Disaster Resilience and Green Growth
Series Editors: Anil Kumar Gupta · SVRK Prabhakar · Akhilesh Surjan

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Hydro-Meteorological Extremes and Disasters

Springer

Disaster Resilience and Green Growth

Over the years, the relationship between environment and disasters has received significant attention. This is largely due to the emerging recognition that environmental changes - climate change, land-use and natural resource degradation make communities more vulnerable to disaster impacts. There is a need to break this nexus through environment based and sustainability inclusive interventions. Science – technology and economic measures for disaster risk management, hence, need to adapt more integrated approaches for infrastructure and social resilience. Environmental and anthropogenic factors are key contributors to hazard, risk, and vulnerability and, therefore, should be an important part of determining risk-management solutions.

Green growth approaches have been developed by emphasizing sustainability inclusion and utilizing the benefits of science-technology interventions along policy-practice linkages with circular economy and resource efficiency. Such approaches recognize the perils of traditional material-oriented economy growth models that tend to exploit natural resources, contribute to climate change, and exacerbate disaster vulnerabilities, Green growth integrated approaches are rapidly becoming as preferred investment avenue for mitigating climate change and disaster risks and for enhancing resilience. This includes ecosystem-based and nature-based solutions with potential to contribute to the resilience of infrastructure, urban, rural and peri-urban systems, livelihoods, water, and health. They can lead to food security and can further promote people-centric approaches.

Some of the synergistic outcomes of green growth approaches include disaster risk reduction, climate change mitigation and adaptation, resilient livelihoods, cities, businesses and industry. The disaster risk reduction and resilience outcome of green growth approaches deserve special attention, both for the academic and policy communities. Scholars and professionals across the domains of DRR, CCA, and green growth are in need of publications that fulfill their knowledge needs concerning the disaster resilience outcomes of green growth approaches. Keeping the above background in view, the book series offers comprehensive coverage combining the domains of environment, natural resources, engineering, management and policy studies for addressing disaster risk and resilience in the green growth context in an integrated and holistic manner. The book series covers a range of themes that highlight the synergistic outcomes of green growth approaches.

The book series aims to bring out the latest research, approaches, and perspectives for disaster risk reduction along with highlighting the outcomes of green growth approaches and including Science-technology-research-policy-practice interface, from both developed and developing parts of the world under one umbrella. The series aims to involve renowned experts and academicians as volume-editors and authors from all the regions of the world. It is curated and developed by authoritative institutions and experts to serve global readership on this theme.

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Hydro-Meteorological Extremes and Disasters

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Foreword

Extreme events such as droughts, heatwaves, heavy rain, and violent storms are now part of our daily news. Disasters due to extreme climatic events have been reported across the globe causing huge loss of property and lives. It is expected that these losses and casualties may multiply in future. Climate change is one of the biggest environmental threats faced by the world, which can potentially impact food production and security, sustained water supply, biodiversity of forests and other natural ecosystems, human health, and settlements. Climate variability and change could result in increased number of extreme events which can cause profound damage to human well-being. Simultaneous occurrence of extreme events not only multiplies the risk but also complicates the process of disaster risk mitigation and management. Hence, it is crucial to understand the occurrence, distribution, and mechanism of extreme events and their role in augmenting disaster risk. This book is a welcome step in that direction. Additionally, it provides an excellent introduction to the field to non-specialist readers.

This book, *Hydro-Meteorological Extremes and Disasters*, is a perfect compendium of recent issues, problems, and their possible solutions in the area of hydro-meteorological and extreme events disaster risk management. It covers wide-range contributions such as reviews, output of research studies, case studies, and reports on technological developments, presenting latest findings and raising awareness about climate change and hydro-meteorological and extreme events. The authors of the book are well-known experts in their respective fields, thereby providing the readers a studied and encapsulated version of the recent issues, challenges, and developments. The content is presented in a well-written and engaging form.

I compliment the editors of the book, Prof. Manish Kumar Goyal, IIT Indore, and Prof. Anil Kumar Gupta, NIDM, New Delhi, along with eminent scientist on the subject Dr. Akhilesh Gupta, Senior Advisor, DST-Govt. of India, for conceptualizing and taking this timely initiative. I congratulate the contributing authors for the

time spent to prepare detailed methods and also for offering practical hints and tips that are often essential to obtain a new working protocol. I am sure this book would be a significant contribution in the area of hydro-meteorological and extreme events disaster risk management.

Director, IIT Indore, Indore, Madhya Pradesh, India

Suhas Joshi

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The editors acknowledge the support and hard work put in by all contributors under tight timelines. Special thanks are due to Prof. Suhas Joshi, Director, IIT Indore, for writing the foreword to this book. Thanks are due to the encouragements from Mr. Kamal Kishore, Member Secretary, National Disaster Management Authority of India; Prof. Ashutosh Sharma, Former Secretary, DST, Govt. of India; Dr. M. Ravichandran, Secretary, DST, Govt. of India; Maj. Gen. Manoj K. Bindal, Former Executive Director, NIDM; Prof. Neelesh Kumar Jain, Officiating Director, IIT Indore; and the entire team of professionals and researchers associated with the volume editors' team. A range of literature, reports, data, and publications were used by the chapter authors in drawing academic inferences, and sources are cited to the best possible extent. Their original sources and contributors are gratefully acknowledged. Fast-track processing of the publication by the Springer Nature team, especially comprising Ms. Aakanksha Tyagi (Senior Publishing Editor) and Mr. Jayesh (Production Editor), is acknowledged along with their support and cooperation.

