Disaster Risk Reduction
Methods, Approaches and Practices

Atta-Ur- Rahman
Amir Nawaz Khan
Rajib Shaw *Editors*

Disaster Risk Reduction Approaches in Pakistan

Springer

Disaster Risk Reduction

Methods, Approaches and Practices

Series Editor
Rajib Shaw, Kyoto University, Japan

About the Series

Scope of the Series

Disaster risk reduction is a process, which leads to the safety of community 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 of risk reduction. The academic research and higher education in disaster risk reduction has made/is making gradual shift from pure basic research to applied, implementation oriented research. More emphasis is given on the multi-stakeholder collaboration and multi-disciplinary research. Emerging university networks in Asia, Europe, Africa and Americas have urged for the process-oriented research in disaster risk reduction field. Keeping this in mind, this new series will promote the outputs of action research on disaster risk reduction, which will be useful for a wider range of stakeholders including academicians, professionals, practitioners, and students and researchers in the related field. The series will focus on some of 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, human security etc. Through academic review, this series will encourage young researchers and practitioners to analyze field practices, and link it to theory and policies with logic, data and evidences. Thus, the series emphasizes evidence based risk reduction methods, approaches and practices.

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ISSN 2196-4106 ISSN 2196-4114 (electronic)
Disaster Risk Reduction
ISBN 978-4-431-55368-7 ISBN 978-4-431-55369-4 (eBook)
DOI 10.1007/978-4-431-55369-4

Library of Congress Control Number: 2014958292

Springer Tokyo Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer Japan KK is part of Springer Science+Business Media (www.springer.com)

Preface

Disaster risk reduction (DRR) strategies not only save lives and minimize damage but also reduce extra burdens on the economy and enhance resilience to respond effectively during an emergency. Spending on risk reduction is always a profitable business. Prior to 2005 Kashmir earthquake, the emphasis of government of Pakistan was on a reactive approach rather than on DRR policies and strategies. The Kashmir earthquake caused a paradigm shift from reactive to proactive. The disaster management institutions at all levels are poor in terms of technical and financial capacities, which need proper attention for building capabilities and strengthening disaster management authorities. The National Institute of Disaster Management is imparting education and training to certain key stakeholders with technical and human resource limitations.

In Pakistan, multi-hazard risk assessment and mapping is a beneficial attempt to limit the population and property in high-risk areas and reduce the chances of greater disaster impacts. In this regard, land-use planning and enforcement of building regulations would be other effective risk reduction strategies. DRR and climate change adaptation, awareness raising, and education are the major strategies for reducing vulnerability and enhancing resilience. For effective emergency response, training of volunteers and preparedness of rapid response teams can raise community resilience and reduce losses from extreme events. Priority needs to be given to community-based DRR strategies, as it empowers the local population with self-sustained efforts to withstand or resist unforeseen events. With this approach, the community relies on locally available resources rather than waiting for external sources to cope with extreme events.

There is increasing evidence from recent disasters that well-informed and well-prepared local governments and local communities can minimize the impacts of disasters. It is a well-accepted fact that communities vary from place to place, and their perceptions and ways to respond to disasters also vary. Therefore, it is important to decentralize policy and to customize it based on local needs and priorities. A strong and committed local government system is often found to be effective for successfully implementing DRR plans.

Disaster Risk Reduction Approaches in Pakistan is a pioneering regional attempt to provide a balanced approach of theory and practice. The book analytically discusses the status of DRR, drawing examples and lessons from the output of national and community-level programs and projects and other experience in the country.

The book covers all different types of disasters in Pakistan, including geo-physical and hydro-meteorological hazards. It attempts to incorporate and draw some of the key lessons learned from the pre-disaster and disaster phases to the post-disaster phase and provides an effective framework in the form of those lessons. The rich content is based on a selection of available documents, a consultative workshop with academicians from different universities undertaking DRR higher education programs, and the editors' own knowledge and experience in the field. Special emphasis is given to analyzing field experiences from academic perspectives and pinpointing key issues and the policy relevance of DRR.

The book is organized into three sections, with a total of 20 chapters. Section one provides the outline and basics of DRR strategies applied at the national level with supporting examples from a global review. Section two specifically highlights the wide ranges of hazards experienced in Pakistan and draws examples, policy options, institutional set-ups, risk reduction strategies, and key lessons learned. The third section of the book is given to approaches and issues of DRR practices and examples of disaster responses.

The primary target groups for this book are students and researchers in the fields of environmental sciences, geography, geology, earth sciences, DRR, and climate change studies. The book will ultimately provide a strong idea of current research trends in each field and will furnish basic knowledge on this important topic in Pakistan. Another target group comprises practitioners and policy makers, who will be able to apply their collective wisdom to policy and decision making.

Peshawar, Pakistan — Atta-Ur-Rahman
Peshawar, Pakistan — Amir Nawaz Khan
Kyoto, Japan — Rajib Shaw

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Part I
Overview of Disaster Risk Reduction

Chapter 1
Introduction and Approaches of Disaster Risk Reduction in Pakistan

Atta-Ur-Rahman and Rajib Shaw

Abstract In Pakistan, the massive 2005 Kashmir earthquake was a turning point to rethink and restructure the disaster risk management system. As Pakistan has a long history of natural hazards occurrence that range from geophysical events to hydrometeorological processes. Almost every year, the impacts of disasters put extra pressure on the country budget. Looking to the transition in economic system, the importance of disaster risk reduction (DRR) was realized and the issue was properly addressed and the national disaster management commission (NDMC) was established in 2006 to proactively respond to various disasters. In this regard, national disaster management authority (NDMA), a focal body was assigned a task to implement policies, strategies and programs for disaster risk reduction. Eventually, national disaster risk management framework (NDRMF) was developed in 2007, which provides guidelines for all the key stakeholders and in 2013 national disaster risk reduction policy (NDRRP) was developed. However, there is a need of sustainable socio-economic and environmental development to properly mainstream DRR in the policies and programs and especially to cater the poor and marginalized people of the country. To make the country more resilient, to a wide range of disasters, there is an emergent and consistent need of enhancement in social, physical, economic and institutional capacity at national, regional and local level. It is also pertinent that stress should remain on multi-scale and cross-sectoral disaster risk reduction approach. This chapter is divided into seven sections. Section 1.1 introduces the disaster risk reduction approaches practiced at global and country level. Section 1.2 highlights the background and progress of disaster risk reduction agenda at global level, whereas Sect. 1.3 highlights the disasters in the context of Pakistan. Section 1.4 of the chapter describes the disaster risk reduction legislations and institutional set-up in Pakistan, while Sect. 1.5 analytically discusses various risk

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*, Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_1

reduction approaches applied in Pakistan. Section 1.6 discusses the key challenges faced Pakistan in mainstreaming disaster risk reduction, whereas conclusion is given in the final section.

Keywords Disaster risk reduction • Approaches • Hazards • Climate change • NDMA

1.1 Introduction

Globally, disasters have increasing impacts on human use system. Each year, massive disaster events of earthquake, floods, drought, heat waves, cyclones, tsunamis etc. killing thousands of people and render hundreds of thousand injuries and cause billions of economic loss (GECHS 2008). The disaster impact largely varies from country to country depending upon the physical and socio-economic resilience of a community. In developed countries, the economic losses due to extreme phenomenon have been registered as higher than the developing nations, whereas it is vice versa for the estimates of human casualties (Rahman 2010). Developing countries are the hot spot for disaster events. It is developing nations, where disasters represent a major source of risk for the poor and can potentially destroy development gains and accumulated wealth (World Bank 2005).

The CRED (2014) estimate shows that the frequency of disaster events are on rise from mere 100 disasters per decade (1900–1940), to over 2,080 extreme events during 1990–2000. In all these disaster events, the occurrences of hydro-meteorological disasters have been increased, whereas the number of geo-physical events has remained fairly steady (IPCC 2007; UNISDR 2009). The CRED report (2014) also reveals that on average each year 373 country-level disasters occur, which kill over 100,000 people, with estimated economic loss of 156 billion US dollars. In 2013, Asia was the hard hit region with an estimated fatality of 88 % from all type of disaster events as against 62 % decadal average. Analysis on the basis of type of disaster indicates that flood and storms were responsible for over 80 % (flood 43 % and storms 41 %) human casualties. In terms of occurrences, mortalities and population affected, more than 80 % is attributed to floods and storm surges (hydro-meteorological disasters), which is attributed to the climate change exacerbations. The IPCC fourth assessment report suggests that climate change is likely to accelerate the intensity, duration and frequency of floods, storms, heat waves, drought etc. The IPCC (2007) has identified impacts of climate change including significant increase in heavy precipitation, increase in tropical cyclone and longer drought periods. Similarly, during 2013 in the list of most affected countries, Pakistan was ranked at fifth position (CRED 2014), whereas German Watch ranged Pakistan at third amongst most affected nations (Kreft and Eckstein 2013).

Pakistan is part of south Asia and relatively bounded from the north by China, north-west by Afghanistan, west by Iran, east by India and south by Arabian Sea.

Geographically, the country extends from latitude 24° to 37° North and longitudes from 62° to 75° East (Khan 2003). The total geographical area of the country is approximately 796,095 km^2. Pakistan has five provinces namely Punjab, Sindh, Khyber Pakhtunkhwa, Baluchistan and a newly established province of Gilgit-Baltistan, a Capital territory and Federally Administered Tribal Areas (FATA; Khan 2010). In addition to these, there is a territory of Azad Jammu & Kashmir (AJK). Each province is further divided into divisions and the same is divided into administrative units called district.

Pakistan can broadly be divided into three physiographic units i.e. mountains, plateau and plains. The country is bordered on the two sides (on the north and west) by mountains. Almost 60 % of the country is mountainous and constitute the world famous mountains of Karakorum, Himalayas and Hindu Kush. The eastern Hindu Kush falls in Pakistan and borders with Afghanistan in the north-western section of the country. The western Karakorum and Himalayas are also located in the north and making a physical border with China. In Pakistan, there are five out of 14 peaks having altitude over 8,000 m above sea level (asl). Similarly, 108 peaks have above 7,000 m altitude (Rahman and Khan 2013). The world second highest peak lies in Karakorum (K2; 8,611 m), which is located in Gilgit-Baltistan, whereas, Nanga Parbat (8,126 m) in Himalaya, Gasherbrum-I (8,080 m) in Karakorum, Broad Peak (8,051 m) in Karakoram and Gasherbrum-II (8,035 m) in Karakoram.

The Karakorum, Himalayas and Hindu Kush are hosted by numerous large and small glaciers (Rahman and Khan 2013). In Pakistan, glaciers have covered around 17,000 km^2 areas. It is the second biggest mass of glacier outside the north and south poles. All these glaciers are the water towers and reservoirs for supplying fresh water. It feeds more than 50 small and large rivers in Pakistan (Khan 2013). The perennial supply of water from these glaciers is the life line for the people and economy of Pakistan. As the country is agro-based and heavily dependent on perennial supply of irrigation for agriculture, industrial use, hydro-power generation and the most important is the domestic utilization. Without these glaciers, the country would have been an uncongenial arid land to support the growing population. Due to climate change phenomenon, glaciers are retreating in northern Pakistan. As a consequence of glacier melting, it would have significant impacts on the agricultural production, hydro-power generation, industrial establishments and eco-biodiversity in the vast Indus plain of Pakistan. Besides this, these glaciers also attract large scale tourists, trackers and scientists from all over the world.

Contrary to this, Pakistan is vulnerable to wide range of hazards including earthquakes, landslides, floods, extreme weather phenomenon, Glacier Lake Outburst Floods (GLOF), snow avalanches etc. The country's extreme vulnerability to climate change is a feature of its geographic location, elevation as well as demographics. Pakistan lies on a steep incline, dropping sharply from almost 8,500 m down to sea level within an aerial distance of less than 2,000 km. This situation is augmented by the presence of huge glacial reserves in the north. Through consistent process of ablation in summer and accumulation in winter, it contributes more than 70 % water to river discharge. This frozen "blue gold" is the country's most precious resource and sustain the agro-based economy aided by the unpredictable summer monsoon rain.

Heavy glacial melt and monsoonal rain supplement sufficient water for irrigation, needed for the arid country but, ironically it increases the risk of both flash and river floods. Over 70 % of the country population is living in the floodplains is directly affected by frequent flooding and reinforces the country's vulnerability. Beside this, the country is exposed to frequent seismic activity and the massive earthquakes of 2005 and 2013 have witnessed the extent of vulnerability.

The climate change has increased the frequency and intensity of hydro-metrological events and also enhanced the unpredictability of the monsoons and posed a major threat to food, water and energy security in the country. In addition to this, the coastal and marine environment, agriculture and livestock sector, forests and biodiversity and health are other areas that will be seriously affected as the climate induced melting of glaciers, heat waves, cyclonic storm surges, diseases/ epidemics, floods, intense precipitation, droughts and variable monsoons have been turned into an inevitable future reality for Pakistan.

Disaster Risk Reduction Approaches are well established within the international development community (Mercer 2010) but still there is a long way and gaps in the strength of knowledge and skill, right from adaptation to prevention, mitigation, preparedness, emergency response and early recovery, which need to be effectively utilized to an ultimate extent. The scientific community, practitioners etc. are struggling to explore and introduce innovative ideas and approaches to effectively address disaster risk reduction and minimize the adverse consequences of disasters. In certain cases, the disaster manager learnt from their experiences and recovered by building safer and better one. Pakistan has also made a shift in the policy, strategies and plans and still in the process of mainstreaming disaster risk reduction in development planning. Vulnerability and risk assessment, emergency response force and mechanism, establishment of multi-hazard early warning system, raising awareness, and disaster and climate change education are one of the long listed strategies to proactively respond to increasing disasters and climate change adaptations. In this changing scenario, the role and responsibility of national disaster management authority is of key concern and need special attention of decision-makers in building capacity and strengthening the disaster management institutions at national, provincial and district level. The challenging task for all disaster related organizations is to effectively manage disaster risk within the country limited financial resources.

1.2 Background and Progress of Disaster Risk Reduction Agenda

Globally there is a paradigm shift in the disaster risk management system from exclusively active approach to proactive one. The concept of disaster management has long been used by the scientific community and practitioners since 1970s. Disaster risk reduction is a crossing cutting discipline and has grown in wider range of holistic approach right from the causing factors to reduction of disaster impacts. In the past few decades, disaster risk reduction policy, strategies and plans consider disasters as social, economic and physical origin. DRR is a systematic process of policies and strategies development for reducing vulnerabilities and building resilience against the unforeseen events (UNISDR 2004). DRR is an organised methodology to identify, assess and minimise the disaster risk and reduce the overall people vulnerability to environmental hazards. Disaster risk reduction focuses on addressing the underlying risk factors in minimizing the potential loss of lives and properties.

1.2.1 Creation of the United Nations Disaster Relief Office

In 1971, general assembly has passed a resolution and as a result the United Nations Disaster Relief Office (UNDRO) was established with its headquarter in Geneva. The purpose of UNDRO was to study natural disasters, assist governments in providing advices and improve disaster warning system. In addition to this, the UNDRO role was to reduce the impacts of disasters and provide technical and financial assistance to disaster prone countries. In 1992, after the establishment of Department of Humanitarian Affair (DHA), the UNDRO was merged under the UN resolution. In 1998, DHA was reorganized into the Office of the United Nations Coordination of Humanitarian Affairs (UNOCHA).

1.2.2 International Decade for Natural Disaster Reduction (1990–1999)

In 1989, the United Nations General assembly designated the period 1990–1999 as the International Decade for Natural Disaster Reduction (IDNDR 1990–1999). The aim of IDNDR was to reduce the human losses and socio-economic disruption caused by disasters. The IDNDR was an attempt to promote disaster risk reduction through rigorous international actions, scientific and technical knowledge. In order to effectively appraise and implement the UN resolution, a Secretariat was established at the United Nations Office in Geneva.

1.2.3 International Strategy for Disaster Reduction

After successful completion of IDNDR (1990–1999), a successor agency under the name of International Strategy for Disaster Reduction (ISDR) was established. In 2002, the World Summit on Sustainable Development, in Johannesburg provided

ISDR with objectives of joint venture of sustainable development agenda, where both the Inter-Agency Task Force on Disaster Reduction and the UNISDR secretariat will work. The objectives of public UNISDR was to increase public commitments, establish linkages to sustainable development and strengthen the networking and partnership.

Under the UNISDR portfolio the International Strategy means to shift from traditional way of dealing with disasters in the form of response to proactive approach of disaster risk reduction, and to promote the culture of disaster prevention. UNISDR (2009) has elaborated that DRR is a concept and practice of minimizing risk by an organized process to analyse and minimize the factors of causing disasters and reduce human exposure to hazards and minimize the people vulnerability. The severity of disasters largely depends on the extent of hazard/s impact/s on a community and environment. The scale of disaster impact is closely associated with the priorities for the type of livelihoods and intervention in environment. The actions which are taken may either enhance the vulnerability to disasters or build resilience against the hazards. It is fact that higher the government, community and individuals understanding of disaster risk and vulnerability, the better equipped would be to cope with and minimize losses.

1.2.4 Millennium Development Goals

In 2000, during United Nations Millennium Summit eight Millennium Development Goals (MDGs) were set-up and all the member states agreed to adopt and accomplish the goals. Out of eight MDGs, four (MDG 1, 3, 7 and 8) are directly related to disaster risk reduction agenda including eradication of poverty and hunger, promote gender equality and women empowerment, ensure environmental sustainability and develop a global partnership for development. In Pakistan, the National Disaster Management Authority is trying to achieve goal 1 through community based disaster risk management and community infrastructural development for building resilience, save lives and protect sources of livelihood earnings. Similarly, a system of compensation for the disaster affectees is already in practice. The risk insurance mechanism is also steadily gaining importance. Regarding MDGoal 2, gender mainstreaming in disaster risk management planning and gender and climate change have already been established. Special attention has been given to provide equal opportunity to women disaster risk management and capacity building. In Pakistan, the Ministry of Climate Change specifically dealing with the MDG 7 to ensure environmental sustainability through introduction of climate change adaptation strategies in disaster risk reduction and introduction of bio-engineering solution. The 8th MDG focuses on development of global partnership for sharing knowledge and best practice. This process however helps the disaster management authority to learn about the best practices and chances of its replication in the home country.

1.2.5 Hyogo Framework of Action (2005–2015)

The 2004 Indian Ocean earthquake followed by Tsunami was a turning point in the history of global disaster risk management system. After fall of Indian Ocean Tsunami, the United Nations call for World Conference on Disaster Reduction, it was held on 18th to 22nd January 2005 at Kobe-Japan. The UNWCDR has provided a platform to bring together the scientific community, government stakeholders and practitioners under a single but comprehensive agenda of reducing disaster vulnerabilities. The Hyogo Framework for Action (HFA 2005–2015) was the outcome of UNWCDR 2005, which insist the nations to explicitly work on five priority areas (GoP 2012b).

The mission of Hyogo Framework of Action (HFA 2005–2015) is to initiate and regularly monitor the progress of building nations and communities' resilience to disasters. UNISDR (2009) highlighted that HFA provides principle and practical guidelines for building disaster resilience. In response, the countries have endorsed DRR in their policies, programmes and development planning process. However, the climate change has further intensified and exacerbated the frequency and intensity of hydro-meteorological disasters. The International Disaster Risk Reduction Community is consistently introducing new tools and techniques to integrate the indigenous and non-indigenous approaches of handling disasters. HFA aims to substantially minimize impacts of disasters and build the resilience of communities and nations. The five key priority areas include:

Priority Action 1: Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation. It stress on the nations to devise policies, institutions and legislative framework for DRR. Population growth, economic development and increasing urban development are the major drivers of escalating trends of disaster impacts. If countries act rigorously can save lives and properties. It further insists on the countries for preparing strategies to quantify the progress in various sectors of the society.

Priority Action 2: Identify, assess and monitor disaster risks and enhance early warning. Increase disaster resilience and climate change adaptation needs knowledge of various hazards, type of vulnerabilities and risk assessment and management are specifically required at the community level. It is poor section of the society, who is hit hard by the disasters because of their high vulnerability. According to World Bank (2014) over 70 % of the disaster hot spot lies in the low income countries. Low income nations accounted for only 9 % disaster events, but fatalities are more than 47 %. With changing variability in climate related disasters, there is utmost need of multi-hazard early warning system and dissemination of the same to the target population. Risk assessment and early warning system is not a one-time activity, it needs periodic monitoring and updating.

Priority Action 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels. Disaster and climate change education is a key to enhance community resilience. Mainstreaming disaster risk reduction approach into policy, planning and development is one of the effective approaches in minimizing disaster impacts. Capacity building at all levels can help in minimizing the impacts of disasters. It is fact that culture of well–informed and motivated citizen has the potential to prevent and cope better the unforeseen events.

Priority Action 4: Reduce the underlying risk factors. The disaster risk pertaining to human intervention in eco-environmental condition and impacts of hazard associated with geo-physical and climate change need to be properly addressed in development plans and programs. The disaster management authorities should focus on mainstreaming disaster risk reduction in development planning.

Priority Action 5: Strengthen disaster preparedness for effective response at all levels. Disaster preparedness and emergency response are the most critical and sensitive stage of disaster risk management process. The impact of disasters can be minimized if the disaster risk management authorities, community and individuals are fully prepared and ready to skilfully respond to extreme event.

1.3 Disasters in the Context of Pakistan

During the past three decades (1980–2012), a total of about 21,000 natural disasters have been reported, out of which one-third (6,800) is reported from Asia alone (CRED 2014; Munich Re 2014). During the same period, 2.3 million human fatalities were occurred, out of which more than half (52 %: 1.18 million) is reported from Asia. Globally in the year 2012, a total of 905 natural catastrophes were recorded (Munich Re 2014), out of which 76 % were hydro-meteorological events. It is reported from all the six inhabitant continents. In these events, approximately 9,600 human death casualties have been registered, out of which 75 % were attributed to the hydro-meteorological events. Continent-wise distribution indicates that out of total events (905), 37 % is reported from Asia with 64 % fatalities, indicating the low resilience and high exposure to natural catastrophes. The analysis reveals that since 1980 the frequency of natural disasters is on rise. The number of meteorological, hydrological and climatological events has been increased, whereas fluctuation is recorded in the geophysical events.

In Pakistan, during 2001–2013 (13-year span), a total of 25 extreme events has been reported, out of which six earthquake, six landslides and almost each year a flood event is registered (Fig. 1.1). During this 13 year span, 80,415 human lives were lost with a highest figure of 74,484 attributed to earthquake followed by flood (5,722) and landslides 209 fatalities. In terms of frequency, floods lead over all other disasters, however earthquake surpasses due to its intensity and the massive 2005 Kashmir earthquake.

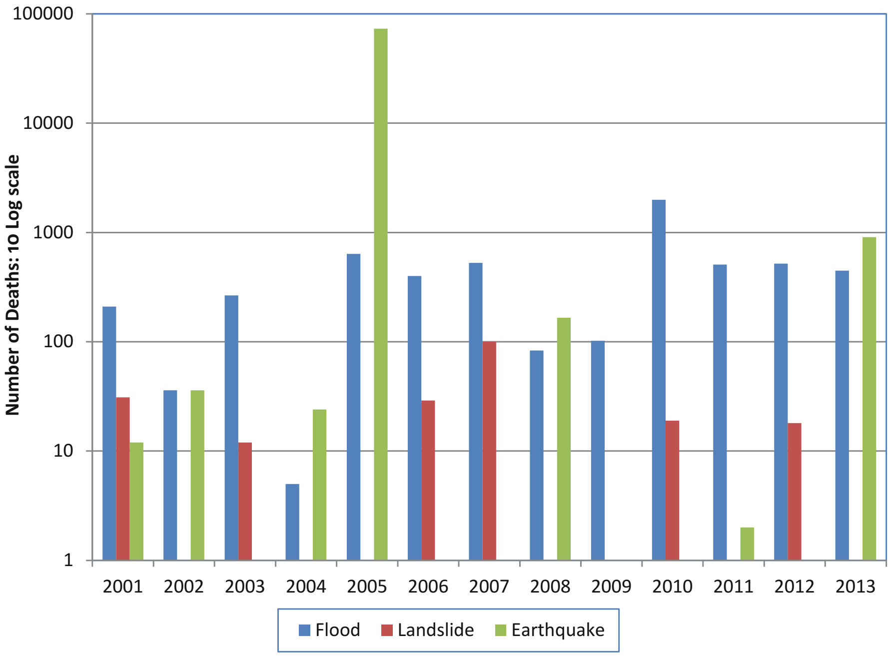

Fig. 1.1 Pakistan, number of geophysical events 2001–2013 (After EM-DAT 2014)

1.4 Disaster Risk Reduction Legislations and Institutional Set-up in Pakistan

Disasters have become a policy requirement for global, regional and local level planning agencies. It demands for effective national strategy, institutional framework and legislation. The disaster risk cannot be eliminated; however, its impact can be minimized through disaster risk reduction (DRR) approaches, systematically. Considering the significance of DRR approaches in minimizing the impacts of disasters, it needs to analyse the disaster resilience, institutional capacity, legislations and practices in Pakistan. The national disaster risk reduction efforts are in progress and trying to systematically mainstream into policies, development planning and programmes.

