native Americans and other indigenous tribes (UNESCO PoIP 2018).

24.6 Indian Context of Policies on Disaster Administration

The MHA Govt. of India has established the administrative agency named "NDMA-National Disaster Management Authority," which works with central, state, and also in district level (Fig. 24.11). On the other hand, "NCMC-National Crisis Management Committee," which was created as part of the original plan, is also housed inside the Center. The Ministry of Home Affairs administers the procedures of the several nodal ministries designated for various sorts of disasters (nodal ministry for disaster management). Because of this, people who are part of the crisis management system have to work on multiple fronts (NIDM 2010).

24.6.1 Policies Implementation

The Indian government develops catastrophe prevention, response, and funding strategies. MHA Govt. of India formed the NDM Program in 1993 and the NCDM in early 1995. In 18 states, including coastal ones, the federal and state governments built disaster management centers and relief programs (Thomalla et al. 1999). Cyclone management was primarily on paper, and the superstorm was a costly result. The 10th (Panchvarshiya Yojna) Fifth-Year Plan of India (2002–2007) emphasized disaster preparedness of NDM Framework (NDMF). (Fig. 24.12) was designed in early 2004 to enhance natural disaster response and mitigation by addressing economic, environmental, and development challenges. 2009: The Indian Parliament approves the Disaster Management Act. Contained by this latest established organization, the Central Cabinet Committee on Natural Catastrophe Management oversees disaster preparation and response. The Cabinet Secretary supervises India's National Crisis Management Committee during crises (SAARC Disaster Management Centre 2009). In crisis prevention and management, the Indian government (GoI) may use the military. As part of the new administrative planning, the Prime Minister chairs the NDMA, involved in preparation and managing national disaster management plans. "NIDM-National Institute for Disaster Management" trains and improves infrastructure. Ten armed police battalions make up the "NDRF-National

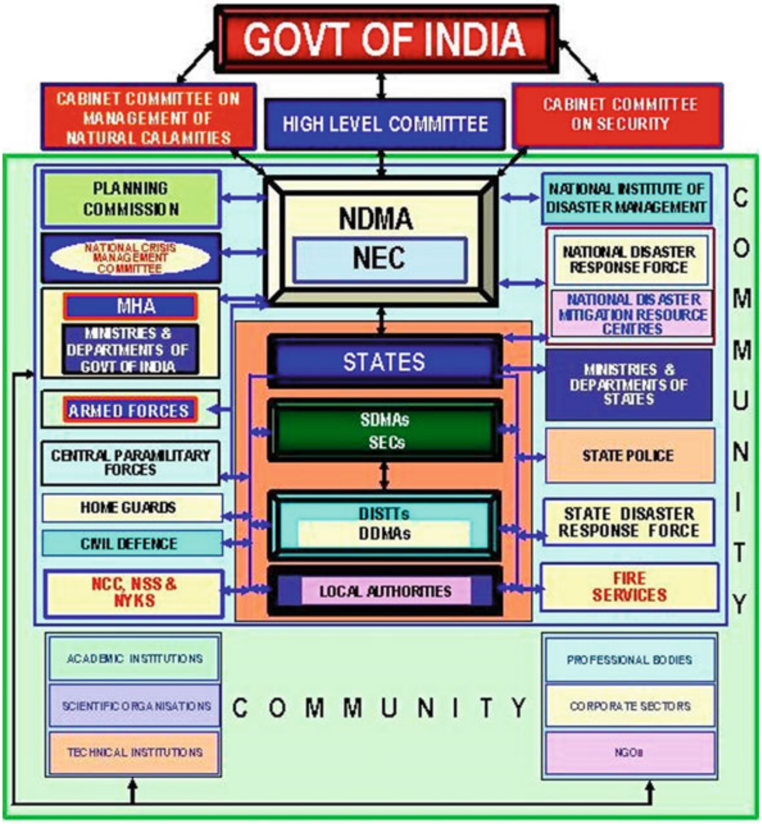

Fig. 24.11 Structural context of NDMP in India. *Source* https://bit.ly/3fR24LF

Disaster Response Force." The state CM leaders the State Disaster Administration Organization, which coordinates program execution across the state. As the most important step toward decentralization, the district magistrate and a locally elected official co-chair the District Disaster Management Authority. This assists communities across the country in planning and preparing. Urban and rural local governments must finish the cycle through community engagement and capacity building (SAARC Disaster Management Centre 2009). The Ministry prepared a micro-plan for district and (Mandal) sub-district health administrators. It would be naive to ignore the political governance in Indian states (AIDMI 2013 and World Bank CDA 2013) that pushed for zero mortality.

Fig. 24.12 National disaster management framework and process. *Source* www.nidm.gov.in

24.6.2 Action Plan on Climate Change Control

In mid-2008, concerned authorities and stakeholders introduced "National Action Plan on Climate Transformation and control," which addresses the country's present and future environmental relief and adaptation policies and activities. Eight "national missions" will carry out targets listed in the plan until 2017, with different ministries entrusted with presenting comprehensive action plans to the PM Council on Climate Change by the end of the year 2008. (NIDM 2008). The strategy "identifies strategies that advance our development goals although producing advantages for successfully managing climate change," emphasizing the crucial need to sustain strong economic development measures to enhance livelihood values. The subsequent initiatives included in the National Climate Change Action Plan consider milestone:

i. *"NERMP"—(National Earthquake Risk Mitigation Project)*
ii. *"NCRMP"—(National Cyclone Risk Mitigation Project)*
iii. *"ICZMP"—(Integrated Coastal Zone Management Project)*
iv. *"NFRMP"—(National Flood Risk Mitigation Project)*
v. *"NLRMP"—(National Landslide Risk Mitigation Project)*
vi. *"DMMP"—(Drought Mitigation Measures project)*
vii. *"FFMP"—(Forest Fire Management project).*

The (NPDM) outlines the national approach to improving disaster preparation and response, and The National Priority Development Strategy (NPDM) specifies national priorities, institutional capacity building, and development, community training, professional technical education, traditional education in schools, artisan training, and training for other groups. For capacity development and expansion, training DM officials, bureaucrats, trainers, elected officials, and community members have been a primary emphasis. A diverse variety of organizations and governments collaborated to design the National Integrated Disaster Management Plan (NIDM 2008).