Introduction

With the changing climate, extreme weather events have become more frequent and severe across the globe in the past decades. Several disasters such as flash flood in Indonesia and China (2020), Cyclone Amphan in India and Bangladesh (2020), and summer heat waves (2019), among others, disrupt socio-technical systems and cause huge social, economic, and environment losses. Such events expose the underlying vulnerability and resilience of the system towards disasters. And, as climate change is going to adversely impact the socio-economic systems, it is of paramount importance to understand the disaster risk and resilience from a multidisciplinary perspective. Therefore, the book is focused upon an integrated approach to assess associated risks and resilience, and further facilitating remediation strategies based upon the principle of sustainability. It offers a unique examination of different perspectives on disaster exposure, risk, resilience, and vulnerability, along with corresponding remedial strategies. It provides a compendium of case studies on risk and vulnerability assessment of floods, droughts, landslides, etc., along with a concise review on recent scientific approaches for disaster risk management. The book concludes with role of sustainable strategies in enhancing disaster resilience in different sectors such as environment, forestry, business, corporate, and transport.

Increasing exposure to hazards and increasing social and economic vulnerability are raising the specter of catastrophic disaster around the globe. Such events have adverse impact upon lives and economies; therefore, scientists\researchers\practitioners across the globe are focused on the most sustainable and efficient way to deal with these situations. Therefore, an integrated risk assessment approach incorporating social, economic, and environment dimensions would be helpful in formulating efficient climate adaptation and mitigation strategies. Despite the availability of a large number of studies/books on disaster management, only a handful of literature exists which focuses upon an integrated approach to assess risk/resilience, and recommend remedial strategies aligning with social, economic, and environmental systems simultaneously. The proposed book is formulated in order to bridge this gap. The book will contain chapters from a broad spectrum of topics from experts, thereby encapsulating research from different fields to further pave a path towards

facilitating sustainable remedial strategies. The book is designed to cater to a wide audience, that is, along with research community (disaster risk, response and recovery, climate science, environment management and policy and others), it will also be beneficial for students, professionals, and policy makers.

The book is a unique work and brings global coverage and wider perspectives on hydro-meteorological extremes and disasters, with aim to support future studies and management of hydro-meteorological disasters. The book is presented in three parts, wherein Part I reviews the overview and strategies of hydro-meteorological and extreme events disaster risk management. Part II describes the tools and techniques required for evaluation of different climatic extreme events and their management. Finally, Part III of the book aims at case studies related to different climate disasters and their implications on water resources and others. Authors are drawn from across the developed and developing world, encompassing varied experience of dealing with hydro-meteorological and extreme events.

Contents

About the Editors

Manish Kumar Goyal is a Professor of Civil Engineering and Dean at the Indian Institute of Technology, Indore. Prof Goyal has 'i' index and 'h' index equal to 82 and 33, respectively, with total citations of 3324. He holds more than 100 refereed publications on different domains of GIS and remote sensing, water resources, climate change, hydrological and hydrodynamic modelling, soil carbon sequestration, anthropogenic changes, risk and resilience. He serves as an Associate Editor for several journals. His contribution fetched him Recipient of ASCE EWRI Visiting International Fellowship, Recipient of ASCE-Best Theoretical-Oriented Paper Award, Indo-US WARI Fellowship Award, DST–SERB Young Scientist-fast track grant, Inspire Faculty award, Erasmus Mundus Interweave Award, JSPS fellowship award and Canadian Commonwealth Scholarship Award.

Anil Kumar Gupta is a sustainability risk management strategist working in the area of disaster management, environment and climate resilience for more than 25 years with national, sub-national and business administrations. He is currently a full Professor and Head of India's National Institute of Disaster Management (NIDM) Division of Environment and Disaster Risk Management. He is Programme Director of the Centre for Excellence on Climate Resilience and implementing projects, viz. CAP-RES (with DST, under National Knowledge Mission on Climate Change), National Agriculture Disaster Management Plan (with Ministry of Agriculture & Farmer's Welfare). He was a recipient of Excellence Award by the Society of Environmental & Occupational Health, and bestowed with IDRC Canada's Thank Tank Initiative Senior Fellowship 2011 for policy research.

Akhilesh Gupta is presently Secretary of the Science and Engineering Research Board (SERB). Also, Dr. Gupta currently heads the Policy Coordination and Programme Management Division (PCPM) division and is the overall in charge of five National Missions at DST – National Mission on Interdisciplinary Cyber Physical System, National Mission on Quantum Technology and Applications, National Super-computing Mission, National Mission on Strategic Knowledge for

Climate Change and National Mission for Sustaining the Himalayan Ecosystem. A distinguished atmospheric scientist, Dr Gupta has to his credit over 200 research articles in national and international journals as well as proceedings. He is editor of 5 books and author of over 350 articles and nearly 1000 reports. He is a Fellow of Indian National Academy of Engineering (FNAE), Indian Meteorological Society (FIMS) and Association of Agro-meteorologists (FAAM).