Keeping in view, the radical changes in the institutional development, the Government of Pakistan has recently established ministry of climate change, climate change policy, National Disaster Risk Reduction Policy and framework to address DRR effectively under the Hyogo Framework of Action (HFA). As HFA priority-1 is more focused on disaster legislations and provides legal basis for other priority areas. The country requires effective legislation and policy framework for institutional development, community participation, resource mobilisation and make these policies and legislations instrumental in mainstreaming DRR in the development plans and programmes.

1.4.1 National Calamity Act 1958

The National Calamities Act of Pakistan 1958 was the only legal document to regulate the relief, rehabilitation and reconstruction. It was only the reactive disaster related legal document functioned throughout the country for a long time. Under this regulation, there was an emergency relief cell within the cabinet division. Again it is refereeing just relief /compensation in either disaster phase or post-disaster period. Under the Calamity Act, in each province there were relief commissioners, who supervised and coordinated the relief and rehabilitation efforts. Few provinces have also developed Disaster Plan such as NWFP Disaster Plan 1978, where list of hazards are available to which the province is susceptible (Rahman 2010). Similarly, it has also highlighted disaster related government line departments and their respective primary and secondary roles and responsibilities particularly in the disaster phase. The Provincial Board of Revenue has been made responsible for collecting information about the damages caused by individual disaster and also to keep record of compensation made to the victims.

1.4.2 UNISDR, HFA and Pakistan

The United Nations General Assembly has created United Nations International Strategy for Disaster Reduction (UNISDR) in 1999/2000. The secretariat of UNISDR is the focal agency in the UN system for the coordination of disaster risk reduction and implementation of the international disaster risk reduction, the HFA (2005–2015). It was adopted under the "Hyogo Declaration" in the World Conference on Disaster Reduction, held in Hyogo prefecture Kobe, Japan in 2005. Its core areas includes ensuring disaster risk reduction (DRR) and climate change adaptation, increasing investments for DRR, building disaster-resilient cities, schools and hospitals, and strengthening the international system for DRR. UNISDR's vision is based on the three strategic goals of the Hyogo Framework for Action: integrating DRR into sustainable development policies and planning, developing and strengthening institutions, mechanisms and capacities to build resilience to hazards, and incorporating risk reduction approaches into emergency preparedness, response, and recovery programmes. The UNISDR introduced new concept to shift from a reactive to a proactive approach HFA (2005–2015) and Pakistan is amongst the 168 signatories of Hyogo Framework of Action (UNISDR 2009). In Pakistan, National Disaster Management Authority (NDMA) is a focal agency for reporting HFA progress. So far Pakistan has been regularly submitting progress reports including the 2007–2009 HFA progress report, 2009–2011 HFA progress report and the recent interim report of 2011–2013.

1.4.3 National Disaster Management Ordinance

After 2005 Kashmir earthquake and one of the signatories of HFA (2005), the Government of Pakistan was stimulated towards institutionalisation for disaster risk reduction. There was high time for capacity building of disaster related agencies at national, provincial, district and local level. As after the earthquake, numerous challenges emerged and encounter the situation. Keeping in view this alarming state, the then president of Pakistan promulgated the National Disaster Management Ordinance (NDMO; now Act) in 2006 (GoP 2012a). Under this ordinance, National Disaster Management System was introduced in the country. Similarly, the National Disaster Management Commission (NDMC) was established at the federal and provincial/state/FATA/G-B Disaster Management Commission at the regional level. The NDMC was assigned the task of preparing and approving guidelines, policies and plan for disaster risk reduction. Eventually, the National Disaster Management Authority (NDMA) was established to follow-up the directives of the commission.

1.4.4 National Disaster Management Authority

In Pakistan, the National Disaster Management Authority (NDMA) was established in 2007. Under the NDMO, the NDMA was made a focal point and held responsible for coordinating, implementing and monitoring body for DRR in the country. Under the Ordinance (now Act), the National Disaster Risk Management Framework (NDRMF) was prepared by the NDMA in March 2007 (GoP 2012b), which serves an overall guideline for disaster risk management at national, provincial and district levels. In March 2010, the NDMA formulated the National Disaster Response Plan (NDRP) for identifying specific roles and responsibilities of the key relevant stakeholders in emergency response including Standard Operation Procedures (SOPs). In addition to this, the NDMA, in collaboration with national and international partners has been in the process of strengthening the disaster risk management system in the country.

1.4.5 Pakistan National Disaster Risk Management Framework

In Pakistan, the National Disaster Management Commission was established at national level and its entities at regional level. The regional commissions namely: Punjab Provincial Disaster Management Commission, Sindh Provincial Disaster Management Commission, Khyber Pakhtunkhwa Disaster Management Commission, Baluchistan Disaster Management Commission, Gilgit-Baltistan Disaster Management Commission, State Disaster Management Commission and

FATA Disaster Management Commission. Each regional commission is headed by chief executive of respective region such as in case of province, the Chief Minister. This was a paradigm shift in disaster management system from active approach to proactive one. Beside these regional entities, the National Disaster Management Authority was set a focal body and held responsible to effectively promote the DRR agenda, develop close liaison and implement the same in coordination with the regional and local disaster management authorities. In this regard, in 2007 the National Disaster Risk Management Framework was developed to identify and guide all the stakeholders. The vision of framework is to achieve sustainable socio-economic and environmental development through minimizing vulnerabilities and risk specifically marginalized groups, emergency response and early recovery. The framework has identified nine priority areas including Institutional and legal arrangements for Disaster Risk Management; hazard and vulnerability assessment; training, awareness and education; planning for disaster risk management; community and local level programming; Multi-hazard early warning system; Mainstreaming disaster risk reduction into development; Emergency response system, and Capacity development for post disaster recovery (NDMA 2007).

1.4.6 National Disaster Management Act

The Pakistan National Disaster Management Ordinance was approved by the parliament in December 2010 and became the Act called as Pakistan National Disaster Management Act (DMA) 2010 (GoP 2010). The Act provides the establishment of national disaster management system in Pakistan. Under DMA three levels of disaster risk management has been established i.e. national, provincial and district levels. The DMA provides the comprehensive guidelines and legislative backup for entire disaster risk management system in the country. Chapter 2 of the DMA highlight the power and function of national disaster management commission and establishment of national disaster management authority, whereas Chap. 3 focuses on the power and function of provincial disaster management commission and establishment of provincial disaster management authority (PDMA). However, Chap. 4 is related to third tier namely district disaster management authority. The Act further elaborates the measures to be taken by the government for disaster management function of local authorities, establishment of national institute of disaster management, establishment of national disaster response force, provision of budget and audit, offences and penalties.

1.4.7 National Disaster Management Plan (2012–2022)

The country faces wide range of hazards, which requires country ability to effectively handle these challenges through comprehensive national approach of disaster risk management. During 2008–2009, on the request of Government of

Pakistan, JICA has studied the entire legal and administrative set-up of DRM in Pakistan and a project document on formulation of a National Disaster Management Plan (NDMP) for Pakistan (GoP 2012b). In 2012, with technical assistance of JAICA, national disaster management plan was prepared. The government of Pakistan approved the project which span on long 10 years (2012–2022) with an estimated cost of 1.040 Billion US Dollars. The plan was aimed at enhancing the capacity to prepare and respond to disasters by proactive approach for dealing through disaster risk management in line with the National Disaster Management Act.

The overall NDMP is a comprehensive plan, consisting of the "Main Plan" document along with three supporting volumes besides the Executive Summary, which identifies macro level hazards and risk assessment, development of the multi hazard early warning system to reduce the vulnerability to disasters by enhancing and strengthening the early warning capacity, identification of the roles and responsibilities of key stakeholders, including federal, provincial and district governments, community organizations, NGOs, businesses, and individuals who are involved in the disaster management. The Community Based Disaster Risk Management (CBDRM) approach, in view of its universal reorganization and importance in DRM planning, has been given due place in the Plan. Based on pilot activities tested in different hazard contexts and social settings, best practices and guidelines have been documented in the Plan to serve as model for future CBDRM activities in Pakistan. The Plan also provides strategic direction for systematic human resource development in the field of disaster management and the operational plan for the National Institute of Disaster Management (NIDM).

1.4.8 Disaster Risk Reduction and Partner Organizations

In Pakistan, the National Disaster Management Authority and its regional entities provincial disaster management authorities and district disaster management authorities are working in collaboration with scientific community as well as national and International partner organizations. The disaster management authorities in collaboration with the key partner organizations are in the process of strengthening the disaster management system. The UN agencies, Oxfam Pakistan, Muslim Aid Pakistan/UK, Church world services, save the children, Action Aid Pakistan, Islamic relief, Red Crescent Pakistan, WWF, USAID, Relief international, IRC, ACTED, Response international, World vision, Intercooperation, OCHA, AKDN, SEED Foundation and JAICA are partially or wholly working in disaster risk management sector. The Japan International Cooperation Agency (JICA) remained one of the key partner organization since 2005 Kashmir earthquake. All the partner non-governmental organizations are registered. These organizations are working on disaster risk reduction and most often working in vulnerable community independently. Beside this, there is a long list of national and regional level NGOs working in disaster relief and rehabilitation.

1.5 Disaster Risk Reduction Approaches in Pakistan

The concept of disaster is used since long but in recent literature the shift is from response to Disaster Risk Reduction (DRR), which means to minimize the losses caused by hazards like tsunami, floods, earthquakes, cyclones, droughts, landslide, cyclone etc. DRR is a concept and practice of reducing disaster risks through systematic efforts. Disaster risk reduction is related to devising and applying policies, plans and practices to minimise vulnerabilities and disaster risks. It is a systematic approach to identify, assess and reduce the disaster risk. It aims to reduce socio-economic vulnerabilities to disaster as well as dealing with the environmental and other hazards that trigger them. For effective addressing disaster risk reduction in existing set-up, it is particularly important to get first-hand knowledge about the area which is thickly populated urban areas, trend of urbanization and risk profile (Sharma et al. 2011). Generally, the disaster risk reduction approaches varies from location to location depending upon the physiography, climate, ecological system, socio-economic and political system of the focused area. There is no sole solution to disaster risk reduction which fit everywhere. It is therefore the practitioners have endorsed solution sensitive to the local environment need to be taken for minimizing disaster risk. AMCEN (2011) described that now-a-days promoting local capacity, minimizing vulnerabilities and building disaster resilience at community level has been stimulated both in policy development and practice.

After 2005 Kashmir earthquake, the government of Pakistan has realized the significance of disaster risk management and shifted purely active approach to proactive one and embarked upon establishing appropriate policy, legal and institutional framework and to implement strategies and programs for minimizing risk and vulnerabilities at all levels (GoP 2012b). The Disaster Management Authorities were established at all level to effectively endorse DRR and climate change adaptation in policy, programmes and plan. In this regard, National Disaster Risk Management Framework has been established to guide the work of entire system in the area of disaster risk management. It is time to achieve sustainable socio-economic and environmental development through reducing disaster risks and vulnerabilities, particularly those of the poor and marginalized section of the society.

In Pakistan, the disaster risk reduction approaches are of many fold and the strategies largely varies depending on the type of hazard, location of hazard, type of vulnerability, extent and level of exposure and capacity of institutions, community and individual. The disaster risks are handled by applying the structural risk reduction strategies, non-structural measures and most often integrated approach are preferred with an intention to save lives and reduce disaster impacts. Implement disaster risk reduction strategies and strengthen disaster preparedness and capacities of institutions, community and individual to effectively respond to emergency situation. The hazard analysis reveals that hazards are handled following the major guidelines for disaster risk reduction, which include multi-hazard approach; vulnerability and risk assessment; strengthening resilience of individual, community and institutions; sharing of role and responsibilities; inter-organization coordination;

accountability and transparency. In Pakistan, following are some of the approaches applied for disaster risk reduction:

1.5.1 Disaster Mitigation

Disaster mitigation is defined as measures taken prior to the impacts of disasters to reduce the effects. Some time it is also refers to all those structural and non-structural measures adopted save lives and reduce impacts of hazards. For example construction of protective marginal embankment to limit water within the channel and minimize the risk of flood water inundation or plantation/regeneration of mangroves along the coastline and reduce the risk of tsunami/tidal surges or increasing hazard awareness is also one of the non-structural mitigation strategies. In Pakistan, disaster mitigation is one the most widely applied strategy of reducing disaster risk.

1.5.2 Disaster Preparedness

Disaster preparedness is a pre-disaster phase and deals with the measures taken in anticipation of a disaster to ensure that appropriate, timely and effective measures are taken. Effective disaster preparedness, early warning system and response mechanism particularly for the rapid on-set events is a key component of disaster risk reduction (Parvin et al. 2013). Disaster preparedness actions embedded with risk minimization strategies and promote disaster prevention and saving human lives and properties. It needs to ensure that in community response mechanism has strong back-up by close risk free community, disaster management authorities, volunteers, national and international response teams. In Pakistan, limited disaster preparedness measures are undertaken. In case of flood, the member of federal flood commission meet at least twice during pre-monsoon period (to devise strategies for vulnerable areas) and post-monsoon (to evaluate the flood period and viability of risk reduction approaches and lesson learnt for the future planning). In case of major urban centres, only few cities have so far addressed some of these issues but there is need to implement it across the board. Experiences show that community involvement in disaster preparedness, early warning and response have always played effective role in minimizing the impacts of disasters.

1.5.3 Vulnerability and Capacity Assessment

Vulnerability and Capacity Assessment are the two parameters help in measuring the extent of community exposure to various hazards and the coping capacity of the target population against the unforeseen events. It is an activity related to disaster preparedness stage and provides feedback to build resilience of community against the natural hazards. In this process, the key stakeholders include community, local authority and development organizations. In vulnerability and capacity assessment process, participation of community can play a significant role in devising strategies for risk management. Undertaking such king of activity at national level, helps in identifying the key risk areas and to suggest what strategies need to be taken to minimize the disaster risk. HFA and national disaster management plan of Pakistan specifically stress on vulnerability and capacity assessment as preparedness strategies.

1.5.4 Cross-Sectoral and Multi-scale Approach

In the recent DRR literature, the stress remained on adoption of multi-scale, cross-sectoral and integrated approach to link disaster risk reduction and climate change adaptation in policy, programmes and planning (Birkmann and vonTeichman 2010). Similarly, mainstreaming disaster risk reduction and climate change adaptation approaches, across the board in activities on sustainable development has been introduced recently. In Pakistan, the disaster related line agencies are working in isolation and lack horizontal coordination and most often overlapping roles and responsibilities have been observed (Rahman 2010). This cross-sectoral and multi-scale disaster risk reduction planning approach is particularly lacking in Pakistan. The introduction of disaster related legislations and disaster management are the hopes for multi-hazard risk management in the country. In national disaster management plan (2012–2022), an integrated attempt has been made to deal with various hazards. One of the best examples is the introduction and establishment of multi-hazard early warning system.

1.5.5 Community Based Disaster Risk Reduction

The role of local community is of paramount significance right from mitigation, preparedness, early warning and emergency response to early recovery. The local community remains the frontline players in minimizing vulnerability and enhancing disaster resilience. The practitioners agree on effective role of community in disaster risk reduction and enhancing their capacity in handling climate change issues. Gaillard (2010) elaborated that community participation in risk assessment, vulnerability reduction, capacity development and building disaster resilience need to be promoted at the local level. Community based disaster risk reduction empower local population with self-sustained efforts to withstand or resist against the unforeseen event. The community based risk management strategies usually applied with intention to enhance and rely on locally available resources rather than waiting for the external sources while coping with extreme event. The assistance from the external sources is only required when there is massive disaster impacts and it is beyond the carrying capacity of local community. In Pakistan, CBDRR has been introduced and steadily expanding its roots in the vulnerable community. It is a positive sign toward local level risk reduction with available resources and strength.

1.5.6 Building Codes and Land Use Regulations

Risk and loss reduction call for a comprehensive approach to handle the increasing impacts of disasters. However, there are three major pillars in risk reduction including the government, vulnerable population and the insurance industry (Munich Re 2014). Nevertheless, the role and responsibility of government is of key significance. It attempts to mitigate, establish the forecasting and early warning system, emergency response and early recovery. One way of minimizing disaster risk is the identification of hazard zones and its depiction on hazard zonation map, which guide and enables the disaster managers and resource planners for risk reduction.

Building codes and regulations provide procedures, guidelines and recommendations for structural design and selection of material in various condition. Building codes and regulations are enforced with aim to protect public health, safety and welfare pertaining to buildings and structures. Keeping in view this challenging scenario, the ministry of housing and works, government of Pakistan has recently assigned the task to NESPAK for preparing building codes of Pakistan with intention to ensure public safety (MOHW 2007). Quetta building codes are there but effective implementation is a critical issue for the urban authority. Country-wise enforcement of building codes and regulations particularly in the urban areas is need of the hour. Parallel to this, it is also important to raise awareness of government officials and community about the disaster resilience buildings and structures. In this context print, electronic media can play a vital role. Similarly, training workshop for masons, builders and community members would further enhance their capacity about the importance and development of structures while applying building codes.

1.5.7 Urban Risk Reduction

In Pakistan, almost all the cities have been reportedly facing the impacts of disasters in one way or the other. Some cities have been threatened seriously while others are at the verge. The mega cities including Karachi, Lahore, Rawalpindi, Islamabad and Peshawar have already come across serious episodes of urban flooding during the past one decade. Intensive heat wave is another notable disaster faced by the urban centres. In addition to this, heavy downpour, drought, storm surges, urban flooding are some of the key effects of climate change scenario. Cities are as vulnerable as they are powerful that's why the urban authorities should formulate effective institutional framework for urban resilience and climate change adaptation in a systematic way.

It is estimated that in the next decade, half of the country population will be living in cities and towns. The major share of urban population will be residing in major cities. This is due to limited financial and institutional capacities to manage both historical rooted and emerging risks and its exacerbations. With the growing urban population, it has been explored that if disaster and climate change is not properly mainstreamed in the urban policies and plans; the urban risks will further grow and would have more serious implications on the urban dwellers particularly the slum dwellers who is often without the benefit of safety nets (WEF 2014). Construction of high rise buildings and ignoring the building bye-laws may further increase the vulnerability and can maximize the exposure to massive life and property damages. Urban authorities should take the responsibility of enhancing city resilience through risk assessment, risk reduction, preparedness, emergency response and early recovery.

1.5.8 Establishment of Early Warning System

The timely provision of information about the hazards, enable citizen/community/authority to take measures to cope and effectively minimize the impacts of disasters. Forecasting and dissemination of early warning to the vulnerable community is a pre-disaster phase. The early warning system is different for different hazard events. However, multi-hazard early warning system is a latest approach. It is the responsibility of disaster management authorities to establish multi-hazard early warning system and develop an effective liaison with the national and regional forecasting agencies in sharing forecasting information and timely provision of factual data to the multi-hazard warning centre for onward transmission. Involvement of key stakeholders may further enhance the coping capacity against the extreme events. While devising early warning mechanism, an effective network of community /people centred is of paramount importance. The early warning dissemination (message) should be understandable, fully trusted by and relevant to the vulnerable community. The early warning is of no value until it reaches in time to the population at risk. This also requires appropriate training and capacity building of community to respond effectively to an approaching hazard. In Pakistan, the National Seismic & Tsunami Early Warning Centre, Tropical Cyclone Warning Centre, Flood forecasting and Warning centre, National drought monitoring centre etc. are some of the early warning systems established but need further strengthening.

1.5.9 Emergency Response System

The establishment of emergency response system at national, provincial, district and community level can help in minimizing the impacts of disasters. The National Disaster Management Act has specifically heighted the significance of emergency response system. The national Disaster Management Authority should develop disaster response plan at all levels to effectively respond to emergency situation. In national disaster management Act has also stressed on the formation of rapid response force at all levels. Inadequate response capacity and ignorance of disaster related implementing agencies have brought into notice the dire need of a specialized response system. Such a mechanism is particularly worthwhile for carrying out search & rescue, and evacuation operation in both urban and rural set-up. This requires enhancing emergency response mechanism and capacity building at all level. However, preference and priority need to be given for building emergency response system such as emergency operation centres, rapid response force, civil defence, search and rescue teams at district and community level.

1.5.10 Disaster Risk Reduction and Climate Change Adaptation

Global warming has dramatically changed the climate and is frequently introducing new paradigm of disaster events, which is explicitly the human contribution. The increasing intensity and frequency in hydro-meteorological phenomenon is the direct outcome of climate change phenomenon. It is expected to further multiply the accumulation of greenhouse gases in the atmosphere as a consequence of both stationery sources like industries and movable sources in the form of vehicles, aircrafts etc. Similarly, rapid deforestation has also reduced the carbon sinking points. In some parts of the world these changes are very obvious and the trend is alarming.

Climate Change is globally posing one of the most pressing challenges to the pursuit of sustainable development. This is especially true for developing countries that are particularly vulnerable to the unavoidable impacts of this new and emerging issue. There is an inescapable linkage between climate change and sustainable development. The Global Risks 2014 report highlights that risks are not only interconnected but also have systemic impacts. To manage risks effectively and build resilience to their impacts, better efforts are needed to understand, measure and foresee the evolution of interdependencies between risks, supplementing traditional risk-management tools with new concepts designed for uncertain environments (WEF 2014). Recent advancement in scientific knowledge, effective DRR policy formulation and local level mitigation strategies need to be mainstreamed and to make it in-line with the changing climate scenario (AMCEN 2011). If global risks are not effectively addressed, their social, economic and political fallouts would be far-reaching (WEF 2014).

The IPCC (2007) defined climate change adaptation as “an adjustment in natural or human use system in response to actual or expected climatic stimuli or their effects, which moderate harms or exploit beneficial opportunities”. Disaster risk and climate change are the major challenging issue in the human use system. In this regard, there is growing call for building resilience of nations and communities to disasters. Shifting vulnerable population from risk area is not technically viable solution, because the same location provides numerous opportunities for the local population. In case of floodplain, inundation remained a serious threat to the local population but at the same time it provides fertile soil and water to grow food and cash crops and fulfil household needs. Similarly, in case of coastal zone, on the one hand coastal population exposed to various coastal hazards but at the same time it provides the opportunity of fisheries, forest and food item, which are the major sources of livelihood earnings in the coastal communities. However, with the climate change phenomenon there is increasing trends both in frequency and intensity of hydro-meteorological events, which particularly needs government attention to enhance people capacity to effectively respond to climate related hazards.

In Pakistan, the trend of hazard indicates that occurrence of disasters has been a recurrently occurring phenomenon. Climate change and variability of hydro-meteorological disaster is intensifying the hazards and due to which the cost of damages have been multiplied during the past decades. Due to poverty and the booming population, the people are frequently encroaching towards high risk areas and increasing the exposure to climate induced hazards. These are challenging issues for the decision-makers and planners that in future the climate related disasters will be more frequent, with high intensity and their impacts will be much more severe on the socio-economic, physical and environmental sectors. During the past decade, the episode of drought (1997–2004), flood of 2003, 2005, 2007, 2008, super flood-2010, 2011, 2012, 2013, followed by heavy snowfall over the northern mountain system in 2005–2013, and drought of 2013–2014 and heat waves of 2010, 2014, cyclones of 2007, torrential and prolonged rainfalls, and triggering of numerous rain-induced landslides are some of the glaring examples of climate change exacerbations. The recent scientific literature reveals that in wake of changing climate scenario, there is consistent change in the hydro-meteorological and climatological phenomenon, which poses new risks to the country population. It is time to think and plan effectively to mitigate or improve adaptation with the climate change consequences.

1.5.11 Early Recovery

Early recovery is a process, undertaken to fully recover from the effects of disasters and restore the affected community to pre-disaster level of functioning (Rahman 2010). Early recovery is a costly approach and usually takes long time to restore particularly the damage structures. In the early recovery phase, decisions and actions are taken after fall of a disaster with an intention to recover the pre-disaster condition of the affected community and also ensure that adjustment measures have also been taken to reduce disaster risk. The recovery should be carried out with intention to build back better in a sense to make it more resilient to extreme events. It is therefore, one school of thought is of the opinion that disasters encourage development.

1.6 Challenges in Disaster Risk Reduction

In the past two decades, Pakistan has faced numerous disasters, which cost over 20 billion US dollars. This has put tremendous pressure on the country economy and almost paralysed the economic growth rate. It is because of these frequent incidences of emergency situation, the Millennium Development Goals and Hyogo Framework of Action was hardly achieved. The country has very good disaster risk reduction policies, programmes and plans but lack of financial capability is a major hurdle in effective implementation. The frequent occurrences of disasters have placed the federal, regional, district and local government institutions pre-occupied and busy with response and recover process. The hazard forecasting and early warning system either lacking or if exist it has certain weaknesses and need further strengthening towards multi-hazard early warning system and timely dissemination to the vulnerable population.

After 2005, several institutions were established at federal, provincial and district level to effectively respond to unforeseen events. These institutions are new and mostly lack capacity of handling emergency situation. In case of provincial and local level authorities, absence of technical personnel is one of the major deficiencies found in devising and implementing disaster risk reduction policies and development plans in true spirit. In Pakistan, disaster and climate change education is lacking at all levels. Therefore, mainstreaming disaster risk reduction in education, community and at institutional level can help in building individual, community and institutional capacity and may enhance disaster resilience. Non-availability of data for disaster risk management planning remained a major challenge in almost all developing countries including Pakistan.