24.7 Communities' Resilient Strategies

It is critical to distinguish climate change from the risks posed by natural disasters. Climate change, like all other underlying risk factors, must be addressed in conjunction with the reduction of other risk factors owing to their close connection. Even if climate change is minimized, if these concerns are not addressed, the likelihood of calamity will grow. The rising frequency of both natural and man-made catastrophes throughout the nation necessitates a diverse set of methods for disaster preparation and recovery. The UNDRR works with Govt. administrations, organizations, individuals, and groups to minimize calamity hazard and damages to promote a securer and more environmentally friendly opportunity. In the case of a catastrophe, however, indigenous communities often get insufficient assistance from political stakeholders and their linked entities. Policymakers often prioritize Western scientific and technical ways of avoiding and reacting to natural catastrophes. However, indigenous peoples who are directly affected by these disasters want responses that are culturally appropriate and tailored to their circumstances. Both locally accessible resources and indigenous knowledge handed down from generation to generation may teach the global society (Guha 2021). There is a definite link between indigenous peoples' thorough knowledge of their surroundings and their attempts to reduce the possibility of catastrophic catastrophes. Traditional weather prediction techniques, for example, make use of the sun, moon, and stars, as well as insects and animals. The indigenous inhabitants of Simeulue Island, Indonesia, are said to have escaped the 2004 Indian Ocean tsunami because of their long-held belief that "buffaloes and cows retreat to the hills as a tsunami approaches."

The UN Eternal Forum on "Indigenous" Issues (UNPFII) emphasized this concept in a report. Residents of low-lying districts along the Damodar River in West Bengal, India, saw ants transporting their eggs to safer ground as a warning of approaching floods (Guha 2021). As seen in Fig. 24.13.

24.7.1 Vernacular Strategies for Climate Change

Traditional knowledge is critical to preserving the planet's biodiversity and making it livable for all kinds of life. Indigenous communities' awareness of organisms, local species, plants, and ecosystem management is critical for safeguarding and using balance in biodiversity, food, health requirements, and religious practices.

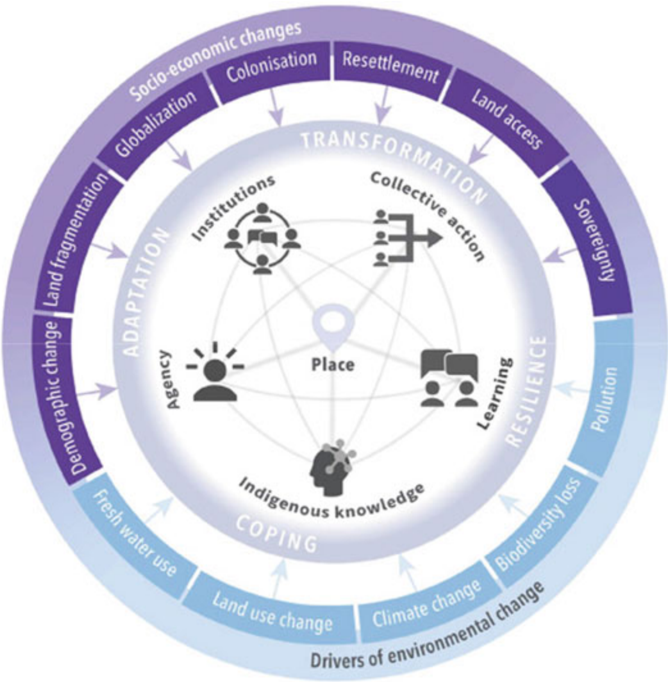

Fig. 24.13 Resilience of "Indigenous communities" to climate change. *Source* Ford et al. (2020) https://bit.ly/3thO9Bv

Natives-Indigenous communities' legacy, socio-cultural representations, microorganisms, creature, plant, and anthropological genomic properties are often housed in genetic material banks, research organizations, arts center, botanical gardens, university databases, as well as industrial laboratories. When indigenous knowledge is exploited or stolen, it may have disastrous consequences for the natural and built surroundings, as well as for the communities or peoples that have the information. Furthermore, indigenous peoples may keep their humanity and grow as a group by handing down their knowledge from generation to generation. Because they give meaning, history, and viewpoint, indigenous languages are critical to the survival of indigenous knowledge. Indigenous and tribal peoples' traditional knowledge is critical for successfully combating and adapting to climate change. The emergence of synthetic biology is one of the possible consequences for indigenous peoples of the incorrect use of traditional knowledge. 16 Biotech companies may help reduce greenhouse gas emissions and alleviate climate change. However, if these biotech firms are unleashed into the natural environment without first getting their free, prior, and informed permission, indigenous peoples' knowledge, techniques, and viewpoints may be risked (2021a). For example, it has been argued that genetically engineered potato plants might aid in the control of late potato blight, a prevalent fungal disease. Indigenous Andean people have done well because they have a huge variety of potatoes and a long history of controlling fungal diseases.

24.8 Case Study 1 Majuli Island

24.8.1 Introduction

The floodplains of the Brahmaputra River contain Majuli Island. Every year, the river island is swamped by enormous floods caused by the Southwest monsoon. The tenacious residents of flood-ravaged places learned to work with their environment rather than against it. Residents have devised strategies for making their dwellings more flood-resistant while still making use of the resources available to them. The goal of this case study is to identify local disaster-resilient approaches in Majuli's flood-prone villages and to develop risk-resilient approaches for the region's flood-prone regions. Regional, municipal, and individual plans for the built environment are analyzed. Local people, architects, and concerned authorities can use the principles to make structures safer and stronger in places that are prone to cyclones and floods Fig. 24.14.