Part I
Overview and Strategies

Chapter 1
Hydro-meteorological Extremes and Disasters: Integrated Risk, Remediation and Sustainability

Fatima Amin, Anil Kumar Gupta, and Syed Towseef Ahmad

Abstract Floods, landslides, and climate change hazards, to name a few, are all common natural hazards that have significant economic and social consequences in India. Tornadoes and floods have aided in the slowing down of progress toward the accomplishment of sustainable development goals. Recent observations of extreme weather events in different countries, as well as a growing understanding of their threat and increased risk of flooding, should compel authorities to act. This work focuses on Integrated Disaster Management strategies, Extreme events and the main causal factors. It was discovered that these events have rather complex components, which are reflected in the combined climatological characteristics, geological substrate properties, and human activity, all of which played a role in the rapid change.

In addition, present study aims key findings, conclusions and recommendations arising from the policy space. Floods, landslides, drought etc. are usually regarded as dreadful dangers that pose a severe threat to societal growth and economic development at diverse spatial and temporal scales an important aspect in developing community resilience to hydro metrological disasters is establishing policies and actions to strengthen early warning systems.

Results from this study suggest some of the mitigation strategies at national as well as on regional levels, the provision of knowledge to enhance the prevention of hazards and the development of appropriate response plans.

Keywords Integrated disasters · Disaster models · Sustainable approach · Preparedness · Gap areas · Resilient cities

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1.1 Introduction

Disasters are the result of combination of hazard and vulnerability. Disaster Risk management minimizes the vulnerability in order to safeguard people and property; it's all about saving lives and livelihoods. As a result, the Sendai Framework's international certification targets and goals of disaster risk reduction, including the 2030 Paris Agreement on Climate Change, included an integrated approach to risk management. The approach proposed by UNESCO is to "integrate economic, political, and social dimensions, as well as ethical considerations and human rights issues."

Natural and technical catastrophes, these two categories of hazards are outlined in the UN International Strategy for Disaster Reduction (UNISDR 2002). There are three types of natural disasters: (1) Natural disasters caused by hydro-meteorological events such as Floods, storm surges, droughts, cyclones, and related disasters (such as forest/scrub fires and high temperatures), and the occurrences like avalanches and landslides. (2) Earthquakes, tsunamis, and volcanic eruptions are examples of geophysical disasters. (3) Natural calamities, such as epidemics and pest infestations. The technological disasters are categorized into three parts: (i) Chemical spills and building collapses are examples of industrial accidents. (ii) Transportation mishaps. Traveling by air, rail, road, or water is an option. (iii) Unusual and unexpected events Household/non-industrial structures collapsing; explosions; fires Natural disasters, whether meteorological (cyclones, floods, tornadoes, and droughts) or geological (volcanoes, earthquakes, and volcanic eruptions) (earthquakes and volcanoes), are well-known for wreaking havoc on human life, the economy, and the environment. Developing countries are extremely susceptible to such catastrophes due to unstable landformsand essential tropical climate, as well as high illiteracy, poverty, lack of sustainable development, and population density. A total of almost 4 billion individuals were affected by disasters, which took around 1.23 million lives on average every year, and disasters led to economic damages caused by natural and techno disasters approximately US$ 2.97 trillion worldwide (UNISDR 2002; Pandey et al. 2021). The terms disaster management and emergency management are often used interchangeably. It entails the adoption of plans, organizations, and agreements to engage the routine endeavor of authorities, volunteer, and commercial entities in a comprehensive and coordinated manner to respond to a wide variety of emergency situations. When a calamity strikes, such operations must be carried out as early as possible.

1.2 Integrated Disaster Management: Concept and Scope

Proactive and reactive strategies are included in the integrated approach. The proactive strategy involves risk identification, mitigation, preparedness, and partial response actions that are based on the identified risk in the phases of prediction and warning. Since these activities are mostly based on the identified risk so, risk

prediction and assessment are important and critical. Assessing impacts and their severity is part of the reactive approach. Response and recovery measures for the warning, rehabilitation, emergency relief, and reconstruction stages of disaster management can be carried out depending on the severity of hazard events. As a result, the impact assessment is important to the success of disaster-related public project management.

The most essential concern in disaster management is hazard identification and assessment (Uitto 1998). Its assessment, accuracy, and information quality are critical elements in effectively mitigating the negative effects of disasters. A risk assessment involves examining not only the physical, economic, physical, and social aspects of vulnerability, but also the technical features of hazards, such as their intensity, frequency, location, and probability. Vulnerability refers to the areas impacted by economic, social, physical, and environmental variables or processes that make a community more susceptible to injury of a disaster (UNISDR 2002). The major actors at the national, regional, district, sub-district, and village levels are typically the responsibility of risk identification and assessment. The government unit, particularly the Department of Mitigation and Preparedness Center, is the primary critical stakeholder in disaster management (DMPC). Impact levels must be assessed because they can be used for rehabilitation and restoration. The main aims are to assess the extent of damage caused by disasters in terms of economic, environmental assessments, and social, for prioritizing the rehabilitation and reconstruction of affected communities, as well as planning and designing the reconstruction process.