In the country, universities, research organizations and scientific community are consistently working on various aspects of disaster risk assessment and management but there is lack of coordination between the disaster management institutions/ authorities and academia. Most often overlapping research has been observed, which is wastages of time and resources, which is unbearable and beyond the financial carrying capacity of a country like Pakistan. There should be strong linkages, sharing technical innovative knowledge and best practices in the public interest.

1.7 About the Book

The book covers all different types of disasters face Pakistan, including geo-physical and hydro-meteorological hazards. The book attempts to incorporate and draw some of the key lessons learnt right from pre-disaster phase, disaster phase to post-disaster phase and provides an effective framework in the form of lessons learnt. The content is rich and based on a selection of available documents, a consultative workshop with academicians from different universities undertaking DRR higher education programs, and the editors' own knowledge and experience in the field. Special emphasis is given to analysing field experiences from academic perspectives, and pinpointing key issues and the policy relevance of disaster risk reduction.

The book is organized into three parts, where part I provides the outline and basics of Disaster Risk Reduction Strategies Applied at country level with supporting examples from the global review. Part II specifically highlights the wide ranges of hazards experiencing Pakistan and drawing examples, policy options, institutional set-up, risk reduction strategies and key lessons learned. Third part of the book is given to approaches and issues of DRR practices and certain examples of disaster responses. The book is classified into 20 chapters.

Chapter 1 focuses on introduction and disaster risk reduction approaches in Pakistan. Pakistan is a country exposed to wide range of disasters and a long history of recurrent occurrences. In the recent past, the massive 2005 Kashmir earthquake and flood-2010 were the eye opening for disaster risk managers and paved way for the institutionalization, policy initiatives and paradigm shift from reactive approach to proactive ones. At country level, National disaster management commission and national disaster management authority were established and at regional level provincial disaster management authorities and district disaster management authorities were constituted at district level. This chapter introduces the disaster risk reduction approaches practiced at global and country level. I also highlighted the background and progress of disaster risk reduction agenda at global level, whereas disasters in the context of Pakistan have been discussed. The chapter describes the disaster risk reduction legislations and institutional set-up in Pakistan. Similarly, the chapter also elaborated various risk reduction approaches applied in Pakistan. The chapter finally focuses on the key challenges faced Pakistan in mainstreaming disaster risk reduction.

Chapter 2 highlighted the concept and assessment of hazard, vulnerability and disaster risk in the context of Pakistan. In the initial part, conceptual background has been supported with examples from the real world situation. The chapter also focuses on various tools and techniques so far applied for carrying out hazard, vulnerability and disaster risk assessment and management. Here a section also elaborated the hazard profile of Pakistan and focuses on the frequently occurring hazards including floods, earthquakes, landslides, drought, GLOF, cyclones, heat waves etc.

Chapter 3 has been focused on generic overview of disaster resilience and in case of Pakistan specific discern has been made on building urban and rural resilience. In Pakistan, there are certain key challenges in building disaster resilience including exposure to hazard events, low level of risk awareness, low level of development risk conscious, absence of multi-hazard risk assessment, lack of mainstreaming DRR in policies and plans and poor DRR capacity in the context of prevention, preparedness, response and recovery. The chapter also discusses the concept of disaster resilience, dimensions, indicators, linkages of disaster resilience and environmental system, disaster resilience and sustainability, disaster resilience and climate risk. Similarly, DRR legislations and resilience issues in Pakistan and how to build disaster resilience at various levels and promote adaptive strategies have been elaborated.

Chapter 4 deals with the flood risk and reduction approaches in Pakistan. As Pakistan is one of the flood prone countries, because of its physical and climatic set-up. It has been estimated that Pakistan is suffering from frequent flood disasters and the resultant losses is multiplying. Since the inception of Pakistan, efforts have been made for building resilience against recurrent flood events. The existing flood risk reduction strategies range from structural to non-structural approaches. The chapter also highlight a review of risks associated with flash and river flooding and analytically discusses past flood events and their adverse impacts.

Chapter 5 analyses the earthquake hazards and risk mitigation in the context of Pakistan. Pakistan is located in one of the earthquake prone regions with a bad history of devastating impacts. The chapter also discusses earthquake hazard assessment across the country and suggest for earthquake risk mitigation. However, the magnitude of prevailing earthquake induced risk needs detailed earthquake hazard assessment, design earthquake resistant structures; implement the seismic building codes and public awareness to adopt for earthquake risk reduction.

Chapter 6 discusses the Tsunami risk, preparedness and warning system in Pakistan. The chapter reviews the tsunami risk posed to the southern coasts of Pakistan and Iran by potential earthquakes from the Makran subduction zone and present a structure for a regional tsunami warning system. Historical data of earthquake in the Makran region shows that the region is susceptible to large earthquakes, which are capable of producing destructive tsunamis. The study suggests for tsunami warning system in the region based on seismic waveforms and using a database of pre-calculated tsunami scenarios. At least 2 deep-water tsunami gauges and 50 coastal gauges are necessary for tsunami understanding and early warnings in the region and strong support from international cooperation between the countries in the region.

Chapter 7 deals with the drought risk and reduction approaches in Pakistan. It is unique among all the other environmental hazards and has long prediction time between the first indications to a point when it begins to impact significantly upon the population of the affected areas. During the past century, several time the territory of Pakistan hit by severe drought. This chapter is focuses on the types of drought, quantification of drought, factors contributing to drought vulnerability, overview of drought in Pakistan, adverse impacts of drought and drought risk reduction strategies in Pakistan.

Chapter 8 focuses on the landslide risk and reduction approaches in Pakistan. In Pakistan, landslides like other extreme events frequently occur in the north and north-western mountains. The chapter also elaborated various causes of landslides, which mainly includes immature geology, wide variation in climate and degradation of natural resource base and intense structural deformation. The chapter highlighted various landslide risk and risk reduction approaches so far adopted in reducing the impacts of landslides. This chapter also discerned the institutional framework and landslide risk management mechanism in the country.

Chapter 9 discusses the desertification risk and reduction approaches in Pakistan. Desertification is a serious global problem and more acute in case of Pakistan. In the country, almost 3/4th of the land is either already affected or likely to be affected by it. The Desertification occurs in both rain-fed and irrigated lands. Pakistan is mainly a dryland country, where 80 % of its land is arid and semi-arid. In recent years, number of Federal and provincial agencies are engaged to combat desertification. However, the efforts made by the line departments and NGOs hardly fill the gap between its increasing intensity and disaster risk reduction.

Chapter 10 analyses sea level change, causes and its impact on the coastal belt of Pakistan. The chapter elaborates the role of glacio-eustatic and Tecto-Eustatic mechanisms, which are the determining factors in explaining the long term global and local changes in sea-level. Several geomorphological and archaeological evidences confirm the glacio-eustatic and Tecto-Eustatic change of sea-level in the Pleistocene and the Holocene epoch. The evidences of current sea level rise reveal that tectonic mechanism and intrusion of sea in the deltaic region of the River Indus is due to reduction of river inflow not because of global warming phenomenon, are the main factors of sea-level change along the coast of Pakistan.

Chapter 11 examines the climate change risk and reduction approaches in Pakistan. Pakistan is one of the most vulnerable countries facing the risk of climate change, despite contributing very little to the global greenhouse gas emissions. The 2010 Global Climate Risk Index of Germanwatch ranked it first among some 180 nations of the world. The country's vulnerabilities are high due to heavy dependence of its economy on agriculture, which is highly climate sensitive. This Chapter examines the present and potential impact of climate change in Pakistan, and reviews national policies and plans to analyse the approaches to climate-related issues. The chapter also identifies the key measures that need to be included in the Climate Change Action Plan of Pakistan and stresses their mainstreaming into the national development policies and planning process.

Chapter 12 reveals the GLOF risk and reduction approaches in Pakistan. The Hindu Kush, Karakoram and Himalayan ranges in Pakistan offer the most rugged and the hostile natural environment for the human habitation. There are over 2,000 glacial lakes in the upper catchments of major rivers of Pakistan. This chapter presents the overall situation of GLOFs in Pakistan and the GLOF risk reduction strategy. This chapter also includes discussion about the mitigation options to reduce the GLOF risk. A comprehensive methodology is recommended in this chapter for the risk assessment of any remote glacial lake using the integrated approach of bringing the field data, numerical relations together with the GIS and remote sensing. The chapter finally recommends how to handle GLOF risk and to have safer communities.

Chapter 13 analyses the national strategies and law for disaster risk reduction and institutional framework for DRR in Pakistan. Prior to 2005 Kashmir earthquake, the DRR strategy was mainly a reactive approach. A paradigm shift has been noted towards the pro-active one in the form of policy development, institutional establishment and disaster management plan at national, provincial and district level. The chapter highlighted the causes of Pakistan's vulnerability to disasters and climate change impacts as well as legal framework for disaster management, Institutional and reorganization and challenges in the current system.

Chapter 14 deals with disaster risk reduction at the local government level in Pakistan. The HFA specifically stresses on mainstreaming DRR at local level and it is the individuals, households and communities responsibilities, which are at forefront of either escaping from or fighting against disasters. This chapter also discusses the key actors at national, provincial, district and local level and analyses the decentralization of disaster risk management institutions, and the role of local actors. The chapter describes the community resilience and local government system, disaster resilience and local government challenges and policy options in mainstreaming DRR in local government system.

Chapter 15 highlights the role of NGOs and disaster risk reduction in Pakistan. The Non-Government Organizations play a vital role in disaster risk reduction. The donor's agencies and International NGOs not only support the NDMA, PDMAs and FDMA to perform their functions effectively but also provide guidelines on policy matter. In Pakistan, local NGOs, CBOs and volunteers closely working with community and thus enhance their risk reduction and emergency response capacities.

Chapter 16 describes the urban risk and reduction approaches in Pakistan. The investment on urban risk reduction is much more effective than picking up the pieces afterwards. It is cities, which empower the societies and hub of industrial and commercial services. Urban resilience is largely a function of resilience and resourceful citizens. In Pakistan, large cities are at risk to various hazards and they have been threatened seriously, while others are at the verge. The mega cities including Karachi, Lahore, Rawalpindi, Islamabad and Peshawar have already come a across serious episodes of urban flooding during the past one decade. In addition to this, heavy downpour, heat waves, drought, storm surges, flash flooding are some of the key effects of climate change exacerbations on urban areas. The chapter discusses growth and development of urban areas, cities and underlying risk factors, impacts of urban disasters and urban risk reduction approaches in Pakistan. This chapter also stimulate new arena for thinking and devising innovative approaches for sustainable urban development in the country.

Chapter 17 focuses on the disaster and climate change education in Pakistan. Pakistan is vulnerable to wide range of hazards and rooting from weather, hydrological, geophysical and human induced disasters. Efforts have been made by the government to endorse disaster and climate change education, and so far variety of initiatives and activities have been planned and some of them implemented. The chapter also stress on strengthening existing disaster and climate change science in the related institutions and universities. This chapter discusses the disaster and climate change education, Pakistan's vulnerability to Disaster and Climate Change, Growth and Development of Disaster's Legislations and Institutions, Disaster and Climate Change Education at School, College, University, Professional and Technical Institutions, National Institute for Disaster Management, Religious Institutions, Community Level, and in the State Departments, Civil Services Academies and promotion of Research environment in the country.

Chapter 18 examines the financing for disaster risk reduction in Pakistan. Disaster's record in Pakistan shows severe impacts both on the citizens and Government and the trend is escalating. This paper analyses the past and present mechanisms to finance disaster management in Pakistan. An empirical analysis reveals that investments in DRR have been scarce and spending on disaster preparedness has not been given priority in the national development plans. Moreover, for every dollar spent on disaster management, only a tiny fraction was spent on. The study found that there is still a big vacuum, which can be filled only by the development of a comprehensive risk financing strategy with a range of instruments. It further recommends financing through public-private partnerships for the promotion of cost-effective solutions.

Chapter 19 scans the community based disaster risk management in Pakistan. It is pertinent to note that active involvement and empowerment of local population is necessary for successful community development. The chapter discusses the community based disaster risk management a theory of participation, paradigm shift in process and practice of CBDRR, role of community in risk reduction planning and implementation. The chapter also examines the key case studies pertaining to CBDR management in Pakistan.

Chapter 20 analyses gender and disaster risk reduction in Pakistan. When disaster occurs, it does not discriminate the gender and its impacts vary for male and female. The chapter also discusses that in any disaster the worst affected section of the community is the women and children and its impacts varies depending on resilience capacity of individuals, households and community and to recover from the impacts of disasters. It is women, children and disables, usually hit the hard because of their high vulnerability and low resilience. The chapter also discusses the tools for gender mainstreaming and engendered government policy, women and disaster impacts, gender in recovery phase, causes of women vulnerability, women are at risk and gender and DRR in Pakistan.

The primary target groups for this book are students and researchers in the fields of Environment Sciences, Geography, Geology, Earth Sciences, disaster risk reduction, and climate change studies. The book will ultimately provide a strong idea of current research trend in respective field and will furnish basic knowledge on this important topic in Pakistan. Another target group comprises practitioners and policy makers, who will be able to apply collective wisdom into policy and decision making.

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Chapter 2
Hazard, Vulnerability and Risk: The Pakistan Context

Atta-Ur-Rahman and Rajib Shaw

Abstract In this chapter an attempt has been to highlight the concept of hazard, vulnerability, capacity and risk. These disaster terminologies were discussed taking help from the latest available literature. All these concepts have been supported with examples from the real world situations. Additionally, various tools and techniques have been discussed for carrying out hazard, vulnerability and risk assessment and management. The chapter also elaborated the hazard profile of Pakistan, which specifically focuses on the frequently occurring hazards such as floods, earthquakes, landslides, drought, GLOF, cyclones, heat waves etc. In Pakistan, the massive 2005 earthquake was a turning point in disaster risk management system. As Pakistan has a long history of natural hazards and almost every year, the impacts of disasters put extra pressure on the country budget. Looking to the transition in economic system, the importance of disaster risk reduction (DRR) was realized and the national disaster management commission (NDMC) was established in 2006 to proactively respond to disasters. In this regard, national disaster management authority (NDMA), a focus body was assigned a task to implement policies, strategies and programs of disaster risk reduction. Eventually, national disaster risk management framework (NDRMF) was developed in 2007, which provides guidelines for all the key stakeholders and in 2013 national disaster risk reduction policy (NDRRP) was developed. However, there is a need of sustainable socio-economic and environmental development to properly mainstream DRR into policies and programs and especially to cater the poor and marginalized people of the country. To make the country more resilient, to a wide range of disasters, there is an emergent and consist need of enhancement in social, physical, economic and institutional capacity both at national and local level.

Keywords Hazard • Vulnerability • Risk • Resilience • Capacity • Risk management

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_2

2.1 Introduction

Globally, there is an increasing trend of major disaster events and resultant losses (Rahman and Khan 2013). This in turn indicates that large extent of humans and their properties are at risk. It is mainly due to the higher level of vulnerability and the major determining factor is the exposure of people and their belongings. It has been estimated that number of people who are exposed to earthquake and cyclone in mega urban centres would double by 2050 and it is expected that with the climate change exacerbations, the spatial extent, intensity and magnitude of disasters will further escalate (Wilkinson and Brenes 2014). To effectively respond to this changing scenario, it is necessary to take initiatives to plan for increasing uncertainties and to mainstream disaster risk reduction and climate change adaptation into policies, development planning, institutional strengthening and building disaster resilience.

In the past one decade, Pakistan has been experiencing wide variety of natural and human induced disasters in the form of earthquakes, floods, landslides, drought, storms, heatwaves, heavy snowfalls, epidemics, accidents, explosions etc. However, the escalating frequency and intensity of hydro-meteorological disasters are on rise and scientists attribute the same with the climate change phenomenon. Such changing phenomenon prompted Pakistan to shift her traditional reactive and relief based approach to proactive one and endorse the DRR in policy, planning and institutional development. It is also of paramount significance to bridge the policy with bottom-up and top-bottom approach in capacity building, identifying hazards, reduce vulnerabilities and stress on risk management strategies at community, regional and national level. This will have positive implications on the community, local disaster related organizations, practitioners and policy makers to prepare citizen to carefully handle the unforeseen extreme events with minimum losses and with higher resilience and strengths.

Keeping in view this changing scenario particularly after 2005 Kashmir earthquake, the government of Pakistan reviewed weakness and gaps in policy, planning and institutions. In this regard, National disaster management commission, national disaster risk management framework, national disaster management authority, national disaster management Act and national disaster plan were the landmark decisions taken at the federal government and the circle was extended to provinces and subsequently to district level. After thorough consultation and policy and institutional analysis the national disaster risk management framework issued key guidelines and principles including expanding the horizons of multi-stakeholder, cross cutting issues and multi-disciplinary strategies; minimizing vulnerabilities of marginalized groups; promoting community level risk reduction initiatives; bridging disaster knowledge of practitioners, scientific community and indigenous rooted resources; introduction of economically capable, socially acceptable and technically viable risk reduction approaches and technologies; promoting sustainable development practices at all level; developing hazard-risk profile right from local area to national level; strengthening liaison and linkages with countries and international community to promote disaster risk reduction.

Owing to the changing climate and resultant implications, it has left no choice for the countries but to rethink and devise risk reduction strategies. The challenges of reducing socio-economic vulnerabilities to extreme events specifically hydro-meteorological hazards have been addressed under few important key research areas including poverty reduction, sustainable development, promoting disaster risk reduction strategies, enhancing disaster education and building disaster resilience.

2.2 Overview of Hazard

The word Hazard and risk are inter-changeably used. The hazard is usually associated with the potentials to cause harm to mankind or its surroundings (Rahman 2010). A hazard is a situation that poses a level of threat to life, property or environment. In other word, it has potentials of adverse impacts on our environment. Hence, hazard is actually a potential source of harm (Figs. 2.1, 2.2, and 2.3). The hazard can cause negative impacts on individual, organization or community (HSA 2006). It may either be on local, regional, national or global level. For example some will say 'Dengue fever' is a hazard but actually dengue viruses could be considered as the Hazard and dengue bearing mosquitoes are hazardous biological agent. Electricity is another example of man-made hazard in our surroundings and its harmful consequences is the shock. Similarly, earthquake is a natural hazard and its harmful consequences are building collapse etc. There are certain conditions, which release uncontrollable energy taking very simple example, fall of glass jug from a table has the potential to cause damage and the energy which plays a key role in converting hazard into disaster is the gravitational energy. When a hazard becomes "active", it may produce an emergency situation.

The terms Hazard and Risk are often used interchangeably but this simple example explains the difference between the two: If there was a spill of water in a room

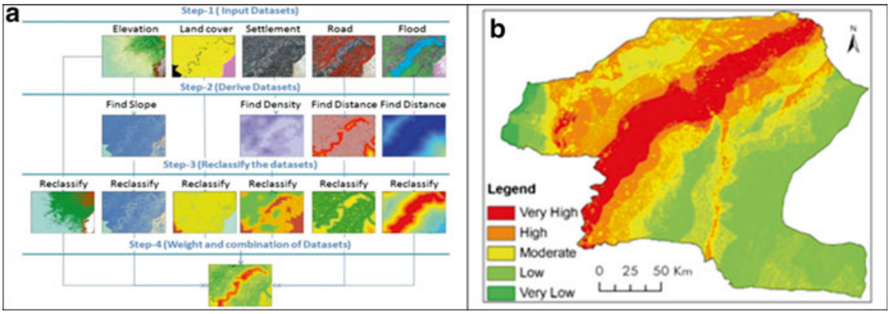

Fig. 2.1 Step-wise development of Flood hazard zonation mapping of northern Sindh, Pakistan using GIS and remote sensing techniques. (**a**) Step-wise process of hazard zonation using GIS. (**b**) Final hazard zonation map (After Uddin et al. 2013)

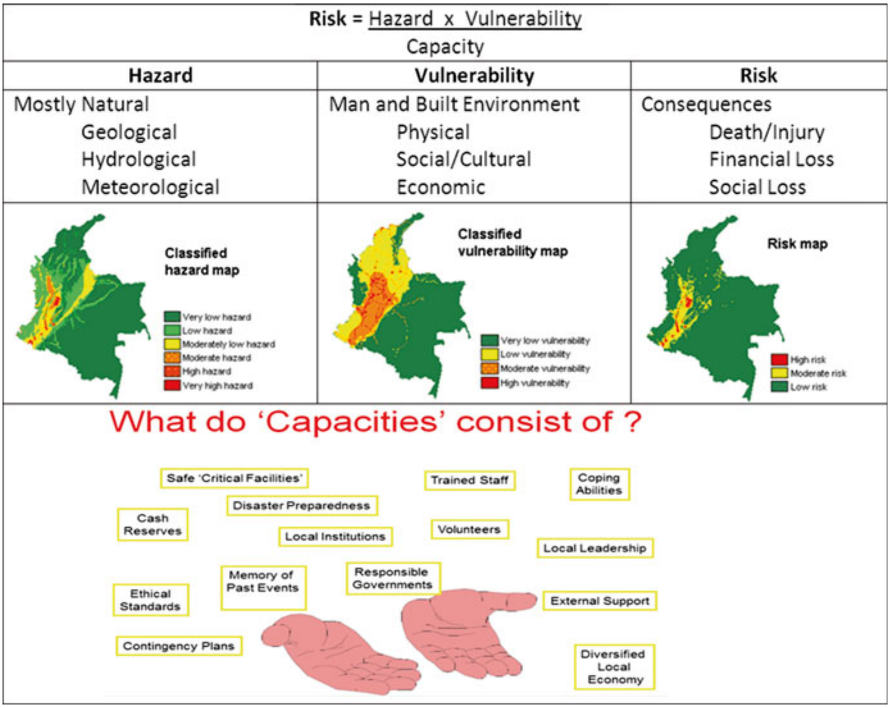

Fig. 2.2 Hazard, vulnerability and risk mapping (Davis 2007)

then that water would present a slipping hazard to persons passing through it. If access to that area was prevented by a physical barrier then the hazard would remain though the risk would be minimised (HSA 2006).

The actions that are taken in advance to minimize or control hazards adverse consequences or the potential exposure to hazard called as hazard mitigation. Generally, hazard risk reduction strategies have been widely adopted for a large scale hazards, whereas control strategies are also been applied but most often it is not achievable and beyond the carrying capacity of individuals, community, institutions and government. While handling hazards particularly in a work environment like in a power plant, industry etc. stress always remains on priorities including elimination of hazards, substitute the hazard with less risk, isolate hazards and use engineering control measures, applying administrative control and use personal preventive approaches.

Elimination of hazards is very costly approach, but there are some small scale hazards that can be uprooted from its source and in turn eradicate exposure to risk. The good example would be the exposure of servant to lead poisoning at petrol station would no longer be at risk after removal of lead from the petrol (HSA 2006). Whereas in the substitution environmental setting, the hazard is replaced with minimum potential risk and exposure to hazard, but there may be chances of new hazards with minimum exposure to hazard. Isolating the hazard is another hazard

Fig. 2.3 Pakistan, seismic hazard zones modified (After MOHW 2007)

reduction approach through which access to power plant or certain machine is restricted or keeps it away or under strict observation. In engineering hazard reduction strategies, effective designs or structures are made between the individual/community and hazard. This is very costly approach and beyond the reach of developing countries but still it is extensively applied while dealing with mega disasters. This is also called as structural mitigation strategies. Administrative approach is another form of hazard mitigation strategies. This is non-structural mitigation measures widely recommended for reducing potential impacts of unforeseen events including adoption of SOPs, enforcement of codes and regulations, safety measures, capacity building of individual, community and institutions (HSA 2006). In addition to other measures, using personal safety measures is the last line of person protection and it is recommended method of reducing potential impacts of extreme events. Figure 2.1 depicts that northern Sindh province of Pakistan is a focused area and for preparing hazard zonation map certain parameters namely elevation, land cover, settlement, road, inundated areas were selected and new datasets were developed after according proper weightage to each parameters using GIS software (Uddin et al. 2013) for detail and further clarification see Fig. 2.3 of earthquake hazard zonation of Pakistan based on selected parameters.

2.3 Vulnerability and Assessment of Vulnerability

Vulnerability refers to the potential for casualty or destruction or a form of loss to a particular element, whereas risk combines this with the probable level of loss expected from a predictable magnitude of hazard (Alexander 2000). Vulnerability is a state of resilience of population, property, sources of livelihood earnings and elements susceptibility to a hazard (Rashid 2013). Resilience and vulnerability is inversely proportion, higher the vulnerability of a community / nation lower will be the resilience and vice versa. Different hazards have varying degree of severity, higher the intensity of hazard, the maximum would be the level of potential vulnerability of destruction. The level of risk directly depends on the severity of hazard, type of vulnerability and the available coping capacity (Fig. 2.2).

Mayer (2007) defines vulnerability as a product of a population's location relative to areas of geophysical risk of mortality, destruction and displacement. Vulnerability usually relies on the characteristics of a community to cope up with the impacts of the event. Any area/community/ or group of people become vulnerable to a hazard if, they have poor engineering and non-structural resilience against the extreme event (Juliana and Andrew 2008). In addition to other information, vulnerability mapping also relies on the land use and land cover information.