Fig. 24.14 Aerial view of Majuli, Assam. *Source* National Film Development Corporation. https://bit.ly/3WOaPa3

24.8.2 Historical Overview of the Region

The Dihing River flowed down what is now the Brahmaputra's channel in the southern portion of Majuli in 1622, while the Brahmaputra flowed down the modern Lohit channel in the northern section of the island. After changing its course in 1671 A.D., the Dihing joined the upper Lohit, and the Brahmaputra, which was diverted by a massive flood in 1735 A.D.2, subsequently followed the Dihing's previous path4. This suggests that the Majuli arose as a direct result of the Brahmaputra River's erosion and subsequent upstream channel change. Majuli was formerly made up of thirteen tiny islands known as "chaperons," which were joined together by canals running from Dihing to Ohi. (Singh et al. 2018). Historians such as Dambarudhar Nath believe that before the aforementioned transition, the Majuli landmass was attached to the present southern back of the Brahmaputra-extended land in the shape of a melon. Majuli is now a flat plain shaped like a myrobalan in the center of the enormous Brahmaputra. Its physical characteristics include many wetland regions, immobile bodies of water, arable and grazing land, sandy beaches, and a natural drainage system. The Tuni River is Majuli's sole river. From the north and east, go south and west. Throughout the raining time, the water level rises and floods the majority of the Majuli Fig. 24.15.

24.8.3 Geography of the Region

Majuli is situated at 26°45′ N, 27°15′ N, 93°45′ E, 94°30′ E, and 84.5 m above sea level. The island's size in 1950, 1971, and 1997–98 was 1246, 924, and 875 km^2. "The morphotectonic development of 'Majuli land' of Brahmaputra River Basin." Except for the extreme northeastern corner, which is linked to Dhemaji by a land bridge, the Brahmaputra runs around the whole perimeter. The Luit runs along the northern coast of the island. It was once the primary tributary of the Brahmaputra. On the eastern edge of the river is Kherkatiya Suti. The Brahmaputra's main stem parallels the coast of Majuli. In the north are Lakhimpur, Dhemaji, Jorhat, and Sivasagar are the geomorphological modifications of Majuli in Assam. Historical evidence indicates that the Brahmaputra formerly flowed north of Majuli and that the present placement of the island is the consequence of a geomorphological interaction between the Brahmaputra and one of its tributaries, the Dihing (Roy et al. 2020). The Majuli biota was created through riverine ecology. The geomorphology of the Brahmaputra delta is alluvial fluvial. Alluvial sedimentation results in fertile soil. Tuni is the sole river on Majuli. Channels include Mari Tuni, Sukan Suti, Khar Jan, Boka Jan, and Dighali Jan. The island's terrain consists of inner marshes (called "bulls" in Majuli), ponds, cut-off meanders, and other wet zones. Typically, they are changed after rainfall. Along these rivers, indigenous tribes establish colonies (Fig. 24.17). The diverse plant and animal life of Majuli attracts migrating birds Fig. 24.16

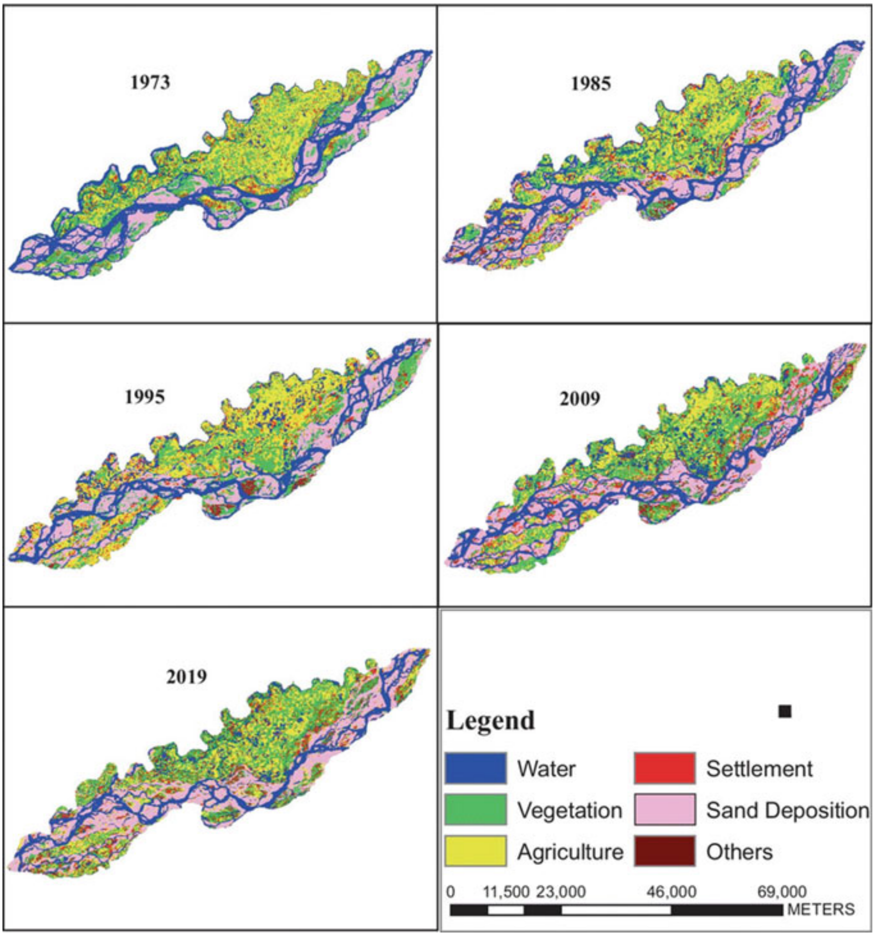

Fig. 24.15 Land use map of Majuli River Island, observation of 1973, 1985, 1995, 2009, and 2019. *Source* (Environmental Monitoring and Assessment 2021)

24.8.4 Climatic Condition of Majuli

The island of Majuli, like the rest of Assam, has a subtropical monsoon climate. The weather is quite similar to that of Nepal and northeastern India. Summers are often hot and humid. Annual precipitation averages about 215 in. As a result, the island's most prominent events take place in the winter, when the weather is moderate. The months of October through March are ideal for a visit to Majuli. Let us learn more about Majuli's surroundings and atmosphere. Summer in Majuli is hot and humid from March to July. Around such times, the temperature may register as high as 34 °C. For obvious reasons, vacationers attempt to avoid this time of year. The monsoon season in Majuli lasts from July to August, following which the dry season begins.