Using an integrated approach to disaster management can yield significant benefits. First, adopting a proactive approach allows for vulnerability reduction, preparedness, and warning before they occur. The onset period of hazards is generally used to categorize them. Some have a gradual onset and give you time to take precautionary measures. Droughts, floods, and volcanic eruptions are examples of slow-onset hazards. Recently, drought and their impacts are widely investigated (Kumar et al. 2021; Poonia et al. 2021a, b).

Other hazards, such as flash floods, tsunamis, and cyclones, have little or no warning time. A sufficient lead time raises the chances of sustaining lives, livestock, property, and livelihoods in a vulnerable population. When a proactive strategy is implemented, these potentials can be fulfilled as gains.

The integrated strategy includes both proactive and reactive disaster administration policies for during, before, and after disasters. As the severity and frequency of natural disasters rise, more and more lessons have been learned on how to improve resilience to catastrophic occurrences using insurance and other risk transfer instruments to better protect people from further natural disasters. There are five steps for managing any disaster (Fig. 1.1):

1. **Prevention**: A risk analysis is the first step in preventing major damage; it involves identifying hazards in a specific area and determining the vulnerability of agricultural areas, infrastructure, and businesses. In the next stages, this analysis will indicate what can be done to avert damage and feed into risk transfer

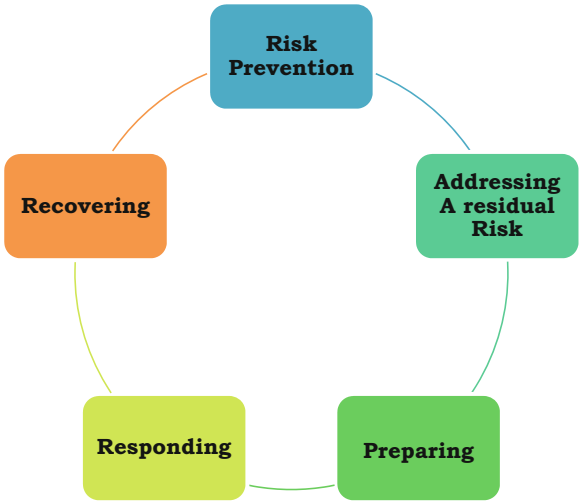

Fig. 1.1 Disaster management cycle

instruments and early warning systems. We can fortify infrastructure with robust materials to make it more resistant to meteorological hazards, and communities can work together to plant trees, build a wall to protect farm land and infrastructure from heavy rain, or clean drainage systems to prevent flooding. Land use regulations can be implemented and enforced by the government to ensure that people should not build in flood-prone areas.

2. **Addressing residual risk:** However, even if all preventative steps are taken, some hazards remain. This is where ex-ante finance, or financing before a hazard occurs, might be beneficial. Individuals can get a micro insurance policy in the event that their property is harmed. Weather Index insurance, which pays out when there is too much or too little rain during the year, could be a useful alternative for farmers in the community. Governments can also protect communities by providing pre-disaster finance through contingency facilities, which ensure that funds are accessible immediately after a disaster strikes to give humanitarian relief and support reconstruction. Different prevention strategies will dramatically reduce the overall risk exposure, reducing the price of these types of insurance and financial instruments.
3. **Preparing:** Community can prepare by stockpiling food and water in case of an emergency and ensuring that they have a safe place to go. Individuals can be trained in rescue and emergency services, early warning systems can be developed, and contingency plans can be developed to emphasize important what to do in the event of an emergency. Adaptation investments can also be are made to assist countries in adapting to climate change.
4. **Responding:** When a natural disaster strikes, the community and the government go into response mode. To avoid further loss of life or damage to property, it is critical to act swiftly. They can do so by assisting in the search and rescue effort, giving temporary shelter and food, and rebuilding the most critical infrastructure

as rapidly as possible. Ex-anti-financing will play a significant part in enabling this speedy response.

5. **Recovery:** The recovery process begins now that the community has responded to the disaster's first effects. Examining the regions and restoring things in a smarter approach that avoids these problems from happening again is necessary for a better recovery. All of these processes are interconnected, and they operate best when countries, governments, communities, and individuals engage. The repercussions will be considerably less severe if everyone learns what to do in the event of a natural disaster. All of these processes will make communities more resilient, ensuring that natural threats do not become disasters.

Many developing countries, which are more prone to disasters, lack proactive early warning, mitigation, and preparedness measures. Without a preventative approach, massive damages and devastation occur when calamity strikes. Previous disasters, which killed many people and destroyed natural and personal property, have always served as a reminder of people's negligent disaster risk management failures. Many lives can be saved by using an integrated approach.