Vulnerability of an area can be determined as described by Rashid (2013) following the parameters of location, socio-demographic characteristics, disaster education and capacity, coping mechanism and resilience, institutional capacity, exposure and knowledge of past disasters. This indicates that vulnerability is not a state of single determining factors but it is the integration of multi-dimensional factors. The level and components of vulnerability varies from hazard to hazard and region to region, because no two hazards and region is alike. The vulnerability components range from physical, socio-cultural, economic and institutional.

Pakistan is bestowed with tremendous resources but unsustainable utilization resource management put the country population to wide range of vulnerabilities. In the present scenario, there is high vulnerability and low resilience but ideally there should be low vulnerability and high resilience and this linkage may be more effective if we emphasise on increasing adaptive capacities particularly in a changing climate scenario. The community vulnerability and disaster resilience is directly linked with the sustainable utilization of resources and man-environment interaction. It is therefore, sustainability is a central point in the framework of hazards vulnerability and disaster resilience. Disaster resilient community is that which has the ability to withstand an extreme event, with a tolerable level of losses, and is able to take mitigation actions consistent with achieving a level of protection (Cimellaro et al. 2010). It is of paramount importance to build disaster resilience and apply latest possible techniques in reducing vulnerabilities and enhancing resilience.

There are numerous factors responsible for the community vulnerability to geo-physical, hydro-meteorological, climatological and human induced hazards. The overwhelming pace of population growth and environmental degradations have been further intensified by the exacerbation of changing climate that has increased vulnerabilities of communities in the country. More than 60 % of the country is mountainous and prone to several hazards. In mountainous regions the non-availability of safer land for construction and harsh climatic conditions further aggravate vulnerabilities. In Pakistan, fragile natural environment, poor hazard prediction/ forecasting, early warning system, lack of disaster education and awareness, poor agricultural practices and poverty are some of the root causes of vulnerabilities. Inefficient transportation and communication infrastructure and lack of critical facilities have intensified communities' vulnerabilities. It has been estimated that reoccurrence and intensity of climate related hazards may increase in future due to climate change, which might lead to greater social, economic and environmental losses.

Assessment of vulnerability is carried out to achieve certain objectives. This process includes the examination of the vulnerable areas, the hazard reduction measures, the development of certain mitigation and adaptive strategies. According to IPCC 2007, there are three main indicators of vulnerability assessment i.e. exposure, sensitivity and the adaptive capacity. In case of flood, exposure is related to the climatic conditions most specifically the condition of rainfall and temperature prevailing in the test area. Here sensitivity refers to the degree or level of being affected by the hazard. Sensitivity of an area depends on both the geographic and socio-economic factors. Likewise, the adaptive capacity describes the strength and resilience of socio-economic factors to cope effectively with the extreme events. Hence, the exposure, sensitivity, and adaptive capacity are the three basic components on which vulnerability is dependent (Otto-Zimmermann 2011).

The objective of vulnerability assessment is to provide a safe and secured environment both in terms of life and property assets (Vellani 2007). The vulnerability assessment process has been classified into three phases, planning phase, conducting vulnerability assessment phase, and reporting and application in the real world situation. The assessment process provides a framework for minimizing vulnerability and building resilience of various assets. Vulnerability assessment is a process of depicting level of vulnerability and usually vulnerability maps are generated. For micro level vulnerability assessment both spatial and attribute data is required. In a system vulnerabilities are identified, quantified and finally prioritised for reducing vulnerability. The role of vulnerability assessment is to determine which particular asset requires prompt action of protection, type and need of protection strategies and suggest recommendations for enhancing its resilience.

2.4 Concept and Background of Risk

Risk is refers to a probability of meeting harm and hazard is the possible adverse consequences (Alexander 2000). Risk can also be expressed as the chance of damages and the effects caused by unforeseen event to human being. Risk is the chance that a person, property or environment will be affected as a consequence of its exposure to a hazard. It may also apply to situations with property or equipment loss. Scholars have also elaborated risk as an integration of hazard, exposure and vulnerability of people exposed to extreme phenomenon. It means that risk is the product of hazard, vulnerability and capacity to deal with it. It is the combination of chance an event and its potential harms on people and their environment. As a cursory hypothesising example of smoking causes cancer, in this case the risk can be expressed as 'smokers have high risk/ likelihoods of lung cancer'. There would be various elements at risk including populations, communities, economic activities, infrastructure, natural environment and services which are under threat in a given area.

The interaction of hazard and possibility leads to risk (Fig. 2.2). An affordable disaster risk reduction needs a comprehensive approach of vulnerability and capacity assessment. There are several methods of classifying a hazard based on factors of "likelihood" of the hazard which led to an emergency and the "seriousness" of the incident. Generally, the method to calculate the likelihood and seriousness against the resilience capacity is one way of measuring disaster risk. The degree of risk is influenced by certain factors including how much an individual/ community is exposed to a hazard condition and how serious would be the implications under such scenario. A simple risk equation, although it is not mathematical (Alexander 2000).

The resultant score is used to identify which particular hazard need priority for mitigation. Higher the score means the more active is the hazard, whereas low score on likelihood of occurrence indicate dormant. The seriousness of hazards varies depending on type, location, intensity and resilience capacity of population. For example a river, flood would have wide impacts on population depending on the distance from the active flood channel, potential of wetted perimeter and river gradient (Rahman and Khan 2013). In addition to this, hazards can be classified and prioritized based on the risk they present during an emergency. This may be measured on the bases of its seriousness, urgency, manageability and growth.

In the context of disaster and climate change researchers, Wilkinson and Brenes (2014) describes that risk is the probable outcome of hazardous extreme events interacting with vulnerable social conditions, leading to widespread impacts on human, economic, physical or environment. Whereas exposure is refer to the degree of contact of hazard with an individual, community, or system, whereas vulnerability has been defined as the degree of susceptible to cause damages. It indicates higher the vulnerability maximum would be the severity of adverse impact. Disaster risk is the complex interaction of hazard, vulnerability and exposure is written in the form of equation. The latest literature also includes capacity in the disaster risk equation, which insists on physical, social, economic and physical capacity assessment.

Disaster risk is the expected losses from a particular hazard (Rahman 2010; Tariq 2013). The expected losses could be physical, social, economic, psychological and ecological or lives etc. Risk can also be defined as the product of hazard, exposure and vulnerability (Birkmann 2007). Hazards are the characteristics of both probability and intensity, whereas vulnerabilities are the product of both susceptibility and exposure (Otto-Zimmermann 2011). However, probability is the likelihood of hazard occurrence (Tariq 2013). Hence, the resultant vulnerability, hazard and risk equations would be:

$$\text{Vulnerability} = \text{Exposure} \times \text{Susceptibility} \tag{2.1}$$

$$\text{Hazard} = \text{Intensity} \times \text{Probability} \tag{2.2}$$

$$\text{Risk} = \text{Probability} \times \text{Intensity} \times \text{Susceptibility} \times \text{Exposure} \tag{2.3}$$

2.5 Hazards Profile of Pakistan

Pakistan is exposed to variety of hazards including earthquake, floods, landslide, drought, desertification, cyclone, storm, heat waves, GLOF, riverbank erosion, waterlogging and salinity etc. The EM-DAT (2001–2013) data reveals that during this 13 years span the country was hit by 25 events of earthquakes, floods and landslides, out of which flood was recorded almost every year. It is owing to its physiographic set-up, geographical location, extensive latitudinal extent and wide variation in climate, home of world three mountain systems, coastal hazards and morphology. Pakistan is vulnerable to extreme events and climate change impacts. The overwhelming growth rate of population, more than half of the country population is living below poverty line, lack of effective social network, low disaster resilience at local, regional and national level, absolutely no or lack of disaster education and training, high pressure on country resources, slow economic growth rate and high dependence on agriculture are some of the key factors that accelerated the country vulnerability. The impacts of disasters are not uniformly distributed, but it varies depending on resilience capacity of individuals, households and community and to recover from the impacts of disasters. Higher the vulnerability maximum would be the impact of disasters. In addition to women, children and disables, it is the poor section of the society usually hit the hard because of their high vulnerability and low resilience.

In wake of changing climate scenario, there is consistent change in the hydrometeorological and climatological phenomenon, which poses new risk to the country population. It is time to think and plan effectively to mitigate or improve adaptation with the climate change exacerbations. For effective addressing disaster risk reduction in existing set-up, it is particularly important to get first-hand knowledge about the area which is thickly populated areas, trend of physical growth and risk profile (Sharma et al. 2011). Earthquake, floods, drought, landslide, Glacial/Landslide Lake Out-burst Flood (GLOF), cyclone and heat waves etc. are the major hazards in Pakistan.

2.5.1 Earthquake Hazard

Pakistan lies in the seismically active zone. Seismically, the entire country is exposed to earthquake hazard, ranging from minor to severe seismic risk (MOHW 2007). Historically, the region has experienced several earthquakes of various magnitudes (Rossetto and Peiris 2009) and a high magnitude earthquake is expected in the future (Bilham and Wallace 2005; Raghukanth 2008). Sharma et al. (2011) argue that a high magnitude earthquake with almost a million fatalities could occur in the Himalayan region, where major cities are the high risk nodes. According to Pakistan Meteorology Department, two-third of the country is located on fault lines that can be triggered any time (MOHW 2007; The Nation 2008).

Pakistan has diverse nature of geological features as it lies at the junction of Indian, Eurasian and Arabian plates. The country is located in active seismic region of Himalayas, Hindu Kush and Karakorum in the north and north-west. In the western part of the country the two active fault-lines namely Makran fault line along the coast and Chaman-Chiltan-Ornachnal fault lines in proximity to Quetta city. In the past 100 year span, the territory of Pakistan has experienced numerous devastating earthquakes of various magnitudes and intensity. However, the 1935 Quetta earthquake, 1945 Makran coast earthquake which also generated tsunami and the latest 2005 Kashmir earthquake and 2013 Awaran earthquake have been marked as the most devastating. However, the 2005 earthquake was an eye opening for the country in terms of disaster risk reduction management, which has prompted the decision makers to shift from pure relief-based active approach to proactive one and to keep pace with the guidelines of Hyogo Framework for Action (2005–2015). The 2005 Kashmir earthquake has increased the Government and community awareness in minimizing the people vulnerability and to think about the proactive approach and policy change regarding the concentration of population in the cities and building low resilience structures (NORSAR and PMD 2006). Globally, it has been realized that poor structures are the major reasons behind the high number of victims.

Quetta and its neighbouring towns are located in the active seismic region of Pakistan. Movement in the Chaman fault has resulted an earthquake on May 31st 1935 (in the morning), which lasted for 3 min with continuous aftershocks. The epicentre was close to Quetta and therefore the death toll was more than 30,000. It was followed by another massive Makran earthquake on November 27th 1945 with an estimated magnitude of 8.1 Mw. In addition to extensive damages caused by earth jolting, it has generated as high as 11 m high tsunami all along the Makran coastal belt with over 4,000 human casualties. In 1974, Hunza-Pattan earthquake is another landmark devastating earthquake in the history of Pakistan. On December 28th, 1974 Gilgit-Baltistan, northern Hazara division and eastern part of Malakand division came under the influence of earthquake with a magnitude of 6.2 Mw followed by several aftershocks. It also activated several massive landslides and blocked the Karakorum highway (Rahman et al. 2014). This earthquake has buried over 5,300 people and around 17,000 were reported as injured.

In the history of Pakistan, the 2005 earthquake was the worst natural disaster that the nation has experienced. It was on October 8th 2005 at 08:50 am; the Bagh-Balakot fault was ruptured and triggered an earthquake of 7.6 Mw. The capital city of Azad Jammu & Kashmir (Muzaffarabad) and entire tehsil Balakot of district Mansehra were the worst hit areas. The Pakistan government official death toll as of November 2005 stood at 87,350, although it was estimated that the death toll could have been over 100,000. Out of total human casualties, more than 19,000 children killed, mostly due to the widespread collapses of school buildings. As of October 27th 2005, more than 900 aftershocks has been recorded with a magnitude of 4 and above on Richter scale. A tremor of this massive earthquake was felt in Nangarhar Province of Afghanistan, India, Tajikistan and western China.

On September 24th 2013 an earthquake with a magnitude of 7.7 Mw hit the Awaran region (Baluchistan), southwest of Pakistan. According to EM-DAT (2014), an estimated 825 people were reportedly killed. It was followed by another earthquake on September 28th 2013 with a magnitude of 6.8 Mw in the same region killing 22 more people. The massive jolting of these earthquakes was felt in the cities of Karachi, Hyderabad, Quetta, Multan, Larkana, Mirpur etc.

In the high seismic zones strict implementation of building codes is the responsibility government authorities. As construction of high rise buildings and ignoring the building bye-laws may further increase the vulnerability and can maximize the exposure and resultant damages. The Pakistan Meteorological Department has seismic stations and network throughout the country, was given the task to demarcate seismic zones and develop seismic risk map for updating the building codes and strengthening its seismic monitoring network (MOHW 2007). Based on this study, the country has been divided into 19 zones. From the past 400 years inventory of earthquakes Fig. 2.3 is depicted which discerns the seismic hazard zones (GSP 2013). The cities of Muzaffarabad, Bagh, Quetta, Chaman, Mastung, Kalat, Nushki and Gwadar are located in severe seismic hazard zone. Similarly, Islamabad, Sialkot, Rawalakot, Abbottabad, Mansehra, Pattan, Chitral, Gilgit, Gopis, Thatta, Turbat, Khuzdar, Jacobabad, Dera Bugti and Kohlu are sited in moderate to severe seismic zones. However, the major urban centres including Karachi, Lahore, Rawalpindi, Gujranwala, Gujarat, Jhelum, Gujar Khan, Hyderabad, Larkana, Khairpur, Sukkur, Dera Ismail Khan, Peshawar Mardan, Bannu, and Mingora are located in moderate to minor seismic hazard zone. The haphazard urban growth has further increased the vulnerability to various disasters and it has been predicted that if proper care is not taken in regulating and retrofitting urban structures, it would have serious fatal implications.

2.5.2 Floods Hazards

In Pakistan, flood is the most frequent and recurrently occurring phenomenon and almost every year it incurs massive damages to both lives and properties. Almost 60 % of the country is mountainous and the rest is occupied by Indus river system, where population are mostly exposed to the impacts of flooding, waterlogging and salinity problems. The country has experienced numerous devastating flood events since its independence and a large area in the country is vulnerable to flood events. The federal flood commission (FFC) through respective Provincial Irrigation and Drainage Authorities (PIDA) and Pakistan Meteorological department have been devising flood risk reduction strategies. Despites of investing billions of dollars, the country is still prone to flood disasters. In addition to this, the frequency and intensity of flood disasters has increased. The damages during super flood 2010, 2011, 2012 and 2013 were stunning. The 2010-flood were the century worst but even during the floods of 2011 about 10 million people were affected, 1.6 million houses were damaged, standing crops of over 9 million ha was lost and 120 thousands cattle heads were perished.

The Table 2.1 indicate that during past 64-year span (1950–2013), 32 deadliest floods with over 100 fatalities hit the country. This explains that every second year the territory was hit by a massive flood event (EM-DAT 2014). In terms of fatalities, the 1965 flood is considered as the most devastating with an overall 10,000 human

Table 2.1 List of massive flood events in Pakistan with at least 100 fatalities, 1950–2013

Year	Region affected	Fatalities	No. of villages affected	Year	Region affected	Fatalities	No. of villages affected
1950	Punjab	2,900	10,000	1996	Punjab	111	–
1954	Punjab, Sindh	300	–	1997	Punjab	140	–
1956	Punjab, Sindh	270	11,609	1998	Baluchistan	1,000	–
1959	Punjab	100	–	1999	Sindh	231[a]	–
1964	Sindh	450[a]	–	2001	Islamabad	210	50
1965	Karachi	10,000[a]	–	2003	Sindh	230	–
1973	Punjab, Sindh	474	9,719	2005	Baluchistan	520	1,931
1976	Punjab, Sindh, KP	338	18,390	2006	KP, Punjab	233	2,477
1977	Karachi	848	–	2007	Baluchistan, Sindh	242[a]	6,500
1978	Punjab, Sindh	393	9,199	2007	Sindh, KP	358	
1988	Sindh, Punjab	196	1,000	2010	Punjab, Sindh, Baluchistan, KP, AJK	1,985	78 Districts
1992	AJK, Sindh and Punjab	1,444	13,208	2011	Sindh	509	23 Districts
1993	Sindh	609[a]	–	2012	Punjab	480	–
1994	Punjab, Sind, KP	316	–	2013	Punjab, Sindh	446	–
1995	Punjab, Sindh, Baluchistan, KP, AJK	1,051	6,852				

Source: Rahman (2010), EM-DAT (2014), Paulikas and Rahman (2014)
[a]Indicate cyclone induced floods

casualties. It was attributed to the tropical cyclone, which strike the coastal primate city (Karachi) of Pakistan. The data further explains that there were ten flood events, where more than 500 people were killed by massive floods. However, the devastating floods of 1950, 1992, 1998, and 2010 has been characterised as over 1,000 deaths and at least 10,000 villages inundated (Mustafa and Wrathall 2010; Paulikas and Rahman 2014).

During monsoon season (July and August) 2010, Pakistan experienced the historical and century worst flood (Rahman 2010). Heavy rainfall in the upper catchment area has caused flash and riverine floods in the north and north-western regions of Pakistan including parts of Khyber Pakhtunkhwa, Gilgit-Baltistan and Azad Jammu and Kashmir and as a result created a combine moving water body roughly equal to the dimension of the United Kingdom travelling southwards passing through Punjab and Sindh. The high-intensity rainfall in Khyber Pakhtunkhwa generated unprecedented flood peaks in Swat River (Rahman and Khan 2013). In addition to colossal loss, it has uprooted Amandara Headworks and washed away the Munda Headworks, which served as a major irrigation structures in the region. The combined flow of the Swat and Kabul Rivers generated another unprecedented flood peak at Nowshera town, causing severe damages to life and properties (Rahman 2010). The floodwaters travelled downstream through the barrages in Punjab and Sindh until they reached the Arabian Sea downstream of Kotri Barrage. Extremely high floods were recorded at Chashma and Taunsa Barrages and a historic flood peak was also recorded at Kotri Barrage. The 2010-flood has inundated almost one-fifth of the country area. About 2,000 innocent lives were lost, thousands of villages were flooded and millions of people were left homeless. This exceptionally high flood-2010 has been registered as the century worst flood.

2.5.3 Drought Hazard

Drought is a slow on-sit disaster and often calls as a "Creeping Phenomena". Its impacts are comparatively less obvious and spread over wide geographical areas and affect more people than any other extreme event. Drought did not kill people but it is due to food insecurity, significant reduction in availability of water, societal adversaries and economic losses (Keshri et al. 2009). It is therefore, in reduction of rain, a drought phenomenon develops and contrary to this heavy rain results flash floods, river floods and urban floods.

Pakistan has a wide spatial variation in seasonal precipitation. Most of the country has arid to semi-arid climate including the central and southern part, whereas in the northern half it has semi-arid to very humid climate (Rahman and Khan 2013). In Pakistan, due to the impact of climate change, a radical change have been noted in the wet and dry spells, and the country receive more intense rain during wet spell, whereas in dry period meagre rainfall occurs (PMD 2013).

In the country, drought is a recurrently occurring extreme phenomenon. Historically speaking, the territory now called Pakistan has experienced several drought periods, some of which have been of intense nature. According to National Agricultural Research Centre and Water Resources Research Institute, the worst drought were that of 1871,1881, 1899, 1902, 1920, 1931, 1935, 1947, 1951, 1998–2001 and the recent drought of Tharparker 2014. However, the intensity of drought largely varied from province to province. Region-wise data reveals that Sindh was severely suffered by the droughts during the year 1871, 1881, 1899, 1931, 1947, 1999 and 2014. However, the province of Khyber Pakhtunkhwa (former NWFP) has experienced the worst droughts in 1902, 1951, 1986 (D.I.Khan) and 1999. The deadly influenza epidemic of 1918 accompanied by two bad harvests severely strained the agricultural resources of the province in 1918 and 1919 (Khan and Rahman 2002). Similarly, the province of Punjab experienced the worst droughts in 1899, 1920 and 1935. At national level, extended worst drought period were that of 1997–2003, which left serious implications on the economy of Pakistan.

In Pakistan, the recent 7-year long drought period (1997–2003) has been marked as the most severe in the past recorded 100 years span. There were drastic reduction in the amount of rainfall and it was more erratic in nature, which has dropped the river discharge in almost all the rivers flowing through Pakistan. Its impact was so wide spread that seriously inflected 58 out of a total 106 districts of Pakistan. The situation was worse especially in rangelands and where rain-fed agriculture practice. This as a result halted the agriculture growth rate to negative 2.5 %, which was alarming situation for an agro-based country like Pakistan. Such disaster situation prompted large section of severely drought affected community to migrate. It has been estimated that more than 3.5 million people were affected, thousands were displaced and hundreds died. In addition to this, over 30 million livestock were affected and around 2 million were died.

The Water Research Institute and International Water Management Institute (2004) and National Agriculture Research Centre have classified the country into humid, sub-humid, semi-arid, arid and hyper arid agro-climate regions. Similarly, the arid regions were further categorised into severe, high, moderate and low drought prone areas. As a result most of Baluchistan and some parts of Sindh province was categorised as severely vulnerable to drought. Throughout the country, the National drought monitoring centre (NDMC) has installed 335 Ordinary Rain-gauges at districts level. NDMC also monitor the water level in small Barani dams. Beside this, the NDMC is using different indices like Standardized Precipitation Index (SPI), Normalized Difference Vegetation Index (NDVI), Cumulative Precipitation Anomaly (CPA), Rainfall Anomaly Index (RAI), percent of normal, probability of occurrence, percentage departure and soil moisture (PMD 2013).

2.5.4 Landslides

Landslide hazard is a frequently occurring phenomenon throughout the mountainous part of Pakistan (Khattak et al. 2010). Geologically, the Hindu Kush, Himalayas and Karakorum are the most fragile mountain systems in terms of landslides (Rahman et al. 2014) and it was estimated that only in Himalayan mountain system over 30 % of the world landslides occur. In Pakistan, amongst the geophysical events during 2001–2013, landslide is the third most devastating phenomenon (after earthquake and flood) in terms of frequency, loss of lives, damages to houses, infrastructure and other properties (Rahman et al. 2011; EM-DAT 2014).

In Pakistan, the landslide vulnerability varies from region to region, depending upon the suitable condition for slope failure including surface geology, availability of moisture, proximity to seismically active zone and angle of slope. Pakistan has been frequently subject to landslide occurrence and mostly triggered by natural factors of rain/moisture, seismic activity, floods and most often it is intensified by human-induced factors of degradation of forest cover, terrain cutting and increasing human intervention over the fragile slopes (Rahman et al. 2011). Khattak et al. (2010) and Rahman et al. (2014) pointed out that in Himalayan region, landslides are mainly triggered by earthquake and rain-induced factors and most often these two factors join hands in accelerating the frequency of landslide occurrence.

Rahman et al. (2014) and Khattak et al. (2010) pointed out that after 2005 Kashmir earthquake, only in Balakot over 1,290 landslides were activated at 174 locations. This also indicates the relationship of earthquake induced landslide. The landslide susceptibility varies from location to location but the rainfall-induced landslides have the highest frequency of occurrence, particularly in regions characterized by heavy seasonal precipitation (Rahman et al. 2011). The problem of landsliding varies from debris fall to massive slope failures. The International Karakoram Expedition of 1980, in 139 km KKH identified 334 (Rahman et al. 2011).

2.5.5 Glacial/Landslide Lake Out-Burst Flood (GLOF)

The devastating floods occur when landslide/glacier block the river and form temporary lake behind the obstruction. As the barrier burst, the entire stored water flow downstream causing worst flood. This phenomenon is referred as Landslide/Glacial Lake Out-bust Floods. In addition to other adverse impacts, GLOF cause damages to life and properties. The high Indus river flood in 1929 were similarly caused by the movement of Chong Kundan glacier across the Shyoke river in Baltistan and subsequent bursting of accumulated water, caused devastating flood disaster in downstream area (Rahman 2010).

Recently in 2010, a huge landslide occurred at Atta-Abad (Hunza valley, Gilgit-Baltistan), covering an area of about 1 km^2. Initially, this huge landslide buried Atta-Abad village and blocked the Hunza River. It created 11 km long lake that inundated several villages and submerged 5 km Karakorum Highway. Besides damages, the worst fear was that the water level consistently rising and might burst this temporary dam and flood the downstream areas. Therefore, an artificial spillway was created to reduce the potential impacts. There are more than 2,500 glacial /landslide lakes in the upper catchments of Indus river system. There are more than 50 vulnerable lakes in Pakistan and are located in Himalaya-Karakorum-Hindu Kush region. In northern Pakistan, the Glacial /Landslide Lake Outburst Floods (GLOFs) might pose serious threat to Pakistan due to climate change and glacial melting.