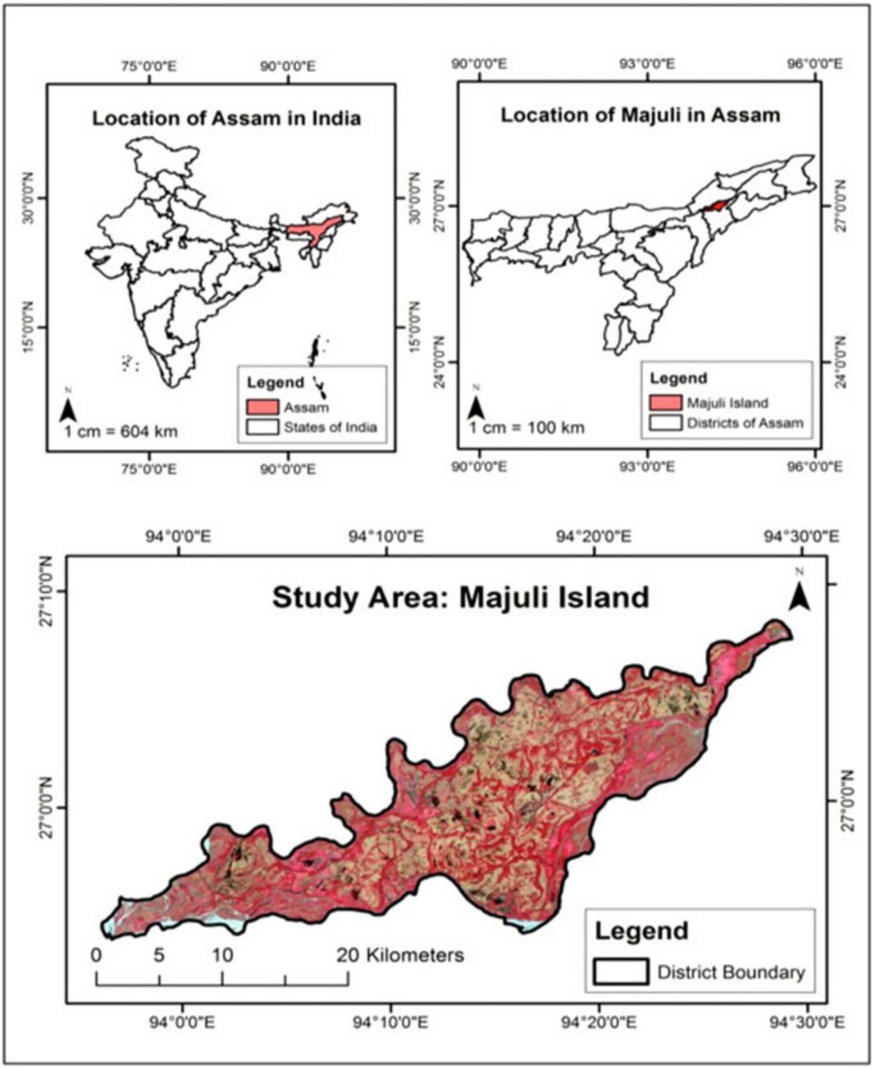

Fig. 24.16 Location of Majuli Island, Assam (India). *Source* Census of India, 2011, (USGS), 2017

The whole island is covered with lush, green foliage at this time of year. Winter, on the other hand, begins in November and lasts until February. In general, seasonal temperatures should vary from 14 to 28° Fahrenheit (7 to −7 °C). This time of year, the Majulians enjoy a variety of cultural activities. Throughout the season, many of the region's events and fairs take place.

Fig. 24.17 Traditional houses of Majuli Island. *Source* Akshat Mishra Feb 12, 2018

24.8.5 Settlement Pattern

The dwellings are built on high poles, have a large front roof, and face the village road (Fig. 24.18). Many of the buildings are linear in design, housing many families next to each other. To defend against periodic floods, all the dwellings in the area are constructed on platforms 1.3 to 1.6 m high. The ground underneath the platforms is used for storage and livestock grazing. Most towns have taken on a linear design due to their closeness to rivers and other sources of water. This design promotes surface drainage, which reduces the likelihood of floodwater accumulating in the region. Many dwellings in a village should be clustered in rows along either side of the main thoroughfare. Because a river flows through the center of town, these areas are prone to flooding whenever it rains Fig. 24.17.

Fig. 24.18 Linear settlement pattern of Majuli island. *Source* Google Earth

Fig. 24.19 Settlement pattern of the island *Source* Authors

Linear Settlement

Wind and water are slowed by vegetation on slopes, avoiding erosion, and impact the community's stormwater directly channeled away; the highest elevation is the ideal place to put it. Dwellings may be seen on both sides of the road. Wind cannot readily harm plants planted in front of a house. Retention of floodwater in ponds for recreational fishing. Except for the west, homes may be located in every direction. Figures 24.18 and 24.20 depict residences that are both parallel and perpendicular to the river.

Vernacular Architecture

Traditional knowledge systems may be better adapted to the local environment and climate due to their concentration on native resources. Natural materials such as bamboo and wood are the best bet when it comes to cyclones and floods (Singh 2009). Nonetheless, as seen in it, different techniques are used in various parts of the world. After being locally coated with coal tar for waterproofing and termite resistance, woven bamboo mats can be used for walls and partitions; broken bamboo pieces were used to construct woven mats in a variety of forms. These fences are made of bamboo, a sustainable resource. A significant proportion of hipped roofs are maintained in these locations to help with rainfall drainage Fig. 24.21. There is no need for normal windows since the bamboo weaving lets in plenty of natural light and allows for cross-circulation. Figures 24.22, 24.23, and 24.24. Locally sourced bamboo and wood are used to support loads. Bamboo is lengthened using lap joints.