1.3 Disaster Management Models

Most models are built on basis of historical data and observations, with the presuppositionthat the past is a good prognosticatorof the present and future. The vertiginousnumber of people on the planet, a changing climate, and the dynamic inter-connectivity of the biological and physical worlds all pose obstacle, forcing us to reconsider our assumptions about the relationship between past and future danger. Researchers and agencies have developed a variety of disaster management methods. Despite their effectiveness in some areas, disasters continue to be a major impediment to long-term development.

Some categories of disaster management models used for integration strategies are mentioned below:

The first category model is logical model. The key incident and acts that make up a disaster are accentuated in logical models, which provide a abbreviated definition of disaster stages. One of the well known and most extensively used disaster management logic models is the traditional model. The typical disaster management approach has three phases in this model: before, during, and after the incident. The first phase comprehend efforts such as prevention, mitigation, and readiness, while the second phase contains reaction and response activities, and the third phase includes recovery, reconstruction, and development activities (ADPC 2000) Integrated models are the second type of model. An integrated model of disaster management is a technique for arranging the actions involved in disaster management in order to ensure efficient and effective accomplishment, and it has four components: hazard evaluation, risk management, mitigation, and preparedness.

One of the most well-known integrated models is the Manitoba model. Strategic plan, hazard assessment, risk management, mitigation, preparedness, and monitoring and evaluation are the six autonomous elements of this concept. Each element has its own set of activities and procedures, as well as its own set of boundaries. The benefit of this strategy is that it strikes a balance between readiness and flexibility, allowing crises to be responded to quickly. This approach establishes a relationship between disaster-related activities and events, which can be either tight or loose.

Cause models are the third type of model. The concept of specify stages in a disaster is not applied to the cause category. This category suggests some of the disaster's fundamental causes. One of them is the Crunch model, which gives a framework for understanding disaster causes (ADPC 2000; Bankoff 2001; Cannon 2004; Heijmans 2001). This model is based on the speculation that certain factors influence catastrophe vulnerability. These facet are referred to as components at risk in this approach, such as human life and property, the environment, and infrastructures. The extension of a community's susceptibility is disclosed, and the underlying factors that fail to meet people's requests are discovered. After that, the model calculates the dynamic pressure and threatening situations.

Combinatorial models, which combine the logical, integrated, and causal models to propose a model, are the fourth type. One of these models, the Cuny model, is constructed up of features from the other three groups (Cuny 1998).

Last, the fifth category refers to models that do not comprise any of the previously stated attribute. Models that fall into this category are miscellaneous and refer to those whose structure and template does not fall into one of the four categories. For example, Ibrahim et al. (2003) proposed a model to depict the stages leading up to technology disasters. Shaluf and Said (2003) have enquired about the model's specifics.

Eight phases are included in this model: the emergence of errors, the accumulation of errors, warnings, and failures of corrections, stages of impending disaster, triggering events, an emergency, and the disaster.

1.3.1 Integration in DRR

Climate change is increasing the risk of disaster – from single climatologically events, and also from sustained global warming, thus cascading risk from impacts on human systems in the short, medium and long terms. It is still difficult to predict how dangers – such as their intensity and frequency – would affect human activity. Current risk measurement and management methodologies are unable to handle the problems of hazard's multidimensional interconnection, exposure's scarcely known breadth, and vulnerability's profound intricacy; we must tackle this inadequacy if we are ever to accomplish more than treat the symptoms. Understanding and controlling risk is everyone's business, and it's critical to the success of all 2015 agendas: "Disaster risk reduction necessitates all-of-society engagement and partnership" and "Civil society, volunteers, community-based organizations, and organized voluntary

work organizations promote resilient communities and all-of-society disaster risk management that strengthens communities, in conjunction with public institutions" (Paras. 19d and 36).

1.3.1.1 Challenges of Increasing Disasters

Disasters' nature and severity are influenced by exposure and vulnerability as well as extremes. Presently, anthropogenic climate change, natural climate variability, and socioeconomic development all have an impact on climate extremes, exposure, and vulnerability. Even when risks cannot be totally removed, disaster risk management and climate change adaptation seeks to minimize exposure and susceptibility, as well as strengthening resilience to the possible negative effects of climatic extremes. Vulnerability and Exposure are important factors in determining catastrophe risk and the consequences if the risk is fulfilled. A tropical cyclone, for example, might have quite diverse consequences depending on where and when it makes landfall. Severe and non-extreme weather or climatic events alter resilience, coping capability, and adaptation, making people more vulnerable to future extreme events. Specifically, the cumulative impact of disasters on local adaptation and disaster risk management measures in a changing environment to minimize and manage disaster risk. Extreme weather and climate events alter in frequency, intensity, spatial extent, duration, and timing as a result of climate change, and can result in unprecedented extremes.