2.5.6 Cyclones

Pakistan has a 1,000 km long coastline along the Arabian Sea in the south. It borders Baluchistan and Sindh provinces. The coastal belt of Pakistan is almost every year hit by cyclone. These cyclones usually occur in pre monsoon (April 15–July 15) and post monsoon (September 15–December 15) period. Most of the cyclones hit the coastal area of Sindh province and very few so far affected Baluchistan coastal belt. Such cyclone develops in the north Arabian Sea and approaching towards Pakistan and Indian state of Gujrat. Mostly these cyclone turn towards India and sometime it has also approached the coastal belt of Pakistan. According to PMD (2013), the Establishment of Tropical Cyclone Warning Centre (TCWC) is part of the approved National Plan "Strengthening National Capacities for Multi Hazard Early Warning and Response System" Phase- I. The tropical cyclone warning centre issue early warning to population and fishermen of coastal Baluchistan and Sindh province.

According to Pakistan Meteorological Department, in the past cyclonic storm struck the Pakistan belt during 1895, 1902, 1907, 1944, 1948, 1964, 1984, 1985, 1999, 2007 and the recent 2010. PWP (2014) mentioned the recorded history of cyclones that in 1895 a cyclone strike the coastal region of Makran. In May and June 1902 two consecutive cyclones hit the coastal region in the proximity of Karachi. In June 1907, once again a tropical cyclone hit Karachi region. In July 1944, a strong approaching cyclone strike Karachi and left thousands of people homeless. Similarly, in 1948, a cyclonic storm struck the Makran coastal area in Balochistan province. In 1964, the cyclone after passing through Indian Territory, entered Pakistan and caused terrific losses to people and property in Tharparker and Hyderabad districts and incurred 460 fatalities and over 400,000 people were left homeless along the coastal Sindh.

In the recorded history, the 1965 was the ever-worst cyclonic storm, which generated tidal floods and smashed Karachi region with over 10,000 human casualties. The PWP (2014) further states that in 1985 cyclonic storm hit the Karachi surroundings. Similarly, in 1993 another powerful cyclone generated flood and hit the coastal Sindh and rendered over 500 casualties. In 1998, cyclonic storm killed 11 persons in Karachi city. It was followed by 1999 ever strongest cyclone, which killed over 6,000 people in the province of Sindh. In 2004, eight persons were killed, 2007 cyclone Yemyin killed 730 persons, 2009 cyclone Phyan trapped six fishermen, 2010 cyclone Phet killed 15 people and in 2011 Keila cyclone triggered heavy rainfall in Karachi (PWP 2014; PMD 2013).

The impact of cyclonic storm has been found very devastating whenever it was accompanied by tidal waves. Almost each time the powerful cyclonic storm has been made responsible for coastal floods. The recent cyclone Yemyin 2007 and Phet 2010 were the powerful one. According to Pakistan meteorological department, the cyclone Phet was responsible for 12–14 ft high storm surges and torrential rainfall along the coastal belt of Pakistan and in turn heavy rainfall was recorded at Gawadar (370 mm), Pasni (130 mm), Jiwani (208 mm), Karachi (122 mm) and Masroor (150 mm). The powerful cyclonic storm with a speed of over 100 km/h was felt in many parts of the country including Mirpur, Thatta, Sujawal, Golachi, Jati, Shah Bandar, Dasht and Gawadar.

2.5.7 *Heat Wave*

In Pakistan, the vulnerability to hazards of heat wave has been very frequent particularly during the past one decade. The climate change experts attribute this ever changing intensity of temperature to global warming. According to PMD (2013), there is increasing trend of temperature from 1961 to 2009 and temperature ≥40 °C for seven consecutive days is increasing in the province of Sindh, Baluchistan and Punjab. This clearly indicates that this region is considered to be the most vulnerable to increasing heat waves.

In addition to loss of lives, heat waves can also significantly affect the economic sector through livestock losses, crop failure and harm to electric equipment etc. High temperature due to heat heaves also lead to excessive electricity demand. Beside this, the stagnant atmospheric conditions generated by heat wave trap pollutants in urban areas and increase the amount of pollutants, which in turn create health problems. During the past one decade (2003–2013), Pakistan has experienced three deadliest heat waves in 2003, 2007 and 2010. In 2007, the heat wave smashed over 100 people.

Prior to monsoon rain, in May 2010 the south-central part of the country was in grip of a century worst heat wave (Rahman and Khan 2013). According to Pakistan Meteorological Department, in the country 11 met stations have recorded ever highest temperature during the last week of May 2010. This has developed a severe low pressure zone over Pakistan. At Mohenju-Daru, on May 26, 2010 maximum recorded temperature was 53.5 °C (Rahman and Khan 2013). This was the ever highest recorded temperature in the south Asia and it is the fourth highest in the world after Al-Aziziah, 57 °C (1922) in Libya; Death Valley 56 °C (1913) in USA; Tirat Zvi 54 °C (1942) in Israel. Following this heat wave, in July 2010, the historic low pressure was developed over northern Pakistan (Douglas 2011; Rahman and Khan 2013).

2.6 Risk Assessment and Management

Disaster risk assessment and management is a logical strategy for minimizing probable losses and provides guidelines to decision makers and disaster related government line agencies. It is in this regard, risk assessment and management is gaining attention at all levels because it focuses both on structural and non-structural risk reduction approaches. In disaster risk assessment three stages are involved, finding and measuring hazards, assessing exposure and degree of vulnerability, and finally assessment of risk in combination with likelihood and severity of consequences (Wilkinson and Brenes 2014).

Disaster risk assessment is a key component HFA (2005–2015) priority area 2, which insist/encourages the governments to undertake risk assessment. The HFA provides framework and policy guidelines to key stakeholders to understand and promote resilience against the unforeseen events. In disaster risk assessment process the severity of hazard and its potential adverse consequences are kept in mind with other factors. In the risk assessment process, hazards are identified, associate risks to hazard are explored and ways are suggested for reducing impact of hazard. There are several risk assessment methods used to calculate level of risk exposure like low, medium, high and risk free zone.

Generally, risk assessment is carried out to explore the potentiality of the risk to life and property. Risk assessment is usually undertaken in relation to residential, agricultural, commercial, recreational and industrial land uses (Cosic et al. 2011). The objective behind the risk assessment is to systematically analyse hazard related information, de-potentialize the force of event and reduce its damaging nature. In case of flood risk assessment some necessary information is required including history of flooding events and the pre and post flood vulnerability record (Rahman 2010). While approaching to successful risk assessment two aspects need to be kept in mind, hazard zonation and potential impacts of an event, which is largely dependent on the type and value of assets in the hazard prone area.

Risk assessment is a hard but most effective way of dealing with extreme events. It requires plenty of data and information, which is lacking in developing countries. Therefore, the scientific community now-a-days rely on using latest tools and techniques to undertake risk assessment results. There are several ways to undertake the risk assessment and usually multi-criteria approach has been applied in risk analysis, which provides a platform for extracting relevant information for the decision makers. Recently, scientists have widely used GIS and remotes sensing for risk assessment. In the risk assessment process, selection of risk assessment methodology, occurrence and consequence mapping is carried out and in turn yielding reliable results.

In case of flood, the datasets along with some other hydro-meteorological and geomorphological data help in preparing vulnerability map of an area (Showalter and Lu 2010). Flood vulnerability mapping shows the damage potential of the assets that are prone to flooding (Zeleňáková 2011). The flood hazard map together with the vulnerability maps are the basic necessity for the generation of flood risk mapping. Flood risk means 'the combination of the probability of a flood event' and of the 'flood potential adverse consequences' on human health, environment, cultural heritage and economic activity associated with a flood event (Georgia and Christos 2011). Flood risk mapping requires rain gauge data, information about assets and the topography of the study area (Zeleňáková 2011). The flood risk is calculated by using Risk equation formula = Hazard × Vulnerability/Capacity. In this formula hazard is the frequency of flood occurrence, vulnerability is the weakness of the community to resist against the floods, and capacity is the strength of the population towards the flood (Georgia and Christos 2011). The population or community requires certain tools and skills so as they can strengthen themselves to cope up with the disastrous situations (Redfern et al. 2008). After combining all the three variables, it provides a bird's eye view towards the exposure of an area to be affected in future. By the use of GIS, one can specifically map out the areas with regard to the flood hazard, vulnerability and risk (Juliana and Andrew 2008). Modelling by the use of GIS is one of the ways of providing a ladder for future coping. Unless certain planned mitigation and prevention measures are not adopted, it would not be possible to save the community from the drastic impacts of floods (Hansson et al. 2008; Rahman 2010).

Disaster risk management is referred to holistic and systematic process to assess disaster risk and build management for reducing disaster's impact. Disaster risk management focuses right from prevention, mitigation, preparedness, emergency response to recovery phase. In case of flood risk management, the common aim is reduction in the area under inundation for increasing habitable lands, reduction in flood stage, and increase in lag time and reduction in peak flood duration. The flood risk management involves an analysis of risk exposure of a flood prone community, flood risk analysis followed by the identification and implementation of appropriate measures to manage existing, future and residual flood risks to acceptable levels (Jha et al. 2012). The flood risk management process involves protection of assets from extreme events, readiness both physically and mentally and reduction in post disaster losses.

Risk and loss reduction call for a comprehensive approach to handle the increasing impacts of disasters. However, there are three major pillars in risk reduction including the government, vulnerable population and the insurance industry (Munich Re 2014). Nevertheless, the role and responsibility of government is of key significance. It attempts to mitigate, establish the forecasting and early warning system, emergency response and early recovery. One way of minimizing disaster risk is the identification of hazard zonation and its depiction on the map, to guide and enable the disaster managers and resource planners for land use zoning.

2.7 Conclusion

The concept of hazard, vulnerability and risk is not a new but with reference to introduction of new tools and techniques, the disaster risk management discipline is yet to mature. The practitioners, scientific community and government organizations are in the process of introducing and implementing new strategies to cope with unforeseen events effectively. In this chapter the concept of hazard, vulnerability, capacity and risk have been discussed in detailed. All these terminologies were specifically highlighted and elaborated by quoting example from the real world situation. Additionally, various tools and techniques have been discussed for carrying out hazard, vulnerability and risk assessment and management.

Pakistan is the hub of geo-physical and hydro-meteorological hazards. The chapter also contains the hazard profile of Pakistan, which specifically focuses on the frequently occurring hazards such as floods, earthquakes, landslides, drought, GLOF, cyclones, heat waves etc. In terms of frequency, floods lead over all other disasters. The devastating flash floods is reported from the north and north-western mountainous region of Pakistan, whereas river flood is a recurrently occurring phenomenon in the Indus river system where more than 80 % of the country population living. Similarly, the urban and coastal floods are other challenging problem and intensify with the changing climate. Similarly, the repeated devastating earthquakes have also carved the country and only 2005 Bagh-Balakot earthquake engulfed about 100,000 innocent lives. It was followed by 2013 Awaran earthquake claiming hundreds of casualties. Landslide is another frequently occurring disaster. It has reported that rain-induce and earthquake triggered landslide events together with the repeated human intervention over the fragile slopes are the major factors responsible for this phenomenon. The climate change phenomenon has further intensified the frequency and intensity of climate related extreme events and it is expected to further exacerbate in the future. This alarming situation has prompted the government to take bold step and endorse disaster risk reduction strategies in planning, policy and programs and build community resilience against the unforeseen events.

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Chapter 3
Disaster Resilience: Generic Overview and Pakistan Context

Atta-Ur-Rahman and Rajib Shaw

Abstract The concept of resilience has been widely used in the disaster risk reduction perspective. Disaster resilience is the capacity to prepare, respond and recover from the impacts of disasters. Building disaster resilience dealt with proofing, adaptation and mitigation. It improves one's ability to minimise the effects of adverse events. Disaster risk management ensure the risk reduction, enhance resilience, in addition to building effective response and recovery mechanism. The United Nations Hyogo Framework for Action (HFA): Building the Resilience of Nations and Communities to Disaster is the agreed framework for making the world safer from the impacts of disasters and building resilience.

In Pakistan, the earthquake of 2005 was an eye opening natural event, which particularly highlighted the country vulnerability to various risks. This has shifted the Government approach towards more proactive and as a consequence national disaster management ordinance, national disaster management authority was established as a focus body to chalk out national DRR agenda. In the country, there are certain key challenges in building disaster resilience including exposure to hazard events, low level of risk awareness, low level of development risk conscious, absence of multi-hazard risk assessment, lack of mainstreaming DRR in policies and plans and poor DRR capacity in the context of prevention, preparedness, response and recovery. This chapter discusses the concept and evolution of disaster resilience, various dimensions, indicators, linkages of disaster resilience and environmental system, disaster resilience and sustainability, disaster resilience and climate risk. The chapter also highlighted the disaster risk reduction legislations and resilience issues in Pakistan. Finally, the chapter focuses on how to build disaster resilience at various levels and promote adaptive strategies.

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*, Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_3

Keywords Resilience • Capacity • Vulnerability • Building resilience • Adaptive capacity

3.1 Introduction

The concept of resilience has been used both in the sense of process and outcome (Manyena 2006a; Cutter et al. 2008). However, in a more effective way, resilience is the capacity of a system, community to cope with, adapt or bounce back by resisting or modifying its impact and maintain an acceptable level of functioning and structure in the light of a hazard shock (Pelling 2003). In the recent literature the concept of adaptation is gaining importance particularly in a climate change context. Building disaster resilience dealt with proofing, adaptation and mitigation to disaster. It improves one's ability to minimise the effects of adverse events. It is determined by the degree to which the social system has the potential of organising itself to enhance the capacity of learning from the past disasters for effective mitigation (UNISDR 2005). Hence, the key characteristics of resilience are coping with the impacts of disasters or bouncing back and recovery from disasters and adaptation to cope better with future risks (World Disaster Report 2004). An effective approach to disaster risk management may ensure the risk reduction, enhance resilience, in addition to building effective response and recovery capabilities.

United Nations Hyogo Framework for Action (HFA): Building the Resilience of Nations and Communities to Disasters is the agreed framework for making the world safer from disasters and building disaster resilience. Similarly, the World Bank has established Global Facility for Disaster Reduction and Recovery has also highlighted and supporting countries in minimize their vulnerability, building disaster resilience and enhancing adaptation to climate change exacerbations. Mainstreaming disaster risk reduction agenda in development planning may also pave way for effective delivering resilience manifestations. The local authorities need to involve community stakeholders while building community related disaster resilience.

The increasing impacts of natural and human induced disasters resulting from poor preparedness and emergency response has prompted the international organizations, governments and communities to initiate and work for building disaster resilience and minimize the risk and vulnerabilities at local, national and global level. It has been recognized that disaster resilience should have roots in the community, local, regional and national disaster management system, which is utmost necessary for a resilient nation. In literature, stress has been made to initiate disaster resilience from community and involve local population to handle the local hazards with available local resources (Zobel and Khansa 2014). Integration of traditional rooted indigenous hazard mitigation strategies and innovative approaches would however be more effective in reducing the impacts of unforeseen events (Gaillard 2010).

Pakistan is exposed to numerous natural and human induced disasters including earthquakes, floods, landslides, drought, GLOF, cyclone, avalanches, storm surge, tsunami, extreme weather phenomenon etc. In Pakistan, the earthquake of 2005 was an eye opening natural event, which particularly highlighted the country vulnerability to various risks that ranges from entirely endogenic mode of occurrence to terrestrial and extra-terrestrial nature. In the past two decades, the impacts of hydrological, meteorological and climatological events have been further intensified due the changing global climate scenarios. It is expected to further intensify in future and we have to think and shift the disaster risk reduction strategies from sole active approach to proactive one. It is because of this changing scenario, the Government of Pakistan has recently realized the shift towards more proactive approach.

In Pakistan, the increasing frequency and intensity of disaster impacts has prompted the federal government to promulgate the national disaster management ordinance, institute national disaster management commission (NDMC), prepare national disaster management framework (NDMF) to guide the disaster risk management activities and establish a focal body of national disaster management authority (NDMA) to operationalize and monitor the DRR agenda at the national, regional and local level. In the country, there are certain key challenges in DRR including exposure to wide range of hazards, low level of risk education and awareness, lack of institutional and technical capacity, low level of risk conscious development, absence of multi-hazard risk assessment strategies, lack of mainstreaming DRR in development programmes, policies and plans and poor DRR capacity in the context of preparedness, prevention and mitigation.

3.2 Concept and Definition of Disaster Resilience

During the past couple of decades, in the planning and development documents, literature and recent discourse on climate change issues, numerous disasters related concepts and terminologies have been used by practitioners, managers, policy makers and scientists. Hazard, vulnerability, risk, capacity and the recent most frequently used concept is disaster resilience (Gaillard 2010). Such concepts have been tied with the disaster risk management realm. However, the concept of resilience is new as compared to hazard, vulnerability, capacity and risk. The notion of resilience has been evolved in the disaster and climate discussions as early as in 1970s and then used by psychologists, engineers and ecologists and later on widely applied by social scientists (Manyena 2006a). As a cursory example, in just 6 pages of Hyogo Framework for Action (HFA) 2005–2015, the United Nations International Strategy for Disaster Reduction (UNISDR) has cited 9 times the word ‘resilience’, 10 times ‘vulnerability’ and ‘capacity’ 5 occurrences (Gaillard 2010).

The concept of disaster resilience has a recent root and widely used in the disaster discussion as well as a slogan by the United Nations, national governments and local level practitioners, managers, policy makers and institutions dealing with unforeseen events. Now-a-days, the disaster related literature frequently highlighting the emergence of this latest culture of dealing with disasters. The 2005 World Conference on Disaster Reduction (WCDR) has also confirmed the concept of increasing global, national and local level disaster resilience and minimizing the impacts of disaster and had recognized a significant place in both theory and practice. Similarly, in a scholarly disaster risk reduction discussions, the term resilience is tied with few related terminologies such as 'sustainable and resilient communities', 'resilient nation and safer community', 'resilient community' and 'enhancing community resilience'. The frequently used notions are 'disaster resilient', 'climate resilient', 'urban resilience' and 'resilient nation'. Nevertheless, the definition of resilience largely varies from discipline to discipline, as disaster resilience has cross-cutting nature and has been widely used in risk reduction perspectives (Manyena 2006b).

The disaster resilience has been defined variously by different scholars (Timmerman 1981; Anderson and Woodrow 1989; SOPAC 2002; UNISDR 2002; Pelling 2003; Manyena 2006a; Christoplos 2006). Timmerman (1981) defined resilience as the capacity of a system to absorb and recover from the occurrence of an event. Disaster resilience has been interpreted as a positive side of vulnerability or the capability to withstand against the extreme event (SOPAC 2002). The UNISDR (2002) defined resilience as the capacity of a community/ society or system to resist for obtaining an acceptable level of functioning. However, a change in socio-cultural, economic or political system is a pre-requisite for achieving resilience (Manyena 2006a; Anderson and Woodrow 1989; Christoplos 2006). Pelling (2003) is of the view that resilience is a component of vulnerability or the ability of an actor to cope with or adapt to hazard stress. It focuses on the preparedness and spontaneous adjustments undertaken. Another attempt has been made that resilience is the capacity to prepare, respond and recover from the impacts of disasters (Manyena 2006b). Cimellaro et al. (2010) defined resilience as a function indicating the capability to sustain a level of functionality or performance for a given building, bridge, lifeline networks, or community, over a period defined as the control time. Amongst the wider practitioners, disaster resilience is understood as the capacity to absorb stress or adaptation capacity to manage during extreme unforeseen phenomenon and to bounce back or recover after a disaster. In certain literature, the concept of disaster resilience has been used in broader sense than the capacity but generally capacity and coping capacity means the same as disaster resilience (Queensland Government 2014).

3.3 Dimensions of Disaster Resilience

There are four inter-connected dimensions of disaster resilience including technical, institutional, social and economic (Fig. 3.1; Chang et al. 2004). Technical resilience is actually the performance of physical systems when exposed to disaster situation (Zobel 2011), whereas institutional resilience is the ability of an established organizations that how it respond to an extreme event. The technical and institutional dimensions are the key role players in the performance and building disaster resilience.

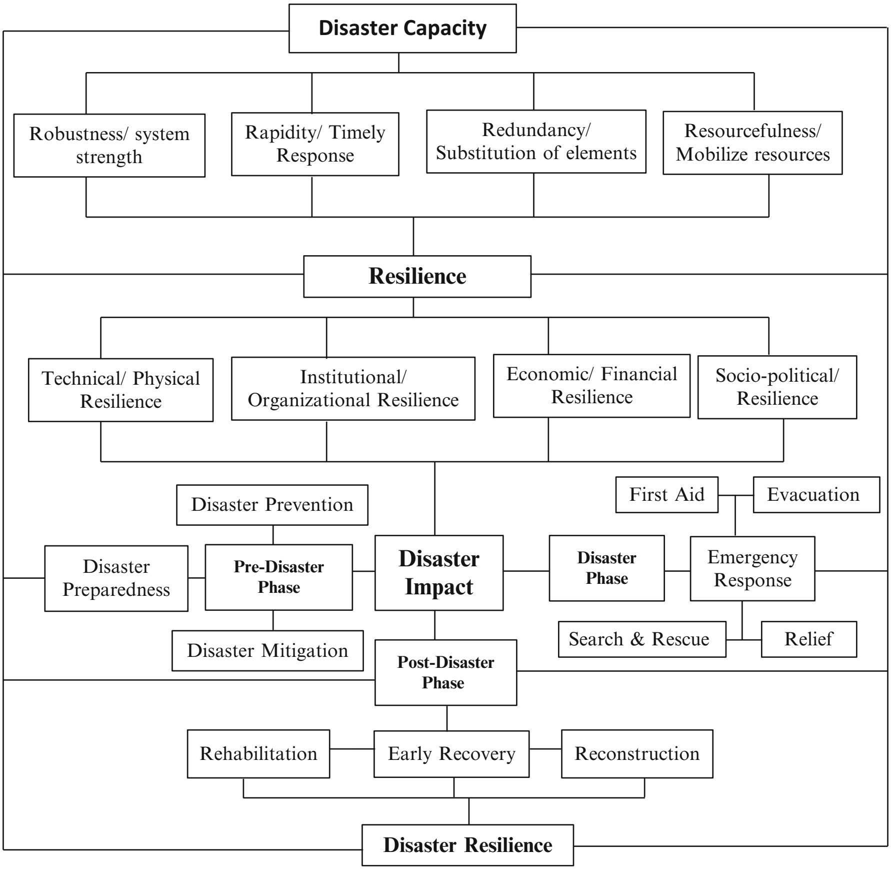

Fig. 3.1 Linkages of resilience in disaster management process (Modified after Adger 2000; Chang et al. 2004; WDR 2004; UNISDR. 2005; Paton 2006; Manyena 2006a; Gaillard 2010; Queensland Government 2014)

Technical resilience can be measured from the strength of physical facilities against the disaster forces. The critical facilities could be the water supply system, electricity and gas transmission lines, industrial, commercial, residential, institutional structures etc. However, the ability to minimize the adverse consequences of losses to societal system is a form of social dimension, while the capacity to minimize both direct and indirect monetary losses from an unforeseen event is economic dimension of disaster resilience. The estimation of social resilience could be obtained from the propensity of a household in seeking temporary shelter during the extreme event.

Properties of disaster resilience have been judged by various scholars and different parameters were used. Bruneau et al. (2003) argue that there are four properties of resilience namely, robustness (strength or ability of a system), rapidity (capacity to timely achieve targets), redundancy (potential of substitution) and resourcefulness (capacity to mobilize resources; Fig. 3.1). The factors of redundancy and resourcefulness are generally considered as important pillars of building disaster resilience with the corresponding "ends" being measured by the impact of these improvements on the factors of rapidity and robustness (Zobel 2011).

3.4 Disaster Resilience Indicators

In disaster resilience, several parameters have been tested to measure the resilience of individual, community, institutional capacity, economic feasibility and physical and technical viability (Fig. 3.1). Cutter et al. (2008) and Joerin et al. (2012) have applied ecological, social, economic, institutional, infrastructure and community competency as disaster resilience indicators. While assessing resilience from the perspective of ecological parameter, the ecological system is usually influenced by factors like biodiversity, redundancies, response diversity, spatiality, and governance and management plans (Adger 2000).

In social resilience, key sub-indicators are demography, social networks, risk knowledge and risk communication, social norms and values and effectiveness of faith-based organizations (Joerin et al. 2012). Building social resilience requires enhancement in risk communications, risk awareness, preparedness, emergency response and recovery process (Paton and Johnston 2006). Likewise, the economic resilience to hazard events has so far been measured on the basis of impacts of disasters and the extent of recovery resilience (Joerin et al. 2012). In building economic resilience, stress should always be made on how to minimize monetary losses from the impacts of disasters, which can be effectively reduced through adoption of prevention, mitigation, preparedness, response and early recover mechanism. Cutter et al. (2008) has included income level, employment status, property value, wealth source, finances and revenue status as sub-indicators of economic resilience.