Fig. 24.20 Orientation of houses and context along the river belt. *Source* Authors

A wire is used to connect two bamboo trees. Area Standard Procedures A stairway made from a single piece of wood is strong and stable. A complicated design is fashioned from broken bamboo fragments.

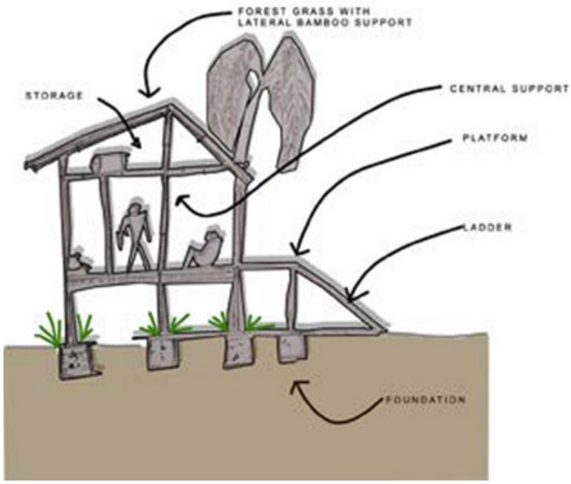

Fig. 24.21 Typical section of traditional house of Majuli Island. *Source* Authors

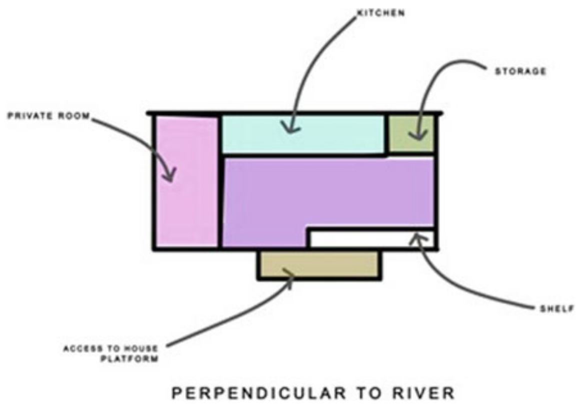

Fig. 24.22 Typical plan of traditional house of Majuli Island. *Source* Authors

Fig. 24.23 Interior view of the traditional woven bamboo house. *Source* UN Office for Disaster Risk Reduction (2021)

Structures Typology

To protect them from storms and heavy waves, every structure along the riverside is elevated on stilts. The bamboo planks that make up the floor are held up by concrete rods. To provide support for horizontal components, the width of a concrete pillar that is located above ground level is shortened. When attempting to waterproof a building, polyethylene sheeting is often used Figs. 24.25, 24.26 and 24.27.

24.8.6 Conclusion of Case Study 1

Majuli Island, located in Assam's Brahmaputra Valley, is one of the most intriguing and quickly changing geological features for a variety of reasons. The geomorphic high of Majuli Island, which stands on "high basement" topography, has posed a

Fig. 24.24 Typical plan of traditional house of Majuli Island. *Source* UN Office for Disaster Risk Reduction (2021)

severe danger to extremely important Vaishnavism spiritual places due to catastrophic erosion in recent years. The relationship between geophysical and topographic data, as well as seismic sections recorded near Majuli, corroborates this. We hypothesize that Majuli and comparable formations evolved in three stages, during which a geomorphic high emerged and the main channel experienced fluvial dynamics. We emphasize the function of the underlying structure and tectonic backdrop in the production of these landforms, placing it above that of a merely geomorphic process. Majuli continues to erode because surrounding rivers such as the Brahmaputra and Subansiri are particularly erosive. However, Brahmaputra is the most devastating, wreaking havoc on the whole island of Majuli. This research focuses on the consequences of the Brahmaputra's Bankline migration on the region near Majuli. Riverbanks changed dramatically between 1976 and 2017. Although the deposit is visible on the right bank, erosion is an issue in the center. As a result, the river gets broader in the Centre. Majuli's land area has diminished as a result, causing the island to progressively sink. Without well-thought-out and scientifically based actions to stop it, it is expected that a lot of Majuli will die out in the next five to ten years.