1.3.1.2 Framework of Integrated Disaster Management Strategies

The efficiency of catastrophe risk management and climate change adaptation are hampered by the lack of a comprehensive conceptual framework that allows for a common multidisciplinary risk assessment. Several worldwide disaster risk reduction (DRR) frameworks have been created over the last few decades. Japan's "Hyogo Framework for Action 2005–2015" and its follow-up "Sendai Framework for Disaster Risk Reduction" provide general instructions for minimizing the risk of natural disasters. As previously said, current research focuses only on a few disaster management related aspects such as inter-organizational coordination, vital infrastructure, mitigation planning, and emergency aid. As previously said, current research focuses only on a few aspects of disaster management, such as mitigation planning, vital infrastructure, inter-organizational coordination, and emergency aid activities. While individual system and phenomenon analysis is crucial, understanding the intricate interactions among many systems and processes, as well as multiple phenomena, is critical to obtaining the desired outcomes. Without the need for an integrative approach, possible integration risks and coordination concerns may occur, affecting performance across the disaster management life cycle. Integrated systems and processes are essential in reality, a little-studied issue in disaster research. Lack of an integrative perspective hinders the ability to assess and build solid strategic and operational plans to cope with disaster consequences in complex

disaster management systems and processes. DRR should be considered in all areas of infrastructure development, health, mountain agriculture, and land use planning, Risk-based planning will aid in the creation of new land uses and the strengthening of current ones.

1.4 Initiative Taken for Integrated Disaster Management in India and Globally

Natural disasters have caused a great deal of concern on a global scale. Despite significant scientific and technological advancements, disaster-related deaths and property losses have not lessened. The United Nations General Assembly recognized the decide 1990–2000 as the International Decade for Natural Disaster Reduction in1989, with the intention of minimizing mortally and property damage and mitigation socio-economic disruption through concerted international effort, particularly in developing nations. The Indian government has initiated a paradigm shift in disaster management over a decade. The new method is premised on the idea that development cannot be protracted unless disaster mitigation is integrated into the strategic planning. Another premise of the method is that mitigation has to be multidisciplinary, encompassing all aspects of sustainable development. The new approach is also based on the assumption that mitigation investments are more cost effective than relief and rehabilitation. The Central Government established a High-Powered Committee on Disaster Management in 1999 to develop India's holistic response to "natural" catastrophes, which was later expanded to include "man-made disasters."Institutional inertia and an inability to comprehend the given context within which disaster management building based at the local level have led in few dramatic shifts to DRR 'on the ground' as an outcome of policy modifications at the national level. The paradigm shift that is anticipated in India is a shift in focus toward integrating national-level management with a bottom-up, positivist paradigm to hazard management.

In Single Hazard approach subsystems are created with which we can model the threat "satisfactorily" and according to the availability of the data. The same procedure is used for the analysis of multiple hazard approach, where subsystems are created for each individual process and just combine and compare the results. However, as natural processes, hazards are part of the same general system; they influence each other and interact. Therefore, the multiple hazard risk contains emergent properties: it is not just the sum of the single hazard risks, as their relationships would not be taken into account and this would lead to unexpected effects. For analysis purposes, the relationships can be divided into changes in disposition and activation (cascades and associated activation). In the integrated development planning process, multiple hazard maps are an important tool. Planning for development fails to address all natural hazards and to make provisions for their mitigation would eventually result in the property damage, bodily injuries, loss of

lives, the disruption of important economic operations, and key facility failures. The real impact of the hazard can be catastrophic and terrible, depending on the size of the event, its location, and its ramifications. Natural resources, energy, infrastructure, agriculture, industry, human settlements, and social services are all prioritized in the integrated development planning process (OAS 1984). It places a premium on gathering and analyzing data on natural hazards in order to mitigate their negative influence on development. Natural disasters are thought to be avoidable or significantly reduced if hazards are recognized and appropriate mitigation measures are introduced into each level of the integrated development planning process.

1.5 Suggestions for Integrated Disaster Management Strategies

Insufficient and ineffective conception of the issues India confronts in developing its approach to disaster risk reduction is viewing the gap between policy and action for disaster risk reduction in India in terms of a few functional challenges. Instead, our findings show that India's DRR policy framework struggles to achieve its objectives because policy discourse has been de-contextualized, and there have been no shifts in perceptions of disasters as being driven by societal issues. Instead, attaining these objectives will demand a focus on (a) understanding how disasters are perceived and experienced at the local level, and (b) understanding institutional opposition to introducing a conceptual framework.

1.5.1 Proposed Approach of Integration for City Resilience

The global human population is projected to increase from 7.32 to 9.55 billion between 2015 and 2050 and at the same period the population of cities will increase from 3.96 to 6.34 billion (Koop et al. 2017). This rate of population growth will have substantial impacts on food and water supply, nature and built-up environment including Air, Water and Soil (Grant et al. 2015; Hoekstra and Wiedman 2014). Climate change, more particular in the urban regions has been observed globally and had a disastrous impact on its human population as well as on the natural biodiversity (Shaw et al. 2010). Cities are complex and dynamic systems that get evolved from the interaction between different elements like urban, social, and economic and policy factors (Vona et al. 2016). These factors continuously interact with each other and make the governance very complex function, more significantly in case of risk management. The functioning of these complex infrastructural systems determines the post disaster resilience of urban areas (Schwab et al. 1998). Therefore, rigorous efforts are needed to be taken in order to make cities and other urban regions more Disaster Resilient (Mileti 1999; Burby et al. 1999; Albrito 2012).