Stephane (2014) *define "economic resilience" and provide rules of thumb to estimate it. "The welfare impact of a disaster does not only depend on the physical characteristics of the event or its direct impacts in terms of lost lives and assets. Welfare impacts also depend on the ability of the economy to cope, recover, and reconstruct and therefore to minimize aggregate consumption losses. This ability can be referred to as the macroeconomic resilience to natural disasters. Macroeconomic resilience has two components: instantaneous resilience, which is the ability to limit the magnitude of immediate production losses for a given amount of asset losses, and dynamic resilience, which is the ability to reconstruct and recover. Welfare impacts also depend on micro-economic resilience, which depends on the distribution of losses; on households' vulnerability, such as their pre-disaster income and ability to smooth shocks over time with savings, borrowing, and insurance, and on the social protection system, or the mechanisms for sharing risks across the population".*

Institutional and organizational resilience includes the community involvement in hazard reduction initiatives, hazard mitigation plan, zoning regulations and building codes, inter-operable communication, emergency services and response plan and consistency of operational plan. It also requires assessment of organization and physical properties including number of technically trained personals, communication network, and emergency response assets. The organization should have hierarchical control, command system and horizontal coordination mechanism with sister organizations and integration in the disaster risk reduction policies and plans. Organization resilience is sometimes judged that how the organization manage and respond to a particular extreme event.

Technical and physical resilience is interchangeably used. It is actually dealt with the physical infrastructure aspects. Resilience of infrastructure includes the physical systems including transportation and communication life lines, irrigation and water storage system, water supply, electricity and gas supply networks, sewage and sewerage system, residential and housing stocks, commercial, institutional and industrial establishments (Joerin et al. 2012). Community competence is an important form of disaster resilience indicator and related to population wellness, local understanding of risk counselling services, education, health and quality of life. In disaster resilience context, the community competence is measured that how effectively community functions in pre, during and post-disaster phases.

3.5 Linkages of Disaster Resilience and Environmental System

Pakistan is bestowed with a tremendous resources but exploitation beyond its carrying capacity exposed the country to numerous threats. The country is vulnerable to various hazards of earthquake, flood, tsunami, avalanches, drought, desertification, cyclones and GLOFs. The German watch ranked Pakistan at 3rd that are exposed to the risks of climate change exacerbations. As a consequence, Pakistan has started planning for institutionalisation to save lives and reduce resultant damages of vulnerable and marginalised community. The scenario was changed from post-disaster relief activities to proactive approach. In this regard, disaster management authorities were established and National Disaster Management Plan (NDMP) was prepared in August 2012 (GoP 2012b). In the history of Pakistan, this was a milestone improvement in building effective disaster risk management system.

The linkages of disaster resilience and environmental system is a generalise depiction of extent of hazards, adaptive capacity, vulnerability and resilience (Fig. 3.2). The linkages between these concepts may help in identifying exposure of environmental system to extreme events (Cutter et al. 2008). Generally speaking, resilient nations/ communities are less vulnerable to the impacts of disasters. Quantitatively, it is hard to measure and enhance disaster resilience, as it requires the understanding that what parameters need to be applied to validate the assumption. Because of the cross cutting nature of disaster resilience and its various aspects, a comprehensive disaster resilience methodology need to be empirically tested at a local level (Cutter et al. 2008). Resilience and vulnerability is inversely proportion

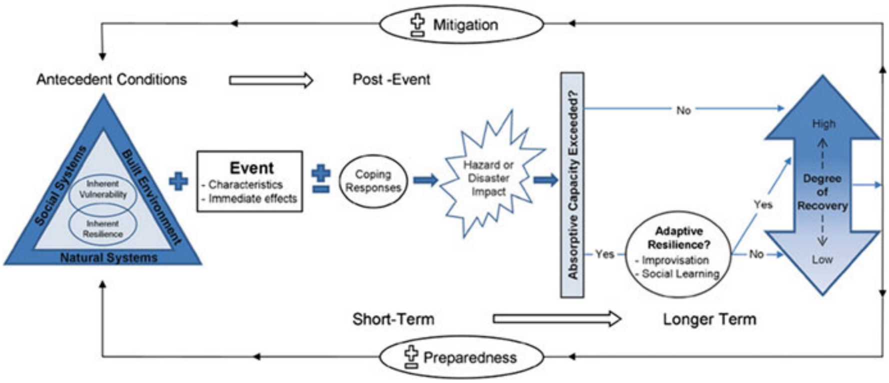

Fig. 3.2 Schematic diagram of disaster resilience linkages (After Cutter et al. 2008)

higher the vulnerability of a community/nation lower will be the resilience and vice versa. In the present scenario, we have high vulnerability and low resilience but ideally there should be low vulnerability and high resilience and this linkage may be more effective if we emphasise on increasing adaptive capacities particularly in a changing climate scenario.

3.6 Disaster Resilience and Climate Risk

In Pakistan, there is dearth of information and analysis about the impacts of climate change on sea level rise, increasing glacier ablation, increase in acid rains, extremes in precipitation and temperature etc. Such increasing frequency of weather related events is partially attributed and endorsed as an impact of global climate change scenario (Rahman and Khan 2013). In Pakistan, there were record breaking wet spell of rainfall in the year 2010, which has caused devastating century worst flood and terrible damages to socio-economic and physical environment (Rahman 2010). Climate change experts attribute this unusual phenomenon with a medium confidence level to climate change (Rahman and Khan 2011; Rahman and Khan 2013). The latest literature reveals that there has been increase in the climate variability and extreme weather episodes with high monetary losses (Kreft and Eckstein 2013). If serious and concrete steps for building disaster resilience were not taken for modifying the negative impacts of climate related disasters, the country would be on the track of posing serious implications.

The Global Climate Risk Index (GCRI) 2014 was developed by German watch, which highlighted and ranked the countries based on GCRI and have been severely affected by the global climate change (Kreft and Eckstein 2013). Due to the global climate change, it has been confirmed that less developed countries suffered more than the industrialized nations (Rahman and Khan 2013). Based on more authentic and reliable data it further explains that there has been increase in the frequency and intensity of hydro-meteorological disasters. While compiling the 2012 data, the GCRI ranked Pakistan 3rd after Haiti and Philippines. As recently, Pakistan was hit by super-flood 2010, flood 2011, flood 2012, flood 2013 and Awaran earthquake 2013. These were the major factors behind the escalation of Pakistan ranking from 12th position during 1993–2012 to 3rd until end of 2013. It is a sort of warning for Pakistan to be prepared for more frequent and high intensity extreme events in the future.

3.7 Disaster Resilience and Sustainability

The community vulnerability and disaster resilience is directly linked with the sustainable utilization of resources and man-environment interaction. It is therefore, sustainability is a central point in the framework of hazards vulnerability and disaster resilience. In the context of disasters, sustainability can be defined as the capacity to bounce back and tolerate the potential adverse impacts of extreme phenomenon relying on locally available resources without jeopardising the environment to reduce its potential for the succeeding generations and devoid of any assistance from outside.

Most often the environment is intensively utilized by unsustainable practices which as a result triggered more severe extreme environmental events. A cursory example of extensive deforestation is one of the key factor in increasing the flood runoff and resultant damages and similarly degradation of wet coastal resources is another major factor responsible for coastal hazards (see Fig. 3.2). Such efforts not only required for minimizing the impacts of environmental hazards, but they are also much more in line with the generational equity concerns inherent in sustainability science (Cutter et al. 2008). This calls to shift our DRR related reactive policies and strategies to more proactive one.

3.8 Rural and Urban Resilience

Disaster Resilience in the context of rural community is pertaining to the capacity of rural community to withstand or adapt to changing extreme environmental events and maintain quality of living standing (Heijman et al 2007). In this strategy, the extent of disaster resilience to which a target rural community is in a position to effectively withstands the unforeseen event. It is of paramount importance that how a rural region can simultaneously balance the ecosystem, social and economic functions (Adger 2000; Heijman et al. 2007) and specifically focuses on how effectively it can reduce the ecological, social and economic vulnerability and build disaster resilience. It is pertinent to note that so far rural disaster resilience with reference to inherited comprehensive socio-ecological rural principles and disaster resilience is not been properly addressed. In rural environment, there are three inter-connected chain of disaster resilience components (economic, ecological and socio-cultural) and most often they are overlapping. If a rural community is exposed to economic vulnerability such as job insecurity, increase in the interest rate etc. this need to be properly addressed while building rural resilience. As rural areas, dominate the primary economic activities. Similarly, in case of ecological vulnerability, the exposure of farmland, greenery, forest and rangeland to eco-shocks requires effective taken into account in enhancing rural resilience. Likewise, in cultural vulnerability, increase rural resilience to withstand with the external shocks of cultural infrastructural. Furthermore, the human capital needs to be strengthened and build resilience to cope with unforeseen event. It is a key to success, if rural resilience is made part of the rural and regional planning process.

Recently, the notion of urban resilience is gaining importance both in literature and practicalities. The urban scientists are of the opinion that urban areas are the hub of socio-economic sectors need to be made resilient to a wide range of unforeseen events and promote sustainable urban developments. In order to effectively respond to urban vulnerabilities across the urban set-up, it is need of the hour to devise and implement strategies for obtaining safe and resilient cities.

Joerin et al. (2012) recently adopted CDRI (Climate Disaster Resilience Index) having five dimensions (Natural, physical, economic, social, institutional) with 25 parameters and 125 variables specifically focusing on the human and institutional capacity and response to potential climate-related disasters in Chennai, India. Similarly, Prashar et al. (2013) also applied CDRI on city resilience and community action planning and to build climate related disaster resilience in eastern Delhi. Through CDRI technique, one can evaluate city's/ regional resilience against climate related disasters from community perspectives. It specifically attempts to find the policy and root gaps in individual as well as in overall sectors and provides direction how to bridge the loopholes and build city resilience. The scaling-weighted scores (1–5: 1 means low resilience and 5 means high) was calculated for the parameters and variables.

3.9 Building Disaster Resilience

In the past couple of years, increasing literature on capacity building for enhancing disaster resilience remained a focusing point of debate on extreme events. The implementation of disaster resilience strategy by the United Nations Strategy for Disaster Risk Reduction (2005–2015) "The Hyogo Declaration", which stress to promote the resistance ability of affected community and further strengthen community resilience to respond effectively and recover at their own (World Disaster Report 2004). Here the role of local planning authorities is indispensible in building disaster resilient communities. Being close to community pressures, they are more appropriate in designing long-term solutions to disasters and other problems generating in their areas of jurisdiction (Manyena 2006b). However, resilience needs to be properly in-capsulated in disaster management plans and local planning activities.

The disaster resilience varies from community to community depending on their capacity, vulnerability and hazard. This is what we call disaster risk, which requires knowledge and understandings about the physical, economic, socio-political and ecological set-up. In a more simple way, disaster resilience is the strength of a community or system, and how effectively can resist, adapt to or recover from an emergency. This involves that to what extent a community has the capability to build disaster resilience against the future disaster. Enhancing disaster resilience emphasises on minimizing physical, ecological, economic and social vulnerabilities, and mitigating the potential impacts of disasters and build capacities of individuals, communities and institutions.

Disaster resilience has dynamic nature and the strength of coping mechanism improves with time. Likewise, the partnerships between the major stakeholders also progress with time. The environmentally conscious community should have preparedness training and drill prior to occurrence of a disaster and should have well-netted mechanism for all disaster phases with intention to improve preparedness, ability of emergency response and recovery system. All these efforts needs true reflections in disaster risk management plan, where stress remains on minimizing disaster risk and building resilience.

Building disaster resilience requires joint and collective wisdom to cope with the challenges and mutual cooperation amongst the key stakeholders including individuals, family, community, local and central government, NGO's and scientific community (WEF 2014). Building disaster resilience improves ones capacity to reduce the impacts of unforeseen events on individual, family, community, economy and physical system. The disaster resilience also gives feedback that how the impacts of disasters can be minimized effectively. It can be summarised as higher the coping capacity of a community, individual and institution greater would be the disaster resilience and vice versa.

The resiliencies' of an asset may be increased by changing the nature of resource or significant repair or replacement by a more resilient asset. Generally, constructing new structures like buildings, roads, and bridges to a more disaster resilient standard is one way of starting from the scratch. Similarly, after a disaster scenario, building back better than the pre-disaster situation is another form of enhancing resistance strength against the extreme event. This in turn, enhances the resilience to the impacts of future extreme events. Building disaster resilience is not restricted to mere infrastructures rather it need to be expedited and widely applied to economic and socio-cultural fabrics of a society. It should be the national motive to build each community a stronger and more resilient to adverse consequences of extreme events.

3.10 How to Build Disaster Resilience in Pakistan?

The earthquake in 2005 highlighted Pakistan's vulnerability to disaster risks and motivated the government to shift from the erstwhile response-focused to the current, more proactive and disaster resilient approach. This shift of expression can be traced in the National Disaster Management Ordinance (NDMO 2007, replaced in 2010 by the current National Disaster Management NDM Act), followed by the National Disaster Risk Management Framework (NDRMF) (2007–2012) that outlined a comprehensive national disaster risk reduction agenda and National Disaster Management Plan 2012. Generally, in disaster risk management plan the activities are addressed in segments of building disaster resilience through disaster prevention, preparedness, emergency response and early recovery. A productive disaster risk reduction strategy would guarantee in minimizing risk, building resilience, enhancing effective emergency response and strength of early recovery.

It is evident that building disaster resilience is not the sole responsibility of disaster risk reduction authorities but it is a joint venture of all the key stakeholders including government, emergency planning authorities and individual, community and business organizations. During the past couple of years, community based risk reduction organizations, individuals, trained volunteers, families, government and non-government organization have made an outstanding efforts in helping the community. It will be unfair to appreciate and quote the extraordinary contributions by all the stated stakeholders during the 2005 Kashmir earthquake, supper flood-2010, flood 2011, flood 2012, Awaran earthquake 2013 and the recent drought in Tharparker. If all the stakeholders support the disaster hit community with share responsibilities and zeal to serve the community may ultimately leads to disaster resilient community. This need to be further streamlined through well netted coordination, effective capabilities and dedication of important role players. Government, community, individual, NGO's and businesses are important pillars of increasing disaster resilience.

3.10.1 Government and Disaster Resilience

Government disaster risk reduction organizations should share their financial and technical capacity for building disaster resilience of the vulnerable society. It is the government responsibility to provide infrastructural facilities and extend mitigation measures against the unforeseen events. The government need to pay special attention on legislation and policy instruments. Likewise, preparation and enforcement of land use regulations and building codes is another effective strategy for increasing disaster resilience. Similarly, prioritising disaster risk assessments and establishment of effective emergency response mechanism would directly build disaster resilience. All this discussion indicate that government need to develop a well-coordinated network for increasing community resilience right from prevention, mitigation, preparedness, early warning, rapid response, evacuation, rehabilitation to early recovery of the victim community.

Training is an integral component of capacity building and it needs to be designed for specific needs and equip the individuals, community, and technical staff with a practical approach. This process is related to strengthening of human resources, which is essential for disaster risk reduction and building resilience. Training participants should include staff of disaster management authorities, related government organizations at national, provincial and local levels, field practitioners working in NGOs, CBOs, international donor agencies, private sector enterprises, religious organizations, civil defence, police and the community. Since each of these have specific work area experience, strengths and weaknesses, it is important to complement each other's efforts to achieve an efficient overall disaster management system. For the purpose of capacity building in disaster management, the National Institute of Disaster Management (NIDM) shall play a key role and develop a standard module for building disaster resilience. Similarly, comprehensive disaster management courses and practical training shall be prepared by NIDM and it needs to develop symbiotic linkages with other research institutions and universities to enhance knowledge of disaster risk management at all level.

3.10.2 Individuals and Disaster Resilience

In a community, how an *individual* can contribute in enhancing disaster resilience. Every individual should have knowledge of vulnerability and risk posed to, from the external environments for example your property or home is exposed to flooding. It is of paramount importance that the entire family need to have preparedness plan including emergency kit against flood and related emergency accessories. During unforeseen event, every family member should know the evacuation plan/ escape route right from home to street and then to safe site in the neighbourhood. It is also pertinent to note that in a disaster phase, individual should know who needs help in the nearby houses. If you are fully equip and trained for emergency situation, serve the community as a volunteer and mobilize your expertise, energy, resources and time for the sake of serving the marginalized group of humanity. This is how an individual can increase and build the disaster resilience in a vulnerable society.

3.10.3 Business Organization and Disaster Resilience

Business *organization and institutions* is another stakeholder which requires disaster resilience to their business system and compulsory part of the system. Each institution and organization should have knowledge of risks to their business from flood, cyclone, fire etc. and may have understanding of disaster risks to their staff, gadgets and other tangible and non-tangible assets. The business organizations and institutions should protect their assets and vital documents from fire, flood water and also keep data backup in different safe locations. A disaster management plan should also be in-hand for continuing business at alternate location (Queensland Government 2014). Obviously, this requires heavy investments, which need to be ensured as a preparedness strategy. Emergency evacuation plan and periodic staff training are another hand-on approaches contributing to increase disaster resilience to business organizations and institutions.

3.10.4 Community and Disaster Resilience

Community itself is a key stakeholder in building disaster resilience and could play a due role in increasing the resilience. In the context of community resilience, the role of community is always central and the first responder to unforeseen events, it is therefore emphasis remained on building community economic progress, social capital and community resilience. Disaster resilience means putting more emphasis on what communities can do for themselves and how to strengthen their capacities, rather than concentrating on the community vulnerability or their requirements during an emergency (Joerin et al. 2012; Queensland Government 2014). There are a number of key success factors for building disaster resilient communities: building on the knowledge, capacities and priorities of people; mainstreaming gender issues in disaster risk reduction; public awareness of disasters; community based disaster risk reduction and creation of effective partnership and networking (World Disaster Report 2004).

Disaster resilient community is that which has the ability to withstand an extreme event, with a tolerable level of losses, and is able to take mitigation actions consistent with achieving a level of protection (Cimellaro et al. 2010). Community based disaster resilience is a sustained capacity of a community to resist or recover from the impacts of extreme event. The Global Risks 2014 report highlights that risks are not only interconnected but also have systemic impacts (Kreft and Eckstein 2013). To manage global risks effectively and build resilience to their impacts, better efforts are needed to understand and to measure and foresee the evolution of interdependencies between risks, supplementing traditional risk management tools with new concepts designed for uncertain environments (WEF 2014). Developing a sense of ownership amongst the community, and also respect their local culture, traditions and political system is a prerequisite for disaster managers. It would be very rational to utilize local resources for building resilience and risk reduction. At the same time, it is of paramount importance that local planning authorities should focus on disaster prevention, preparedness, emergency response and effective recovery strategies within the available local resources.

The disaster resilient community is an ideal but there is no community which is safe from hazard. It would be very rational work for the disaster resilient community to apply latest possible technology in reducing vulnerability and enhancing resilience. The community members should know various risks to the community and should also understand the high, moderate, low and risk free areas. The community should also have sufficient knowledge of various escape routes and evacuation plans for the entire vulnerable community. Likewise, the role of volunteers in a society should not be underestimated and it should be utilized to a greater extent in all the disaster phases. The community must have information about the vulnerable population and prioritise who need help in a disaster situation. Try to in touch and connect with rest of the community through an instant system may be wireless, mobile phone and keep these devices in safe place. The community based organizations must gather the information about the trained local volunteers and they should be tied in a well-established network so that each member must know their role and responsibility particularly during disaster phase. Every volunteer should have a brief disaster kit, torch, radio and mobile to keep intact-with and well inform.

It has been increasing recognized that building disaster resilience amongst the vulnerable community is inevitable. It is a challenging task for the national, regional and district level disaster management authorities to build community resilience and enhance their capacity to effectively prepare for, respond to and recover from the impacts of disasters. Decentralisation of disaster risk reduction strategies from federal government to local planning authorities is one of the tested approaches for building disaster resilient communities. In disaster resilience, while discussing “ability to adapt”, it means that community is not mere passive disaster victims but they should have the capacity to positively work against the unforeseen events. Therefore, international organizations most often stress on building local resilience, which directly targets the role and responsibilities of local planning authorities in building disaster resilience. Local planning authorities may use participatory approach, which increasingly demands for active involvement on the part of the affected populations (Olwig 2012). To summarize this discussion, enhancing community disaster resilience is an effective way to cope with extreme natural events. In this strategy the capacity of community is judged through its coping ability using its own resources. In the changing climate scenario, building community based disaster resilience is utmost required for tackling impacts of disasters particularly at local level.

3.11 Key Disaster Resilience Issues in Pakistan

Pakistan recurrently suffers from a plethora of natural and man-made disasters, which has seriously affected the lives and livelihoods of its citizens. During the past one decade, the frequency of natural disasters including floods, earthquakes, landslides, cyclones and drought remained very high, whereas amongst the human induced disasters conflicts, accidents, and infrastructure failure were top of the list (EM-DAT 2014). Over the last decade, Pakistan has experienced large natural disasters such as the half-decade drought followed by 2005 Earthquake, 2010 heat wave, 2010 Cyclone Phet, 2010 super flood, 2011 flood, 2012 flood, 2013 Awaran earthquake and 2014 drought, which has caused significant impact on human lives and national economy (Rahman 2010; Rahman and Khan 2013; EM-DAT 2014). In Pakistan, key issues in disaster management can be discussed under the following areas.

3.11.1 Strengthening Disaster Management Institutions at All Levels

The government of Pakistan has established NDMA, Regional Disaster Management Authorities (F/G/S/PDMAs) and District Disaster Management Authorities (DDMAs) at national, provincial/regional and district levels, respectively. However, the disaster management organization at the national level has not been established with clear roles and responsibilities with the federal ministries in terms of financial and technical coordination. Moreover, linkages between NDMA and F/G/S/PDMAs are quite weak and there is no clear coordination mechanism between NDMA and DDMAs. Since the National Disaster Risk Management Framework (NDRMF) was prepared in 2007, Pakistan has received heavy damages from flood 2010, 2011, 2012, 2013, Awaran earthquake 2013 and 2014 drought. The coordination mechanism of disaster management among national, provincial and local levels needs to be strengthened (GoP 2012a) particularly in terms of policy integrations, technical and financial resource mobilization. There is also need of building and strengthening disaster management institutions and clear cut policy for planning, finances and capacity building at national, regional and local level.

3.11.2 Enhance Disaster Management System in the Pre, During and Post-disaster Periods

Since inception of Pakistan, emergency response has remained a predominant activity of disaster management system. Because of extensive trained personal, throughout the role of Pakistan army has remained of immense significance in disaster management, especially in emergency response and early recovery phases. However in pre disaster phase, priority attentions need to be given to building disaster resilience of our disaster related human resources via hazard prevention, mitigation and preparedness in the project formulation period, which is lacking in the country disaster management system. Similarly, during post-disaster phase, there is absolutely lack of clear institutional systems or funding sources for disaster rehabilitation, early recovery and reconstruction. Therefore, the district, provincial and federal governments need to prepare disaster risk reduction plans covering actions and measures to be taken in all stages of pre, during and post-disaster situations.

3.11.3 Mechanism for Assessment and Monitoring of Disaster Risks

Risk assessment and monitoring of hazards is essential for disaster risk reduction and building resilience. In the country, there is dearth of technical knowledge and information about hazard identification, risk assessment and management, and linkages between livelihoods and disaster preparedness. Risk and vulnerability assessments of hazards are prepared by different agencies like federal flood commission (FFC), Pakistan meteorology department (PMD), NDMA, F/G/S/PDMAs and few disaster related provincial department, but they are in segments and representing only few areas. Similarly there is lack of effective coordination and sometime overlapping powers and responsibilities (Rahman 2010). There is an urgent need of multi-hazard risk assessment, early warning, effective emergency response and recovery system to save human lives, property and sources of livelihoods earnings.

3.11.4 Mechanism for Mainstreaming Disaster Risk Reduction into Development Planning

Disaster risk management, development planning and environmental management operate in isolation and integrated planning approach between these sectors is almost completely lacking. The National Development Plan should include a disaster risk reduction approach as a part of the nation's sustainable development policies. There is lack of long-term, inclusive / coherent planning systems to address disaster issues with a national vision. NDMA determined ten ministries and started evaluation of development projects with reference to the disaster risk management concept. However, there is an absence of a central authority to integrate disaster management into development planning. A dedicated technical staff and financial resources for disaster risk management has never been part of overall development planning at the federal and provincial/regional level.

3.11.5 Disaster Risk Reduction Through Building Resilience at All Levels

In Pakistan, disaster risk reduction through building resilience at federal, provincial, district and community level remained all time key issue in disaster risk management process. There is lack of knowledge and skills of officials in relevant government agencies and civil society in disaster risk management. State-level disaster preparedness and mitigation measures are oriented towards structural measures and undermines the significance of non-structural measures such as training, education, awareness, early warning, first aid, search and rescue, and recovery. Disaster related departments and organizations remained under-resourced and untrained and are not given required training and education, which is necessary for capacity building and increasing disaster resilience. Likewise, community is the heart of disaster risk management cycle also needs special attention in building disaster resilience. Enhancing the knowledge and building resilience capacities of individuals, community, and technical staff would definitely help in risk reduction at all levels.

3.11.6 Multi-hazard Early Warning System

Flood forecasting and early warning is necessary component of a comprehensive flood risk reduction strategy. Timely warning can reduce loss of life through evacuation from the disaster prone areas; allow preparedness measures to be taken in advance to minimize damages to vital structures, and alert authorities responsible for maintenance and operation of flood control facilities (Rahman 2010; GoP 2012b). In the country there is absence of multi-hazard early warning system. The flood forecasting and warning division is only responsible for extreme weather phenomenon (Rahman and Khan 2013). Whereas in the dream of multi-hazard early warning system, there is need of further strengthening the capacity of early warning system and minimize the vulnerability against multiple hazards.