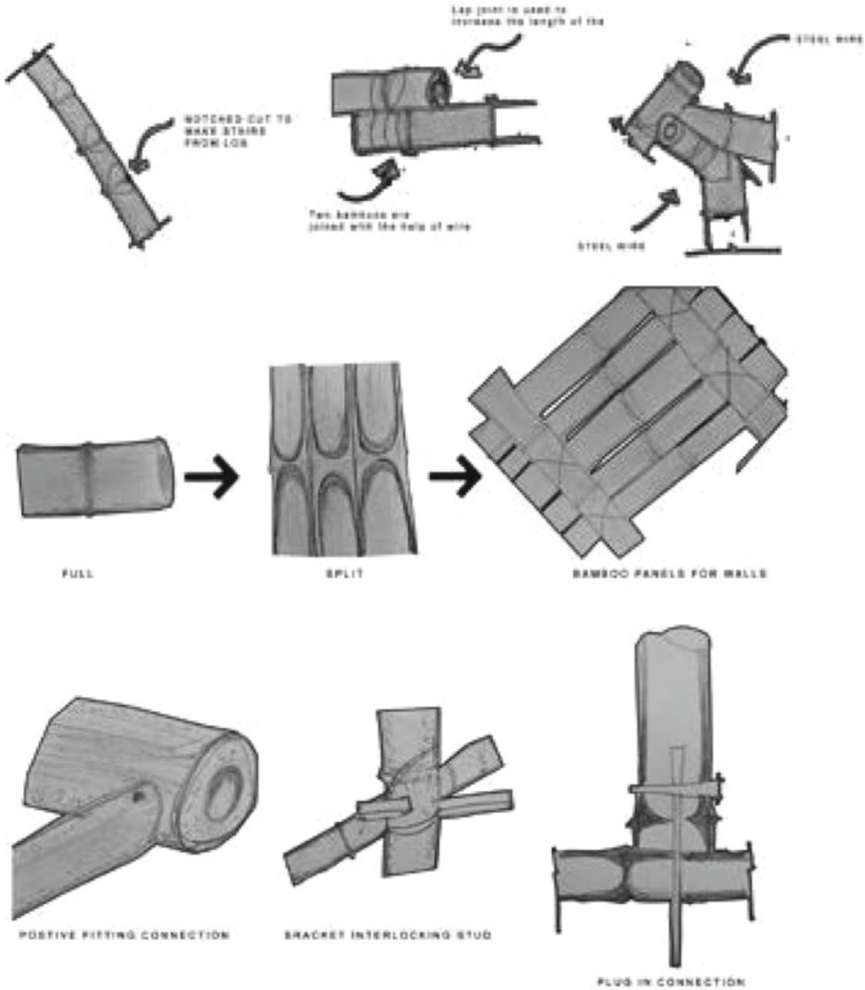

Fig. 24.25 Vernacular construction techniques. *Source* Authors

24.9 Case Study 2 Chehni Kothi Village

24.9.1 Introduction

Chehni Kothi in northern India is one of the world's long-forgotten settlements, with a remarkable stone and wood tower. Chehni is a modest settlement in the Indian state of Himachal Pradesh Fig. 24.28. In the Indian Himalayas, ancient Kath Kuni

Fig. 24.26 Stilled structure of the traditional house of Majuli Island. *Source* https://www.adotrip.com/city-detail/majuli

Fig. 24.27 Panorama of Chitkul, Kinnaur, with a medieval spire shrine at the greatest end and a conventional town clinging to brightly curving hillsides. *Source* Himalayan Vernacular: Kath Kuni Architecture (2018)

architectural methods have a long and illustrious history, culminating in the Chehni Kothi village. Indigenous building practices are strongly anchored in the atmosphere and the vernacular practices and rituals of the place as a natural response to knowledge of topography, climate, and the availability of local materials and skills. It gradually developed through time, being handed down through the ranks. Given the frequency of earthquakes in the Himalayas, it demonstrates a thorough knowledge of building science. The research as a whole shows the variety of methods, materials, and joinery that go into building a traditional Kath Kuni, as well as the beauty of the way the walls, openings, and corners are put together, which is a key part of the appeal of Himalayan architecture.

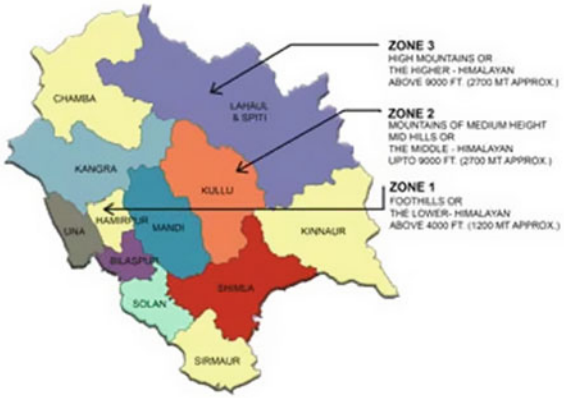

Fig. 24.28 Topography and climate zone of Himachal. *Source* Google Map, and edited by Authors

24.9.2 Topography of the Region

Elevations in Himachal Pradesh vary from 300 m above sea level to 6500 MT. higher than the sea level, and the state stretches from the "Shivalik mountain" array to the Great Himalayas. There is a general regularity and similarity of conventional buildings and raw material across its length, despite the significant differences in topography that are there. Figures 24.28, 24.29, 24.30 and 24.31.

Fig. 24.29 Topography of the village settlement. *Source* Google Earth

Fig. 24.30 Kath Kuni architecture style buildings of Chehni Kothi. *Source* https://mysterioushimachal.wordpress.com/2021/10/14/chehni-kothi-historic-fort-tower-temple/

Fig. 24.31 Geography, and climate of Himachal Pradesh

Table 24.2 Climatic characteristics of Himachal Pradesh

Attributes	Shivalik region	Mid hill region	High hill region	Trance Himalayan region
Elevation	800 m	800–1600 m	1600–2700	2700–3600
Area typology	Valley and foothills	Mountain region	Alpine region	Lahaul Spiti and Kinnaur **region**
Climatical conditions	Semitropical	Warm and moderate temperature	Cold temperature with mid humidity	Dry and extreme cold
Rainfall (MMt.)	1500	1500–3000	1000–1500	500

24.9.3 Climate

Because of its high latitude, the climate of Himachal Pradesh differs widely from place to place (between 300 and 6500 m). Temperatures in the southern lowlands range between 300 and 900 m above sea level, whereas temperatures in the eastern high mountains range from warm and temperate (900–1800 m), to chilly and temperate (1900–24,000 m), to frigid glacial alpine. Temperatures in the eastern high mountains range from warm and temperate (900–1800 m), chilly and temperate (1900–24,000 m), and frigid glacial alpine (24,000–48,000 m) Table 24.2 (Ecotourism 2022).

24.9.4 Settlement Pattern

Chehni Kothi is one of the rare groups of local tribal communities where traditional construction techniques are being used. The stone temple's tower rises above the forests. The hamlet, with its narrow roads and stone buildings, emerges from the mountainous terrain. The precious stone and timber constructions seem to be from a different age; against all odds, they have endured the test of time. This roughly 30-m-tall, nine-story temple tower depicts the Himachal Pradesh community's traditional habitation structure. Several locals allege that during the 1905 earthquake, the tower lost several stories. In this case, the tower's beginning height may have been forty meters. When do you inquire about the age of the tower? Some say it is 1500 years old, but others say it is just 500 (Ecotourism 2022). It is worth noting that the tower survived the 1905 Himachal Pradesh earthquake, which killed over 10,000 people. It does not matter how old the building is, but the fact that a 30-m-tall skyscraper was built in an area prone to earthquakes without using concrete or steel is a feat of engineering.