Scholars from diverse fields have extensively carried out research on climate resilient cities. The concept of 'resilience' in the contemporary times has carved its place in different fields (Vale 2014). Cutter et al. 2014 aid the emphasis upon the importance of culture creation of resilience and it was observed that the community resilience should be integrated approach based. Significant progress has been made to investigate, understand and improve the frame work and methodology for better community resilience (Ainuddin and Routray 2012; Zobel 2011; Olwig 2012).

In the last 20 years, disasters have affected billions of people, caused trillions of dollars in damage and killed millions. People in developing countries, particularly the most vulnerable communities, have been affected by natural disasters. Urban dangers are continuing to rise, particularly in the context of rising urbanization. Cities are becoming more vulnerable to disasters, owing to the poor living in high-risk metropolitan locations. However, disasters such as earthquakes, hydro-meteorological hazards, and others are not taken into account in urban planning and development. As a result of this fact, countries must focus on making the globe a safer place for urban dwellers and adopting novel techniques to strengthening resilience (Fig. 1.2).

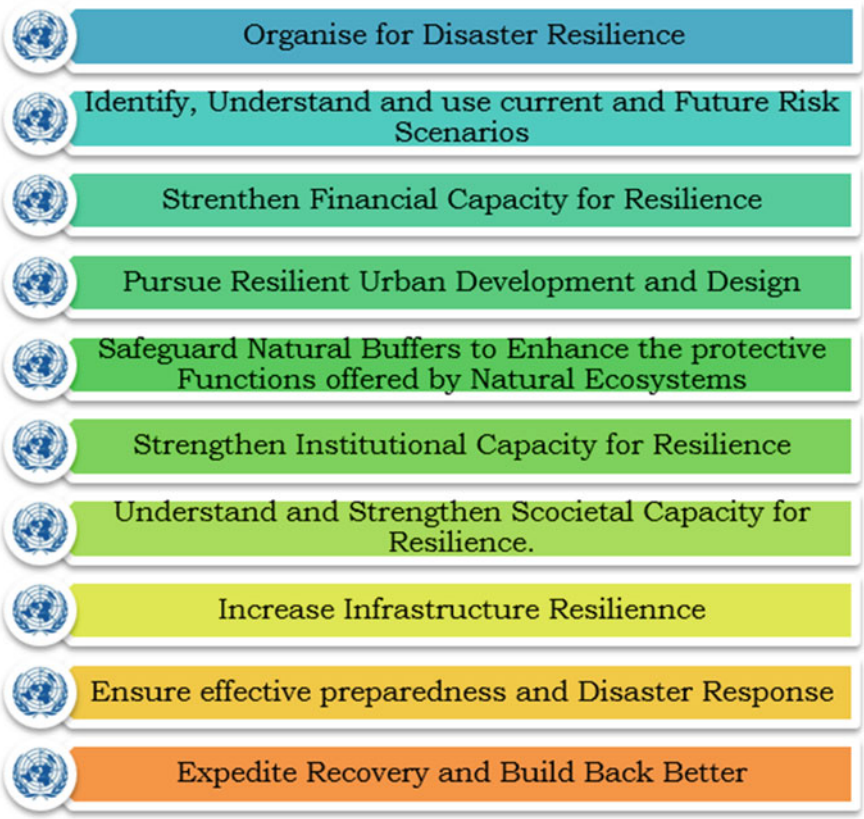

Fig. 1.2 Essentials for making Resilient Cities. (Source: UNISDR 2017)