The present flood forecasting division (FFD) call herself as of worth effectiveness and efficiently fulfil the country requirements. At the national level, since 1975, to some extent flood forecasting and warning system has been supporting flood preparedness and response system. But the fact is that it doesn't cover the catchment area of all the rivers (Rahman 2010; Tariq 2013). Flood Forecasting Division (FFD), Lahore is the only national agency responsible for flood forecasting and its dissemination to the warning centres (GoP 2012b). FFD receive hydro-meteorological data from the various national and international sources, which is then analysed to produce flood forecasts, warnings and disseminate to various Federal/Provincial organizations and print/electronic media. The 5.3 cm radar has been installed at Sialkot for quantitative precipitation measurement and to detect the position of clouds and precipitation within the radius of 230 km. Another Doppler radar is installed at Lahore which provides quantitative and three dimensional precipitation data in catchment areas of eastern rivers.

Pakistan also faces a problem of flood forecasting in most part of the upper catchment area of Sutlej, Ravi, Jhelum and Chenab Rivers, which lies across the border in Indian Kashmir. Several water storage reservoirs have been constructed on Chenab, Ravi and Sutlej across the border. As a result, the free floods flow conditions are disrupted making the operation of the rainfall/runoff model extremely difficult (FFC 2012). The cursory example is the catchment area of Kabul and Swat rivers is beyond the carrying capacity of existing country radar system (Rahman 2010). It is therefore, during the super flood 2010, neither the prolonged heavy wet spell was forecasted and nor the early warning disseminated to the vulnerable community (Rahman and Khan 2011). That's why the highest number of human casualties and subsequent flood damages has been reported from the Swat and Kabul river basins (Rahman and Khan 2013).

The existing organization set-up for flood forecasting and early warning is functioning. Therefore, radar coverage over the North Western mountains for catering the catchment areas of Kabul and Swat rivers need to be enhanced by the procurement of an additional Doppler radar of 10-cm at *Warsak*. This need further meteorological studies to take full advantages of the new radar and satellite data to improve quantitative precipitation measurement and forecast of rainfall in the upper catchment of Kabul and Swat rivers. Beside this, dissemination of early flood warning to the vulnerable communities is specially lacking in flood management planning, when assessed during field survey (Rahman 2010). Hence, the location of radar system will also provide a database for both forecasting and subsequent dissemination to the vulnerable communities. The recent emphasis of Government on this response is attractive, because the flashy rivers means that advance technology is required to provide sufficient warning time for preparedness.

3.12 Disaster Resilience and Adaptive Strategies

Disaster resilience is measured that how individual and community can adapt to a local disasters and explore new approaches as adaptive capacities. To encapsulate the potentials of new possibilities, an element of learning and growth need to be implicit in its conceptualization, as the notion for disaster is the catalyst for development (Paton 2006). The capacity to adapt and the capacity for post disaster growth and development requires consistent efforts on the part of institutions, community and individuals to mobilize resources for building disaster resilience and adaptive capacity. The provincial and district disaster management authorities can play a due role in enhancing community knowledge and training in emergency planning and community development.

The adaptive capacity consists of four major elements. Primarily, the community, individuals and institutions should have resources for emergency planning, safety measures and normalizing the societal system. Secondly, they should have the competency in terms of trained people, self-efficiency to mobilize and organize the available resources and adapt to the extreme events (Paton 2006). Thirdly, the planning and development mechanism to facilitate resilience and ensure societal capacity at all levels. Fourthly, the disaster risk reduction strategies need to be consistent and sustainable to use them as and when needed. This will however, help in facilitating the maintenance and development of societal capacity to cope with, adapt to challenges encounters pre, during and after the disaster phase.

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Part II
Hazard, Risk Profiles and Mitigation in Pakistan

Chapter 4
Flood Risk and Reduction Approaches in Pakistan

Atta-Ur-Rahman and Rajib Shaw

Abstract Globally, flood is a recurrently occurring damaging phenomenon. In terms of flood related damages, approximately 90 % is reported from the developing countries, where poverty is a major risk factor and holding low resilience. Pakistan has no exception to it, where flood is a frequently occurring adverse event. Pakistan is one of the flood prone countries in the world because of its physical and climatic characteristics. The Indus plain is occupied by more than 120 million population, where agriculture is a major source of livelihood earnings. Majority of them are poor section of the society and tenant cultivators. During the span of 67 years (1947–2013), on average of 4-year, a severe flood hit the country. The increasing population, degradation of ecological environment and the changing climate scenario have further multiplied the risk of flood disasters. It has been estimated that Pakistan is suffering from frequent flood disasters and so far 11,239 human lives were lost, out which 1,985 is reported from the super-flood of 2010. It was a century worst flood, where 20 million people were affected and over 100,000 km^2 (1/5th of the country total area) inundated and ≈US$ 10 billion economic loss was registered. Since the inception of Pakistan 1947, efforts have been made for building resilience through various flood reduction approaches. The existing flood reduction strategies range from structural to non-structural measures. This chapter provides a review of risks associated with flash and river flooding in Pakistan. It also gives an analytical discussion on the historic flood events and their adverse impacts. In addition, the flood risk reduction approaches undertaken so far in Pakistan have also been discussed.

Keywords Flood risk • Flood causes • Impacts • Flood reduction strategies

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*, Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_4

4.1 Introduction

Historically, rivers and other large bodies of water have played a pivotal role in the development of civilization. Floodplains with fertile alluvial soil has always encouraged settled agriculture and enjoyed a long history of settlement (Khan 2003). Globally, flood is the recurrently occurring damaging phenomenon. Flood encompasses from a wide range of unpredictable, highly localized flash floods to anticipated and widespread river floods. Therefore, floods considers among the worst natural disasters affecting society. However, in terms of flood related damages ≈90 % is reported from the developing countries, where poverty is a major risk factor and holding low resilience (Douben 2006; Rahman 2010). Similarly, societal vulnerability to flood damages is a function of land use, land values, human occupancy and population (Tariq 2013). All together flood accounted for about 30 % of all natural disasters and 40 % of the fatalities (Rahman 2010). However, floods may also bring benefits as it recharge the ground water and deposit fertile silt (Khan and Rahman 2003).

Pakistan is one of the flood prone countries, because of its physical and climatic characteristics (Fig. 4.1; Khan 2003). In Pakistan, flood is one of the serious and recurrent extreme natural events (Khan and Rahman 2003). During the span of 66 years (1947–2012), on average of 4-year, a severe flood hit the country (Rahman 2010). The discharge in river Indus and its tributaries is subjected to seasonal fluctuations. It is high in summer due to melting of snow, glacier and summer monsoon rainfall (Rahman and Khan 2013). However, the discharge remains low in winter due to retarded ablation of glaciers and precipitation in the form of snow over the catchment area of Indus river system. The Indus plain is occupied by more than 120 million population and agriculture is a major source of their livelihood earnings (Tariq 2013). Majority of them are poor section of the society and tenant cultivators. It is evident that the increasing population, degradation of ecological base and the changing climate scenario have further multiplied the risks of flood disasters.

From time-to-time Indus River and its tributaries overflow the levees and cause heavy damages to human lives, standing crops, agricultural land, infrastructure and other properties (Rahman 2010; Khan and Iqbal 2013). It is estimated that Pakistan has been suffered from frequent flood disasters and in past 20 mega flood events, 11,239 human lives were lost, out which 1,985 is reported from the single event of super-flood 2010 (UNDP 2012; Tariq 2013). It was a century worst flood, where 20 million people were affected and over 100,000 km^2 (1/5th of the country total area) inundated and ≈US$ 10 billion economic loss was registered (FFC 2012). Scientific evidence indicated the increasing extreme precipitation events, which implies that heavy flood events will become more frequent in future (GoP 2013). Parallel to this, exposure and vulnerability to floods have increased due to over urbanisation in the flood-prone areas, even without taking climate change into considerations; flood related damages are expected to further increase (Tariq 2013).

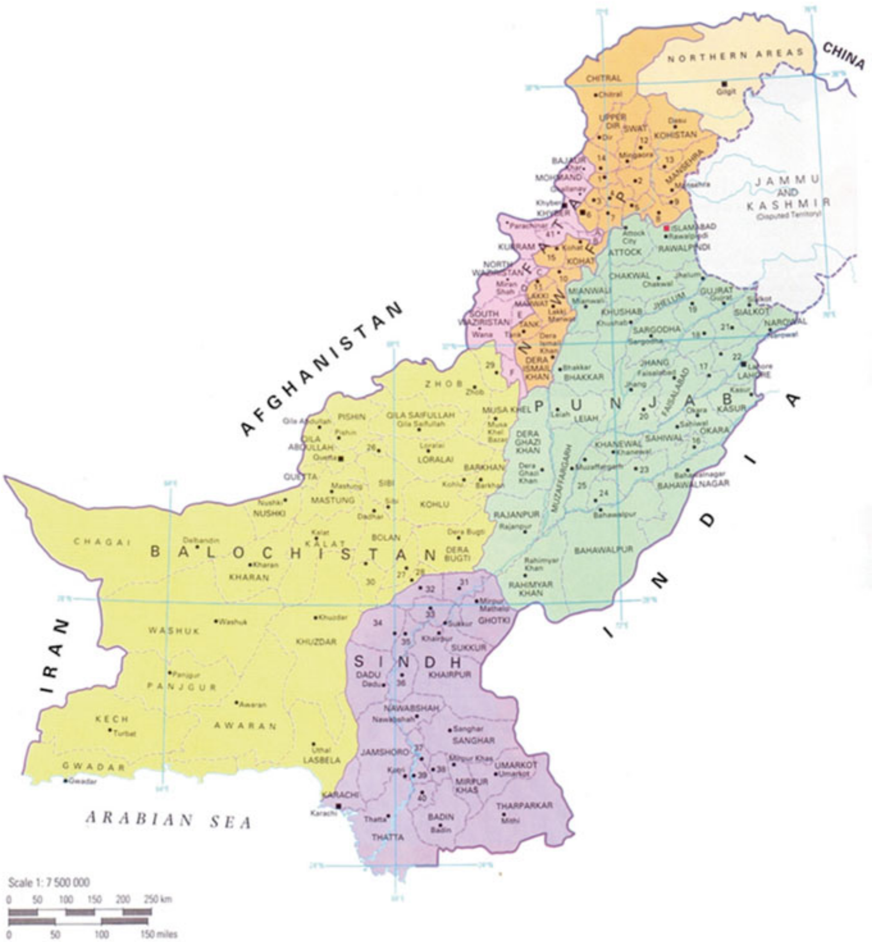

Fig. 4.1 Administrative regions of Pakistan (Modified after Khan 2008)

Since the inception of Pakistan (1947), efforts have been made for building flood resilience through various risk reduction approaches. At selected places, flood related line agencies have constructed water reservoirs, barrages, embankments and guided head spurs, to ensure flood water within the channel. But due to limited budget, it is economically and technically impossible to confine water within the channel. The existing flood reduction strategy ranges from structural to non-structural measures (Rahman and Khan 2013). This chapter provides a review of historic flood events and their adverse impacts. It also elaborates the risks associated with flash and river flooding in Pakistan. In addition, the flood risk reduction approaches undertaken in Pakistan have been analysed in the final section.

4.2 Physical Settings of Pakistan

In Pakistan, large variations exist both in terms of climate and physiography (Kazi 2014). Physically, Pakistan can broadly be classified into five physiographic units, formed by various geomorphological processes in the past. (1) The Himalaya, Karakorum and Hindu Kush form the north and north-western part of the country. Almost 60 % of the country is mountainous, which mostly lies in the north, north-west and western part. The world renowned peaks of K2 (8,611 m in Karakorum), Nanga Parbat (8,126 m in Himalaya) and Tirich Mir (7,706 m in Hindu Kush) lies in these mountains. These lofty mountains experiences long winter and receive heavy precipitation in the form of rain and snow. This is the region which hosts thousands of glaciers and a major source of perennial water for Indus river system. Some of the large glaciers are occupying area of more than 100 km^2 (*Siachen glacier in Karakorum*). Flash flood is a typical feature of this region. (2) Baluchistan plateau forms the south-western portion of the country and comparatively dry in nature. Hill torrents and associate flood is a landmark feature of this physiographic unit. (3) Potwar plateau is located south of sub-Himalayas and physically bordered by Jhelum River in the east and Indus in the west, while Salt range lies in the south. (4) Indus basin making almost 40 % of the country area and support more than 60 % of the country population.

Indus is a longest river of about 3,100 km with a total drainage basin of about 1 million km^2 (Khan 2003). The catchment area spread over Tibet, China, Afghanistan, India and Pakistan. Out of the total catchment area, 65 % form the Indus basin of Pakistan (Kazi 2014). Throughout the river course, right from its origin (lake Mansarwar in Tibet), Indus River passes through narrow gorges in Karakorum and Himalayas, and enters into a wide Indus plains and ultimately empties in the Arabian sea (Khan 2003). Throughout its course, Indus River receives several tributaries both from right and left banks. The major right hand tributaries are Jhelum, Chenab, Ravi, Sutlej and Beas, whereas Kabul River is a notable right hand tributary. The Indus plain occupies almost all the province of Punjab and major part of the Sindh province.

Continental type of climate is prevailing in the Indus plain, whereas highland climate is reported from the northern and western mountains (Fig. 4.2). There are extremes in rainfall and temperature both daily and seasonally. During winter, most often temperature falls below dew point, whereas in summer the ever highest recorded temperature is 53.5 °C, which was recorded on 26th May 2010 at Mohenjo-Daro, Sindh (Rahman and Khan 2013). Similarly, arid to semi-arid type of condition is prevailing over 60 % of the country area and less than 10 % area has humid to sub-humid climate. In Pakistan, rainfall occur in two well-marked seasons i.e. monsoon (summer) and western depression (winter). Eastern half of the country receive maximum rainfall from monsoon, whereas the western half in winter from western depression. In addition to this, the northern half of the country receives more rain as compared to southern half. It means that the amount of rainfall decreases as one move southward. The record breaking ever highest one day rainfall is 620 mm, which was received on July 24, 2001 at Islamabad. Murree is the humid station, which receive on average 1,789 mm annually.

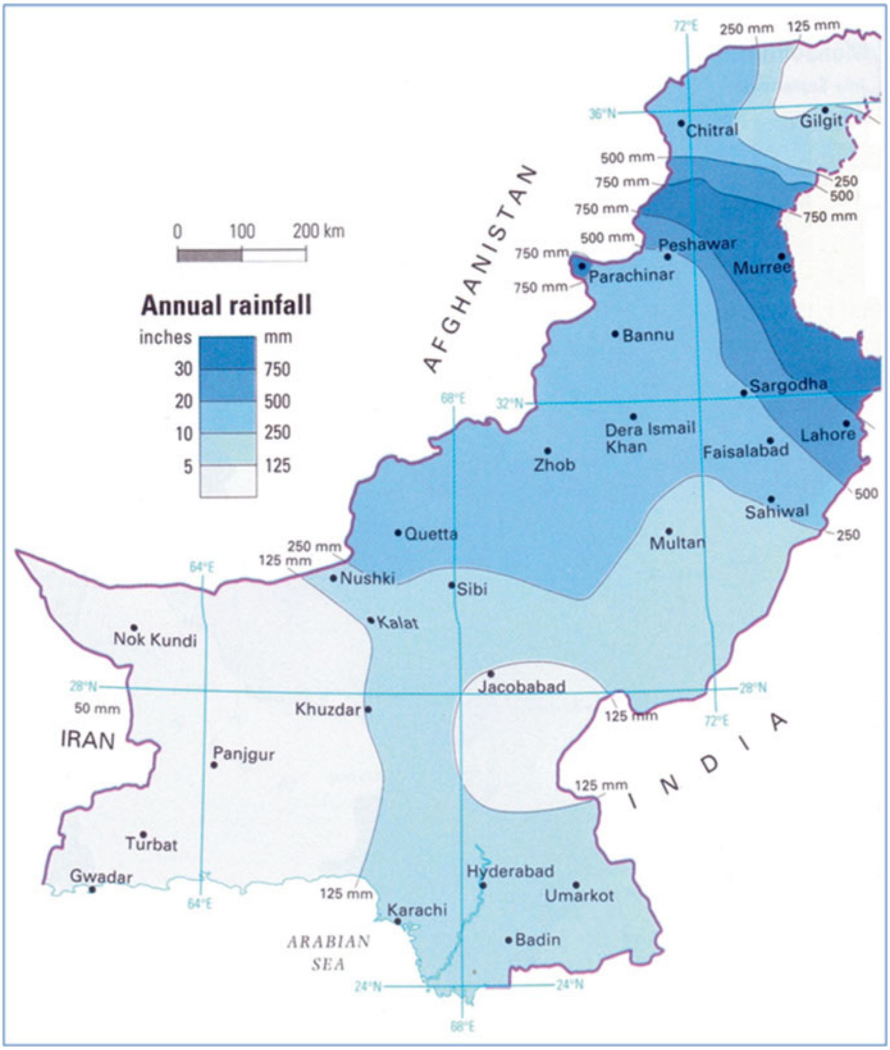

Fig. 4.2 Rainfall distribution in Pakistan (Modified after Khan 2008)

4.3 Types of Floods in Pakistan

Flood is any abnormal rise of water level, which overflow the levees and inundate the adjoining areas (Rahman 2010). There are several types of floods depending upon the physiography, tectonics, climatic condition and sources of water. Some of the major types of floods include riverine floods, pluvial/urban floods, flash floods, coastal floods and barrier lake floods (Kazi 2014). These floods are caused by a variety of factors that range from physical to human intensifying factors. Heavy and prolonged rainfall remained the major contributor in the inland flood occurrence.

Pakistan is exposed to frequent riverine floods, flash floods and coastal floods. Historical records shows that Pakistan has experienced almost all types of floods but in terms of frequency and magnitude river and flash floods dominates over all other kind of floods. Therefore, in this chapter focus has been made on riverine and flash floods, which poses more risk than other types of floods in terms of damages to lives and property.

4.3.1 River Floods

In Pakistan, river flooding is a type of inundations, which occur in Indus, Jhelum, Chenab, Ravi, Sutlej and Kabul river systems (Khan 2003). However, the hilly terrain has a flash flood characteristic, whereas the coastal area has a risk of tsunami. Largely, it is catered by existing flood forecasting and early warning system, established under the flood forecasting division (FFD), Lahore. The Indus plain has a long history of river flooding. Floods in the Indus River and its tributaries is evident to be the most devastating (Tariq and Van-De-Giesen 2012), because downstream Chashma Barrage, the might Indus enters into the gentle sloping floodplain and meandering throughout the course till it falls into the Arabian Sea. In addition to this, high population density, poverty, farmland, infrastructure and concentration of economic activities are the major risk factors. According to Federal Flood Commission (FFC), in the past 35 years more than US$ 210 million has been spent on flood mitigation under different programmes. In response to flood damages, no significant decrease in the farmland inundation has been registered (Tariq and Van-De-Giesen 2012).

4.3.2 Flash Floods

Flash flooding is an extreme natural event throughout the mountainous region of Pakistan. It is a recurrently occurring phenomenon. Flash flood is more disastrous and occurs within 6 h of heavy/prolonged rainfall. The Himalaya-Karakorum-Hindu Kush (HKH) region is more susceptible to flash floods. However, flash floods are also reported from the Sufaid Koh, Waziristan hills, Sulaiman, Kirthar and Makran ranges. In mountain system, it is the physiographic and climatic conditions, which leads to hydro-meteorological disasters. Particularly in the HKH region, the torrential rainfall is some-time supported by cloud bursting, thunder storms, heavy melting of snow/ice and glaciers. Eventually, it increases the intensity and magnitude of flash floods. Forecasting of flash flood is difficult and provides short time for preparedness such as early warning and response. In Pakistan, no flash flood warning system exists except for nullah Lai, which was established in 2001, after massive flash flood that hit Rawalpindi and adjoining areas. The north-western of Pakistan is more susceptible to flash floods and almost every year heavy casualties have been registered. Such sudden flashy water pick up the silt, sand and in effect cause damages to human lives, standing crops, infrastructure and other property.

4.4 Case Studies

4.4.1 *Flash Flood in Rawalpindi Nullah Lai (Punjab Province)*

Nullah Lai is a hill torrent flowing through Islamabad and Rawalpindi. Margallah hills are the catchment area of nullah Lai. During monsoon, it is flooded almost every year, but in the past one decade the flood of 2001 and 2008 is remarkable. On 23rd July 2001, a record rain of 620 mm was occurred at Islamabad in just 10 h. As a consequence, a havoc urban flood occurred in the twin cities (Islamabad-Rawalpindi) and a total of 74 lives were lost, ≈400,000 people were affected, 742 livestock were perished, 1,087 houses were fully damaged and 2,448 partially (WMO 2004). Another terrible situation was occurred on 5th July 2008, when a torrential rainfall of 104 mm was recorded at Islamabad in just 100 min and 162 mm in 5 h. Eventually, it has caused a disastrous flood in nullah Lai. Besides massive damages to urban property, 3 precious lives were also lost. It has prompted the Government to establish Flood Forecasting and Early Warning System for Nullah Lai.

4.4.2 *Flash Flood in Karachi and Thatta (Sindh Province)*

In July 2003, the province of Sindh was severely affected by heavy monsoon rainfall and caused flash and urban floods in major part of Karachi, Thatta and Badin. In Karachi, 284 mm rain fell in just 2 days, which generated massive urban flood and disastrous situation in the city. Similarly, heavy rainfall was also recorded in other parts of the province. In Thatta, 404 mm rainfall was recorded in just 2 days, which as a result caused flash floods in the district. In Sindh province, due to July 2003 flash floods, a total of 484 human lives were lost and around 4,476 villages were affected.

4.4.3 *Flash Flood in Rajanpur, Punjab*

On August 2, 2013, flash flood hit the Rajanpur district of Punjab province. A total of 17 Union Councils were affected in the three tehsils of district Rajanpur. The eastern part of the district frequently affected by river flooding in Indus, whereas the western section of the district is exposed to flash floods generated in the Suleiman ranges. Heavy monsoonal rainfall has been blamed as the major factor responsible for flash floods in the district. Flash flood has inundated the area up to 8 ft. The available reports reveal that early warning was not issued and there were absolutely lack of preparedness for such disastrous flash flood. According to District Disaster Management Authority, besides structural and other economic damages, 2 precious human lives were also lost and approximately 150,000 people were affected.

4.4.4 Flash Floods in Peshawar, Khyber Pakhtunkhwa

On 14th August 2002, the heavy rainfall occurred around Warsak. Sources also indicate that several cloud bursts was also noticed in the area. A total of about 500 mud houses were collapsed and 930 partially damaged when heavy flash flood hit the five union councils namely Mathra, Panam Dheri, Kafoor Dehri, Shahi Bala and Ghari Sherdad. Similarly, on 4th August 2008, another flash flood hit the northern part of the district. There was a torrential rainfall in the catchment area of *Thara* and *Chorai* hill torrents originating from the Khyber hills. A total of about 50 villages were affected and approximately 700,000 people were affected. Besides this, 12 people were also killed due to flash floods.

4.5 History of Flood Events in Pakistan

The territory of Pakistan has a bad history of flood events. During 1841 a heavy flood hit the Indus basin, when a Glacier blocked the Shyok River in Karakorum and subsequent breaching of Glacial Lake Outburst Flood (GLOF) has caused disastrous flood in the down-stream area. Similarly, during the British period in 1929 another deadliest flood occurred in the Indus river, when Indus river was choked-up by the moraines near Roykot (Diamir district), Gilgit-Baltistan Province (Table 4.1). The bursting of this temporary water reservoir has caused heavy floods in the Indus basin. Since 1947, Pakistan has experienced severe flood events with various magnitude and frequency. All the four provinces including FATA, Gilgit-Baltistan and Azad Jammu & Kashmir has been hit by riverine, flash, urban and coastal floods.

The major river system including Indus, Chenab, Ravi, Sutlej, Kabul and Swat rivers have a long history of flood events and resultant damages (Table 4.1). In the upper Indus basin, the flood water after inundating the contiguous areas often return to the main river. However, in the lower Indus plain (Sindh province), which is flowing at a relatively higher elevation than the adjoining lands, spills water do not return to the main river channel (FFC 2012). This is one of the major reasons behind the excessive flood losses in the lower Indus plain. Although, flood protective embankments has been provided along the major section of Indus River in the Sindh province and at many locations in the upper parts of the country (GoP 2012). As in this part of the country, flooding has been a regularly occurring phenomenon with various intensities.