Fig. 24.32 Kath Kuni architecture style. *Source* The Himalayan Vernacular: Kath Kuni Architecture–2018

24.9.5 Vernacular Architecture

This settlement's architecture is common across the region. The tower's corner beams are crisscrossed, and stones are placed between the wood layers. Figure 24.32 depicts typical hamlet buildings; they are all constructed in the same style. Kath Kuni is a combination of wood (Sanskrit: kashth or kath) and corner (Sanskrit: kona). Many typical old cities with multi-story structures have weathered geological changes; Kath Kuni architectural creations are strong because indigenous practices are flexible. There are temples and halls of worship that have lasted decades, if not centuries, and have never been devastated by earthquakes or other natural calamities. The exceptional discoveries shown in Fig. 24.33 provide a distinctive aesthetic dimension to traditional construction practices and indigenous knowledge.

24.9.6 Climate Responsive Design

Steel is resistant to earthquakes, the weather, and the environment because of its great tensile strength. A kadil, or wooden peg, holds strong wood beams in place, while a stone corner protects them. Masonry and piled wooden beams without glue. To minimize erosion and snow accumulation, the stone plinth was raised at an angle above the ground. The construction is weatherproofed by having two layers of walls and an air disparity among analogous timber beams filled with wobbly, tiny stepping-stone particles. The air gaps that occur after an earthquake may prevent wall cracks and collapse (Abhyankar 2019). The stone roof provides weight and stability to the structure, while the low windows and overhanging balconies make the inside pleasant

Fig. 24.33 A free-standing granary in Chitkul, *Source* The Himalayan Vernacular: Kath Kuni Architecture Visual and Material Arts, September 2018

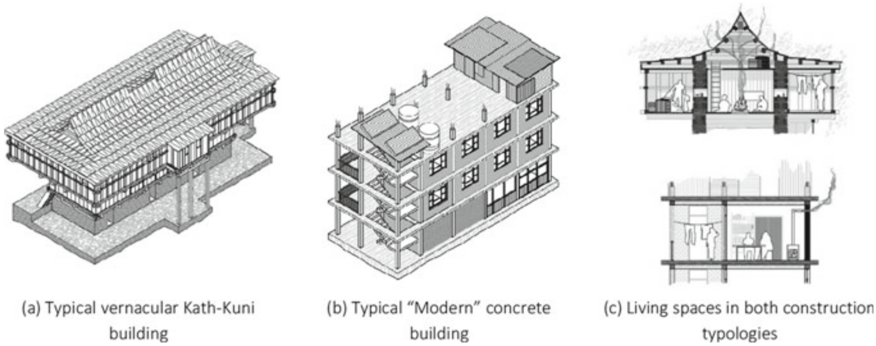

Fig. 24.34 Kath Kuni architecture comparison to Concrete building failure. And sectional view of climatic responsive characteristics of buildings. *Source* Singh and Narasimha (2015) and M. V. D. Zanden, Semantic scholar—2018

all year. Many cow shelters are in the basements of buildings. At the highest point of the village, nine-story temple towers stand guard, which is very different from the two- or three-story houses that are more common Figs. 24.34 and 24.35.

24.9.7 Vernacular Strategies

Kath Kuni was constructed to withstand the vibrations of a Himalayan earthquake, much as we created climate-resilient houses. During catastrophic earth occurrences like landslides, Kath Kuni's reactivity is superior to that of other species. One of the

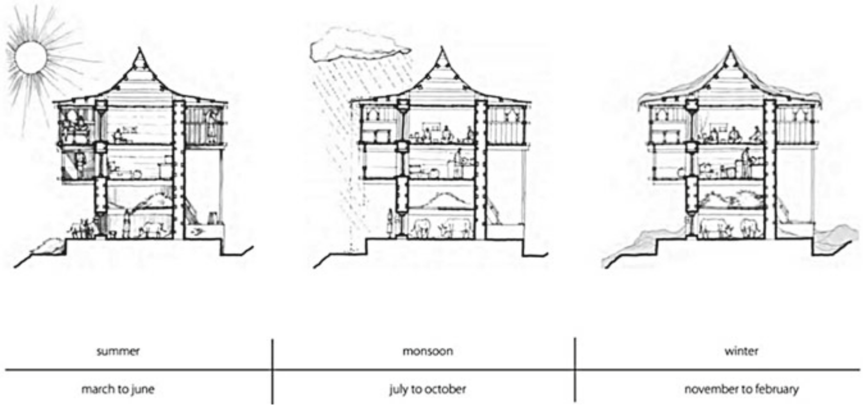

Fig. 24.35 Kath Kuni architecture comparison to Concrete building failure. And sectional view of climatic responsive characteristics of buildings. *Source* Singh and Narasimha (2015) and M. V. D. Zanden, Semantic scholar—2018

homes had survived a landslide just under its foundation, according to a guy who was out in the field. The house was constructed on a steep slope that finally gave way owing to the region's periodic landslides. It was designed such that each of its four corners lay on firm ground, and even if the soil under the foundation shifted, the giant oak beams at the center of the construction could keep it stable (Fig. 24.36). The future belongs to women (Garima 2022). Himachal Pradesh's traditional timber "frames" are created using complicated interlocking methods to survive the shocks of the Himalayan terrain. The wooden corner, which gives Kath Kuni her name, is one of its distinguishing characteristics. The incredible flexibility of Kath Kuni buildings is due to the expert interweaving of hardwood beams at these corners. When an earthquake strikes, the interlocking technology enables the walls to bend and change form, absorbing and dispersing the enormous energy generated by the shaking. River stones cover the crevices between the staggered wood panels. In Kath Kuni buildings, two walls support and retain heat. This gap between the walls is clogged with hay, stones, and other random debris. Mud plaster is often used to coat walls and provides great insulation for structures. Slate tiles add weight to the roof, making the whole building stronger (Figs. 24.37 and 24.38).