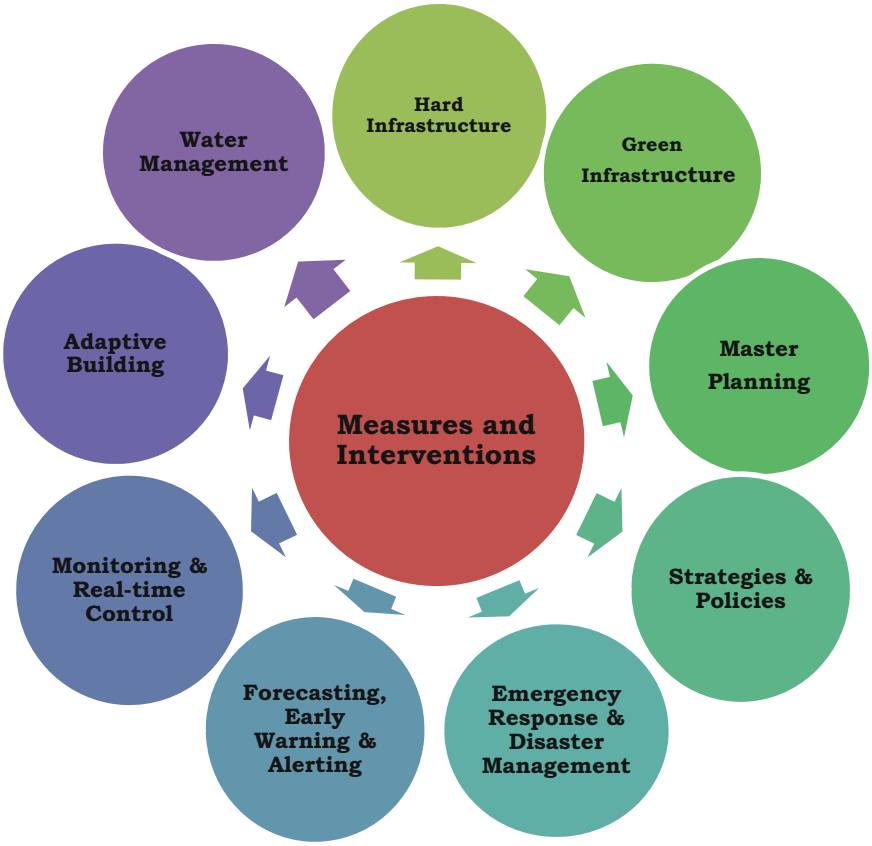

Fig. 1.3 Measures and Interventions for Resilience of Cities

The need for urban resilience is growing and local governments in the regions have shown some progress in building disaster resilience at the local level. Despite its importance, the poor financial situation and the inconsistency of resources are the most prominent problems. Cities should take improvement initiatives by incorporating identified disaster risk reduction measures into appropriate plans and taking proactive steps to implement DRR measures to ensure resilience and therefore reduce losses caused by disasters. Responding to the problems of achieving urban resilience and the Sustainable Development Goals will take significant work all over the world (Fig. 1.3).

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Chapter 2
Public Policy in Environment and Sustainability Strategies: Global & National Scenario

Sweta Baidya and Anil Kumar Gupta

Abstract Policies are the way of bringing change in the system and regulating the behaviour of the allied stakeholders. The idea of policies dates back to the ancient ages of Harappa Civilization 4500 years back. Since then numerous policies have been prepared for saving the nature and environment. United Nations (UN) has taken important roles in environment and climate change related policy intervention, starting from creating awareness to implementing strict laws within the countries. In India, keeping pace with Paris Agreement, several environmental policies have been prepared and implemented, but being a developing country, India is facing challenges in implementing the Nationally Determined Contributions due to economic shortfall. Mobilization of International finance is in need to implement many of India's targeted Green Policies. India has numerous policies and guidelines to safeguard the natural setting and the environment but proper implementation is needed.

Keywords Environmental policies · Sustainability strategy · Climate conference · Climate change adaptation · Disaster risk reduction

2.1 Introduction

Policies are rules those are followed at country level (Sertyesilisik 2019). Policies are guidelines, methods or systematic principles which are implemented or adopted as procedure or protocol by governing body to help in decision making and achieve rational outcomes (Kalu 2021; Alzadjali 2019). Policies are "Defined guideline used to direct and support decisions and actions" (Mayes 2015, www.igi-global.com). Policies can also be termed as "The science and art of employing, a careful plan or method, the art of devising or employing plans or stratagems toward a goal, an adaptation or complex of adaptations (as of behaviour, metabolism, or structure) that

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serves or appears to serve an important function in achieving evolutionary success" (Baporikar 2018, www.igi-global.com).

Policies play an important role in citizens' life and livelihood. As a common practice lawmakers are employed by Government, to set policies to be followed by government workers and all citizens of the country (Point Park University Online 2021). Sometimes the policies can be made in international level by coalitions of Governments of various countries to achieve some common goals and those policies are implemented worldwide, like for example, climate policies and policies on green growth. The cycle of policy making starts with the setting of the agenda. At this very first stage normally the public problems or challenges those are impacting the livelihood or associated things like environment etc. are identified and on the basis of this agenda is set. Agenda could be of four different types viz., Systemic agenda, Institutional agenda, Discretionary agenda and Decision agenda. In systemic agenda, all public issues are considered for addressing whereas in Institutional agenda, policymakers pick few of the challenges for working on When lawmakers themselves prepare the agenda is known as Discretionary agenda and the ultimate list of issues which the policy makers are going to address are known as the Decision Agenda. The next step of the policy cycle is Policy formation, involves the development of policy options and debate on the justification and possibilities of the proposed policies. Then comes the decision making stage, where the course of action is decided by the government for benefiting maximum people. After that the implementation of policies come, which is the most important step, where the government puts the chosen policy into effect either for some particular region or entire country. The last step of one policy cycle is policy evaluation where the impact of a particular policy is scrutinized to understand whether the policy is able to achieve the intended goal (Point Park University Online 2021; Benson and Jordan 2015).

2.2 Policy Implementation

There are various approaches for policy implementation. Research shows that the enactment of the legislation happens successfully if "Making it happen", – strategy is taken up (Fig. 2.1). "Making it happen"-strategy is proposed by Dean L. Fixsen, which aims towards enabling with the help of systematic training, supervision and follow up. Implementation through capacity building is another way where adequate capacity building within the organization is taken care of. Implementation of any new policy means change in the already existing procedures and practices which requires individual and organizational capacity building. In the word of Pekka Sundman (Director of the City Development Group, the City of Turku, Finland), "Implementation is about enabling-instead of liner implementation. The key is changing attitudes". irrespective of the quality or intention of the policy, it normally faces resistance. Figure 2.2 explains various types of resistance faced by the policies.