24.9.8 Traditional Construction Techniques

The Kath Kuni style of building is well known for using wood and stone from the area. The hardwood fittings and fixtures throughout the building are a great touch. The flexibility of the structure is due to the wooden beams, while the precise packing of the stones assures its stability. Slate tiles give the roof a heavy covering, which helps keep the building stable. A Kath Kuni construction may vibrate during an

Fig. 24.36 Corner detail: Cantilevered wood supports notch-and-lap-joined wood at the corner. *Source* Himalayan Vernacular: Kath Kuni, Architecture Visual and Material Arts, 2018

Fig. 24.37 Dry masonry with infill and lap-joined pieces at the corner. Source: "HV-Himalayan Vernacular," Kath Kuni, Architecture and Visual Material Arts, 2018

earthquake, but it will not collapse. Himachal Pradesh is well known for its harsh winters. During this time of year, homes made of concrete may get very cold and need to be heated with expensive tools. Kath Kuni homes have superior thermal insulation. The double-layer thickness of the walls helps keep heat in, and the mud plaster lets air flow through. The number of Kath Kuni constructions in Himachal Pradesh is gradually decreasing. This is due to the simple availability of low-cost substitute materials like RCC, which has contributed to the Himalayan countries' rising Tavu, a

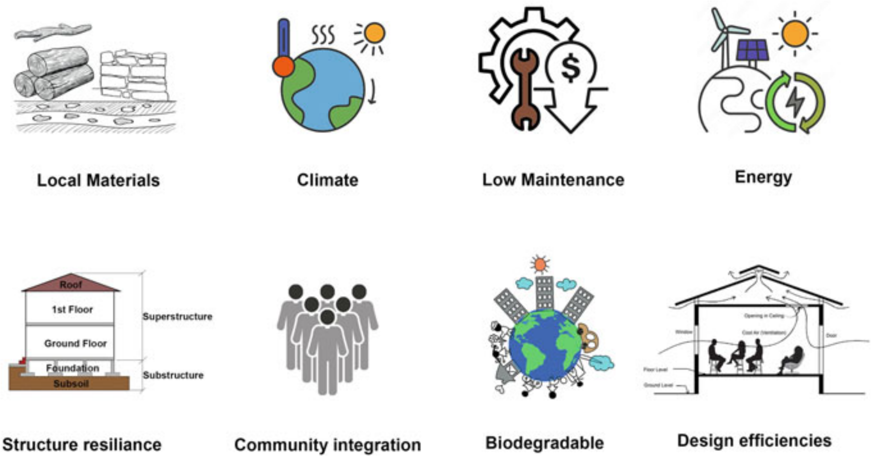

Fig. 24.38 Climate responsive strategies. *Source* Stock shutter image

skilled carpenter, oversees the building process. The huge amount of knowledge these artisans have about how to build a Kath Kuni has been handed down from production to generation. Himachal Pradesh has almost entirely discontinued construction in the traditional Kath Kuni style. Their downfall was mostly caused by a lack of resources, high manufacturing costs, and a lack of trained workers. Northern Indians argue that employing bamboo or other eco-friendly, low-cost, and long-lasting materials like mud instead of wood might minimize the time and money required to build a home using the Kath Kuni method. Himachal Pradesh's healthy ecology requires the preservation and revitalization of Kath Kuni culture and handicrafts.

24.9.9 Analyzing the Building Structure

See Table 24.3.

24.9.10 Analysis of the Overall Vernacular Settlement

There are very few things that can match the creativity of the indigenous architectural practices in Himachal Pradesh when it comes to withstanding the difficulties of weather and earthquakes. The joints used in the indigenous form of construction are expertly intertwined with one another rather than being nailed together. Older materials are progressively being phased out and replaced by newer ones as society, the construction industry, and human expertise continue to improve. It is improbable that aboriginal customs would endure considering these recent developments.

Table 24.3 Comparison of the RCC structure—Kath Kuni

RCC structure	Kath Kuni structure
Having enough compressive strength, but lacking in tensile strength of steel, the structure becomes critical during earthquake	Kath Kuni is earthquake-resistant because of the layered and interlaced wood and stones
The RCC structure is heated up in summers and cooler in winters	Wood and stone walls have a high time lag, preventing heat transmission for eight hours. This lowers summer interior temperatures and raises winter ones
Fire resistant to some extent	Catches fire quickly because of wood
High ceiling height	Low ceiling height for warmer interior
Concrete is non-reusable	Wood and stones are reusable
Requires more labor	Requires less labor
Not that much durable	Durable
Presence of vertical members	There are no vertical members
High Waste in construction	Very less wastage in construction
Needs a bit maintenance	No maintenance
Takes time to execute the construction	Time efficient

24.10 Conclusion

Many Kath Kuni homes are in Himachal Pradesh. RCC and other low-cost options have aided the development of Himalayan countries. Tavu, a carpenter, manages the project. The art of manufacturing Kath Kuni has been passed down through generations of artisans. India's Himachal Pradesh is losing its distinctive Kath Kuni architecture. Their downfall was brought on by a lack of resources, excessive manufacturing costs, and subpar workers. Some people in Northern India believe that Kath Kuni will be more affordable and efficient if bamboo or other environmentally friendly, affordable, and long-lasting materials, like mud, are used. Ecosystems in Himachal Pradesh need Kath Kuni culture and handicrafts. The construction systems of Himachal Pradesh are among the most innovative and earthquake- and environmental resistant in the world. Joints are weaved, not fastened with nails. Older construction materials are being phased out by society, the building industry, and human capabilities. Indigenous practices might alter because of these developments. This study links the many elements and procedures of climate-responsive architecture. They did it nevertheless to protect a local construction method.

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