Table 4.1 Historic flood peaks in major rivers

Dam/Barrage site	Design capacity (Cusecs)	Highest recorded year	Highest recorded flow (Cusecs)
Indus River			
Tarbela	1,500,000	1929	875,000
Jinnah	950,000	1942	950,000
Chashma	950,000	1958	950,000
Taunsa	1,000,000	1958	789,000
Guddu	1,100,000	1976	1,199,672
Sukkur	900,000	1976	1,161,000
Kotri	875,000	1956	980,000
Jhelum River			
Mangla	1,230,000	1929	1,100,000
Rasul	850,000	1929	1,000,000
Chenab River			
Marala	1,100,000	1957	1,100,000
Khanki	800,000	1957	1,066,000
Qadirabad	900,000	1992	948,530
Trimmu	650,000	1959	943,000
Panjnad	700,000	1992	744,152
Ravi River			
Jassar	–	1988	582,000
Shahdara	–	1988	576,000
Balloki	225,000	1988	399,000
Sidhnai	175,000	1988	330,000
Sutlej River			
Suleimanki	325,000	1955	598,872
Islam	300,000	1955	493,000
Kabul River			
Warsak	–	2010	250,000
Nowshera	–	2010	300,000

Source: GoP (2012)

4.6 Causes of Floods

In Pakistan, flooding in the Indus River system is one of the major frequently occurring hazards. It normally occurs in summer season (July–October). Summer monsoon rain has been the major cause of floods together with the heavy melting of snow, ice and glaciers in the catchment areas. Monsoon currents originate from the Bay of Bengal and proceed towards the Himalayan foothills depression and cause heavy rainfall. Such heavy rainfall led to flash floods in the hilly areas and river floods in the lower reaches.

The cause of floods in river Indus varies at upper reach and lower reach. The floods in the upper Indus generally result from heavy precipitation in the hilly catchment area in Himalayas and Hindukush which have limited valley storage. There is significant snow melt contribution. Occasionally, floods have been caused by formation and collapse of temporary natural dams either by glacial movement like the GLOF of Shyok river in 1841 or by the landslides like the one in 1929 that blocked the Indus near Roykot (FFC 2012). The upper reaches of all these rivers passes through mountainous territory, with a concentration of population in the valleys. Heavy rainfall in these areas usually generates massive flash floods in the headwater regions.

The lower Indus basin receives combined flows of the upper Indus and tributaries Jhelum, Chenab, Ravi and Sutlej. The floods in this reach occur in August, but could also occur from July to October and the river can be in high flood for a period exceeding 1 month (Sheikh 2004). In the lower Indus basin, the river system meandering and sloping gently, causing overflow of water that adversely affects the population and agriculture land lying in the active floodplains.

4.7 Flood Management Legislations and Institutions

4.7.1 National Calamity Act 1958

The National Calamities Act of Pakistan 1958 was the only legal document to regulate the relief, rehabilitation and reconstruction. This was only the reactive legal document functioned throughout the country for a long time. Under this regulation, there was an emergency relief cell within the cabinet division. Again it is refereeing just relief /compensation in either disaster or post-disaster phase. Under the Calamity Act, in each province there were relief commissioners, who supervised and coordinate the relief and rehabilitation efforts. Few provinces have also developed Disaster Plan such as NWFP Disaster Plan 1978, where list of hazards are available to which the province is susceptible (Rahman 2010). Similarly, it has also elaborated the Government line departments and their primary and secondary responsibilities in the disaster phase. The Provincial Board of Revenue has been made responsible of collecting damages data and record of compensation.

4.7.2 UNISDR and HFA (2005–2015)

The United Nations General Assembly has created UNISDR (International Strategy for Disaster Reduction) in 1999. The secretariat of UNISDR is the focal point in the UN system for the coordination of disaster risk reduction and implementation of the international disaster risk reduction – the "Hyogo Framework for Action 2005–2015: Building the resilience of nations and communities to disasters". It was adopted under the "Hyogo Declaration" in the World Conference on Disaster

Reduction, held in Hyogo prefecture Kobe, Japan in 2005. Its core areas includes ensuring disaster risk reduction (DRR) is applied to climate change adaptation, increasing investments for DRR, building disaster-resilient cities, schools and hospitals, and strengthening the international system for DRR. UNISDR's vision is based on the three strategic goals of the Hyogo Framework for Action: integrating DRR into sustainable development policies and planning, developing and strengthening institutions, mechanisms and capacities to build resilience to hazards, and incorporating risk reduction approaches into emergency preparedness, response, and recovery programmes. The UNISDR introduced new concept to shift from a reactive to a proactive approach HFA (2005–2015) signed by 168 countries including Pakistan.

4.7.3 National Disaster Management Ordinance – 2006

After 2005 Kashmir earthquake and HFA, the Government of Pakistan was stimulated towards institutionalisation for disaster risk reduction. There was high time for capacity building of the disaster related agencies at national, provincial, district, local and community level. As after the earthquake, numerous challenges emerged and encounter the situation. Keeping in view this alarming state the president of Pakistan promulgated the National Disaster Management Ordinance (NDMO) in 2006 (GoP 2011). Under this ordinance, National Disaster Management System was introduced in the country. Similarly, the National Disaster Management Commission (NDMC) was established at the national level. The NDMC was assigned the task of preparing guidelines, policies and plan for DRR. Eventually, the National Disaster Management Authority (NDMA) was established in 2007.

4.7.4 National Disaster Management Authority

The National Disaster Management Authority (NDMA) was established in 2007. The NDMA was held responsible for coordinating, implementing and monitoring body for DRR in the country level. Under the Ordinance (now Act), the National Disaster Risk Management Framework (NDRMF) was prepared by the NDMA in March 2007 (GoP 2012), which serves an overall guideline for disaster risk management at national, provincial and district levels. This necessitates NDMA to directly interact/ communicate with all stakeholders, including Ministries, Divisions, and Departments. In March 2010, the NDMA formulated the National Disaster Response Plan (NDRP) for identifying specific roles and responsibilities of the key relevant stakeholders in emergency response including Standard Operation Procedures (SOPs). In addition to this, the NDMA, in collaboration with national and international partners had been in the process of strengthening the DRM system in the country.

4.7.5 National Disaster Management Act 2010

The Pakistan National Disaster Management Ordinance was approved by the parliament in December 2010 and became the Act called as Pakistan National Disaster Management Act (DMA) 2010. The DMA has established three levels for the disaster risk management in the country i.e. national, provincial and district levels. National disaster management authority is working at federal level, provincial /state disaster management authority at provincial/state level and district disaster management authority/unit at the district level.

4.7.6 Provincial Disaster Management Authority

The National Disaster Management Ordinance insisted for the establishment of a Provincial Disaster Management Commission (PDMC) as well as Provincial Disaster management Authority (PDMA) to cope with the challenges of Disaster Management in a professional and efficient manner. Both the Organizations have been mandated to effectively set up a system to look after disasters and calamities whether natural or man induced and coordinate with the key players. Previously the Provincial Relief Commissionerate had been responsible for the relief, compensation and rehabilitation of people affected by natural disasters. With the establishment of PDMA, the functions of the Relief Commissionerate have been incorporated into the new Organization.

4.7.7 District Disaster Management Authority/Unit

In order to involve local organization in DRR planning and implementation, district disaster management authority (DDMA) has been in the process of establishing at district level. In Khyber Pakhtunkhwa, there is district disaster management unit instead of authority. As per plan, the Head of the local council at the district level shall be the chairperson, Deputy Commissioner /District Coordination Officer as secretary, whereas District Police Officer and Executive District Health Officer are the ex-officio members. The power and function of District Authority include preparation of district disaster management plan, coordinate and monitor the implementation of the National Policy, Provincial Policy, National Plan, Provincial Plan and District Plan. In addition to this, DDMA shall ensure that the vulnerable areas in the district are identified and measures have been taken for their prevention and mitigation at district level (GoP 2012).

4.7.8 Federal Flood Commission

Prior to 1977, flood mitigation was the concern of respective provincial Governments. However, the heavy floods of 1973 followed by flood-1976 has prompted the provincial Governments to raise the issue at federal level that planning and execution of flood mitigation is beyond their carrying capacity (Rahman 2010). As a consequence, in 1977 the Federal Flood Commission (FFC) was established to tackle the flood issue at federal level. The key responsibility of FFC include: Preparation of National Flood Protection Plans; Approval of flood control schemes prepared by Provincial Governments and concerned Federal Agencies; Review of flood damages to flood protection infrastructure and review of plans for restoration and reconstruction works; Measures for improvements in Flood Forecasting and Warning System; Standardization of designs and specifications for flood protection works; Evaluation and monitoring relating to progress of implementation of the National Flood Protection Plans; Preparation of a Research Program for flood control and protection; and Recommendations regarding principles of regulation of reservoirs for flood control (GoP 2011).

4.7.9 Pakistan Meteorology Department and Flood Forecasting Division

The Pakistan meteorological department provide services of flood forecasting and early warning together with the generation of weather data and its dissemination to the relevant agencies. The Pakistan Meteorology Department has so far installed 97 weather stations all over the country to record rainfall and other weather elements. One of the core areas of Pakistan Meteorology Department is the Flood Forecasting division. This division is fully equipped with Doppler radar to remotely sense and measure the quantitative precipitation over the catchment area of major river systems. Such 10-cm Radar facilities are available at Lahore and Mangla, whereas 5-cm radar at Sialkot, Islamabad, Dera Ghazi Khan, Rahim Yar Khan and Karachi, which cover almost all the catchment area of major river systems in Pakistan. The Flood Forecasting Division is also applying mathematical model on Indus river system for computing the stream hydraulics and to identify vulnerable areas for issuance of early flood warning.

4.7.10 WAPDA

WAPDA activities impinge on the sector in a number of ways. WAPDA has traditional responsibility for the investigation design, construction and operation of the major storage works in Pakistan. WAPDA also held responsible to maintain gauges at various site and disseminate the discharge data to FFD for analysis and early warning.

4.7.11 Provincial Irrigation and Drainage Authority

The Provincial Irrigation and Drainage Authority (PIDA) is headed by a respective Secretary, and technically supported by two Chief Engineers responsible for development and Operation & Maintenance. PIDA's also records discharge at their respective jurisdictions, which they share with the FFD for analysis and onward dissemination. At provincial level, construction of flood protective embankment and spurs is the direct responsibility of PIDA but if budget accede certain limit then they seek approval of FFC.

4.7.12 Other Players

Beside the above mentioned major implementing agencies, health department, animal husbandry department, communications and works (C&W) department, Pakistan railways, home department (Tele-communication, Police, Civil defence), food department, directorate of social welfare, finance department, information department, education department, law department, Telephone and telegraph department, public health engineering department, and army are other key role players in disaster situation (Rahman 2010). After the receipt of information of disaster occurrence, the control centre of concerned department at provincial, divisional, district and sub-divisional level shall have at all times ready to respond and execute their emergency plan. They must also send their rescue and evacuation team to the affected area for rescue operation, emergency assessment of losses and net requirement.

4.8 Impacts of Floods

Historically speaking, floods remain the major catastrophic events that has resulted enormous damages to life and property. During 1931 flood, 3.7 million human lives were lost in China (Rahman 2010). The records show that number and trends of hydro-meteorological events is gradually increasing since 1985 (MunichRe 2010). Despite all these disadvantages man has clung to the river, because of the fertile land as well as irrigation and navigation facilities.

In Pakistan, flood is one of the serious and recurrent extreme natural events (Khan and Atta-ur-Rahman 2002). The discharge in river Indus and its tributaries is high in summer due to melting of snow, glacier and summer monsoon rainfall and low in winter. From time to time Indus River and its tributaries overflow the natural levees causing heavy damages to human and animal lives, standing crops, agricultural land, infrastructure as well as housing and other properties (Fig. 4.3; Rahman 2010). Whenever, major flood disaster occurred, it swept away rural and urban settlements and have caused human deaths and rendered thousands of people homeless. It is estimated that Pakistan has been suffered from frequent flood disasters and in past 20 mega flood events, 11,239 human lives were lost (Table 4.2), out which 1,985 is reported from the single event of super-flood 2010 (UNDP 2012; Table 4.3). It was a century worst flood, where 20 million people were affected and over 100,000 km^2 (1/5th of the country total area) inundated and ≈US$ 10 billion economic loss was registered (FFC 2012).

Fig. 4.3 2010-flood damages in Khyber Pakhtunkhwa

Table 4.2 Flood damages in Pakistan, 1950–2012

Year	Number of lives lost	Number of villages affected	Flooded area (sq. km)
1950	2,190	10,000	17,920
1955	679	6,945	20,480
1956	160	11,609	74,406
1957	83	4,498	16,003
1959	88	3,902	10,424
1973	474	9,719	41,472
1975	126	8,628	34,931
1976	425	18,390	81,920
1977	848	2,185	4,657
1978	393	9,199	30,597
1981	82	2,071	4,191
1983	39	643	1,882
1984	42	251	1,093
1988	508	1,000	6,144
1992	1,008	13,208	38,758
1994	431	1,622	5,568
1995	591	6,852	16,686
2010	1,985	17,553	160,000
2011	516	38,700	27,581
2012	571	14,159	4,746

Source: Federal Flood Commission (2012)

Table 4.3 Province-wise summary of flood damages and losses during 2010 flood

Province	Deaths	Injured	Houses damaged	Population affected
Baluchistan	54	104	75,596	700,000
Khyber Pakhtunkhwa	1,156	1,198	284,990	3,800,000
Punjab	110	262	497,700	6,000,000
Sindh	411	1,235	876,249	7,274,250
A.J.K	71	87	7,106	200,000
Gilgit-Baltistan	183	60	2,830	100,000
Total	1,985	2,946	1,744,471	18,074,250

Source: National Disaster Management Authority, Islamabad

Scientific evidence indicated the increasing extreme precipitation events, which implies that heavy flood events will become more frequent in future (GoP 2013). Parallel to this, exposure and vulnerability to floods have increased due to over urbanisation in the flood-prone areas, even without taking climate change into considerations; flood related damages are expected to further increase (Tariq 2013).

4.9 Flood Risk Reduction Approaches in Pakistan

In Pakistan, the existing flood risk reduction approaches has been the result of a long history of flooding experience. In Pakistan, the aim of flood risk reduction is to save lives and reduce damages. In this regard, government has been taking interest in implementing both structural and non-structural strategies (Table 4.4; Fig. 4.4). The existing flood reduction strategy ranges from structural to non-structural measures (Khan et al. 2011; Rahman and Khan 2013). Structural measures are those physical measures which are applied to minimize or alleviate potential impacts of hazards by construction of hazard-resistant structures (FFC 2012). Structural measures are usually cost-intensive and take long time to implement. Whereas non-structural measures refer to policies, plans, awareness, capacity building and provision of information for reducing risk and related impacts. At national level following flood risk reduction approaches were found:

4.9.1 Structural Measures

Since the inception of Pakistan, maximum stress remained on the structural flood management approaches, but the limited structural measures have so far not reduced the flood damages to a greater extent (Table 4.4). In Pakistan, the structural measures include water reservoirs, flood protective embankments, flood dikes, guided

Table 4.4 Province-wise, existing flood protective infrastructures, 2012

Province	Embankment (Km)	Spurs (No)
Punjab	3,334	496
Sindh	2,424	46
Khyber Pakhtunkhwa	352	186
Baluchistan	697	682
Total	**6,807**	**1,410**

Source: GoP (2012)

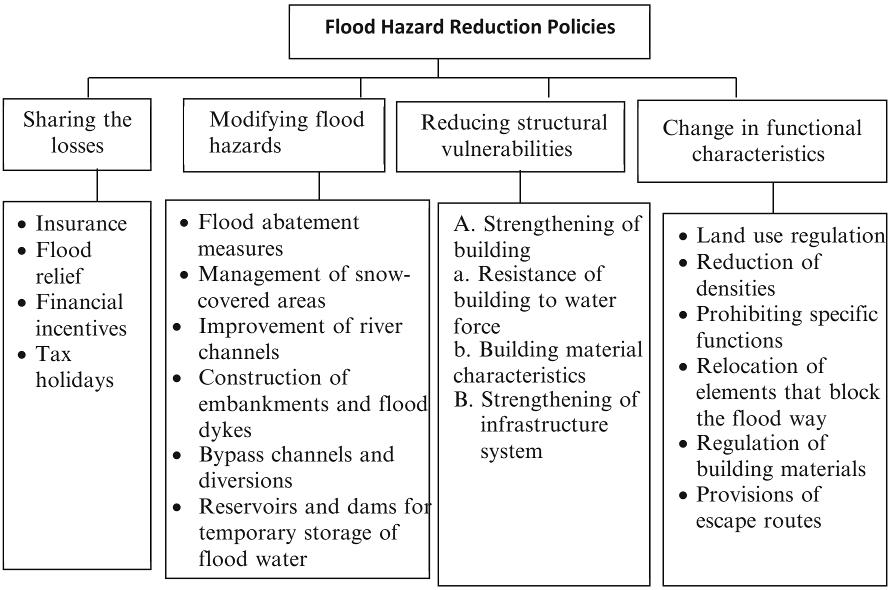

Fig. 4.4 Flood hazard reduction policies (Modified after Rahman 2010)

head spurs, and flood diversion channels (Rahman 2010). Generally, the structural measures are adopted where flood problems emerges. Nevertheless, the structural mitigation approaches are very expensive and beyond the financial capability of developing countries like Pakistan (Rahman and Khan 2011; Rahman and Salehin 2013). Therefore, the structural strategy is subject to the availability of finances and its subsequent implementation. While mitigating flood losses in critical areas, the structural approaches have largely reduced the flood damages (Tariq and Van-de-Giesen 2012). This could have been the most viable solution for flood risk reduction if implemented throughout the critical breaching areas of river system. However, it is not feasible both economically and technically. As throughout the length of river, numerous irrigation channels have been taken out for agricultural practices. Application of such strategy would hinder the economic activities throughout the floodplains (GoP 2012).

4.9.1.1 Channel Modification/Link Canal/Flood Relief Channels/ Diversion Channel

These schemes have received little attention in the past, although there are examples of flood relief channel or link canals on the rivers. These channels intercepting the flow of main river (GoP 2012). Channels enlargements and channels straightening are more common in Pakistan and have adopted this measure as a flood alleviation strategy.

4.9.1.2 Embankment and Spur/Dyke

Embankment and spur/dykes schemes have been utilized more than any other structural measure in Pakistan. The rapidly rising flood inherent in the country added to the necessity to prevent flood water spreading much further than the main channel, because of the high degree of urban development and fertile agriculture land have encouraged the employment of such levee system (GoP 2012). Therefore, this scheme has a long history and can be found throughout the country on a variety scale.

4.9.1.3 Flood Water Reservoir

Reservoirs have never been built in Pakistan for the sole purpose of flood alleviation. However, some multi-purpose reservoirs do operate in order to ensure the most efficient over all water management (Khan and Rahman 2003). Thus, maximum flood retention capacity in autumn is progressively reduced during the winter and spring, so that increased water level are available both for power generation and for river regulation purposes in summer.

4.9.2 Non-structural Measures

In Pakistan, the flood risk reduction policy recognizes the importance of non-structural approaches. Non-structural measures are relatively less expensive and the effects of reduction in human casualties can be realized sooner. The non-structural or behavioural group of schemes generally requires a greater involvement of the floodplain inhabitants and extends from the more passive use of loss-bearing and public relief funds towards active policies of flood insurance, flood warning and floodplain zoning. Non-structural approaches are not very effective in flood risk reduction (Tariq 2013). Its efficiency varies from place to place and it largely depends upon the availability of resources, accessibility and community awareness (Rahman 2010). The following non-structural approaches have been reported from the country.

4.9.2.1 Flood Forecasting and Early Warning

Flood Forecasting Division (FFD), Lahore is the only national agency responsible for flood forecasting and its dissemination to the warning centres (GoP 2012). FFD receive hydro-meteorological data from the various national and international sources, which is then analysed to produce flood forecasts, warnings and disseminate to various Federal/Provincial organizations and print/electronic media. Flood forecasting and early warning is necessary component of a comprehensive flood risk reduction strategy. Timely warning can reduce loss of life through evacuation from the flooded area; allow preparedness measures to be taken in advance to minimize damages to vital structures, and alert authorities responsible for maintenance and operation of flood control facilities.

The present flood forecasting division (FFD) call herself as of worth effectiveness and efficiently fulfil the country requirements. But the fact is that it doesn't cover the catchment area of all the rivers (Tariq 2013). The cursory example is the catchment area of Kabul and Swat rivers is beyond the carrying capacity of existing country radar system (Khan and Rahman 2003; Rahman 2010). It is therefore, during the super flood 2010, neither the prolonged heavy wet spell was forecasted and nor the early warning disseminated to the vulnerable community (Rahman and Khan 2011). That's why the highest number of human casualties and subsequent flood damages has been reported from the Swat and Kabul river basins (Rahman and Khan 2013). The existing organization set-up for flood forecasting and early warning is functioning. Therefore, radar coverage over the North Western mountains for catering the catchment areas of Kabul and Swat rivers need to be enhanced by the procurement of an additional Doppler RADAR of 10-cm at *Warsak*. This need further meteorological studies to take full advantages of the new radar and satellite data to improve quantitative precipitation measurement and forecast of rainfall in the upper catchment of Kabul and Swat rivers. Beside this, dissemination of early flood warning to the vulnerable communities is specially lacking in flood management planning, when assessed during field survey (Khan and Rahman 2002). Hence, the location of radar system will also provide a database for both forecasting and subsequent dissemination to the vulnerable communities. In addition to this, at the national level, since 1975, to some extent flood forecasting and warning system has been supporting flood preparedness and response.

4.9.2.2 Flood Emergency Response System

HFA-5 specifically focuses on strengthening disaster preparedness for effective response at all levels. In response to 2005 earthquake as well as 2010 and 2011 floods, the massive damages to life and property and the lack of response mechanism prompted the Government machinery to enhance response system for search, rescue and evacuation operation. The same was also highlighted in the National Disaster Management Act-2010, which instruct for the establishment of national disaster response force. In this regard, NDMA formulated the National Disaster Response Plan in March 2010 to enhance the country's ability to properly respond to disasters. The NDRP has become an official document and provides Standard Operating Procedures (SOPs) at national, provincial/state and district levels for emergency response. Furthermore, the Government of Pakistan has incorporated in NDMP (2012–2022) to establish a national emergency response system and capacity building for post-disaster recovery. Furthermore, there is utmost need for enhancing emergency response capacities at the community level. Flood relief are still very common response to the flood problem in Pakistan. In practice, flood relief are not very effective, because they rarely achieve even 10 % of the total reported losses. Such aid is usually limited to emergency relief such as shelter, food, medication and other essentials for the flood victims (Rahman 2010). In this measure the role of community is of key significance, they are the quick and much effective than Government.

4.9.2.3 Flood Abatement

Flood abatement policies like those of flood storage reservoir have never been tackled seriously as a means of reducing flood losses in Pakistan (Khan and Rahman 2005). Some flood dealing line agencies have considered the effectiveness of flood abatement approaches, but none of them implemented on large scale. Watershed management is one of the flood risk reduction strategies through which excessive runoff checked at the source. Lack of preference to this approach has encouraged the problem of erosion, which eventually caused siltation in dams and rivers and drastically reduced their carrying capacity. This need serious considerations both from national and local level authorities otherwise the problem will multiply in future.

4.9.2.4 Flood Insurance

Flood insurance measure is extensively adopted for flood loss-sharing in the developed world where flood insurance is directly sold by private companies without any direct Government control. The idea behind this mechanism is that those knowingly expose themselves to the flood risks should assume most of the financial burden (Smith 1996). Under such a system it is more likely that new development in flood-prone areas will occur only when the expected advantages exceed the total public and private costs. The most important weakness of this approach is its discrimination against the low-income communities. In Pakistan, flood insurance is not practiced. Because of 2 % of the country population is living below poverty line. In addition to this, 98 % population are Muslim and insurance is prohibited in Islam.

4.9.2.5 Real-Time Flood Preparedness

In flood management planning, there is absence of real-time flood fighting (Ali 2013). During super flood 2010, there was lack of flood preparedness plan to guide the peak discharge. At several places the breach was politicised (Shah et al. 2011). In the Swat and Kabul rivers, flood occurred from July 27 to 30th, and the same peak flood discharge reached Chashma barrage on 30th July. After 8 days, it reached Gudu (6th August) and Sukkur (7th August) barrage and after 23 days the peak discharge reached Kotri (21st August) barrage. This is really a long time of ≈550 h (23 days) for preparedness and flood fighting. In flood management planning, there is need to formulate standard flood preparedness plan for routing peak discharge at various critical breaching point from areas of high economic importance towards low socio-economic significance. This negligence is already been reported in 2010 flood inquiry report (Shah et al. 2011). The report further summarises that due to meagre flood preparedness measures, insufficient flood fighting arrangements and negligence in observing the standard operating procedures caused the breaching of the flood levees at the Jinnah and Taunsa barrages, this as a result has caused severe losses to Punjab. This weakness could be overcome by preparing a flood-fighting plan for critical locations with several options, and by discussing the plan with the communities and other stakeholders before the monsoon season (Ali 2013).

4.9.2.6 Land Use Planning

The purpose of land use regulation is to obtain the beneficial use of flood prone areas with a minimum of flood damage and little expenditure on flood protection (Rahman 2010). Such form of land use regulations is beneficial to mitigate flood hazards including reduction of densities, prohibiting specific functions, relocation of elements blocking the floodway, regulation of building materials and provision of escape routes. The most effective way to ensure that inappropriate development in the hazard prone area will not continue in future if land use regulation is prepared and subsequently implemented. Land use management is the latest trend to limit and control the occupancy in the hazard prone area. In Pakistan, the flood management machinery has initiated the preparation and development of flood zoning in 1988 but so far no proper attention has been given to complete.

4.9.2.7 Building Regulation

This policy has been considered as a major long-term instrument for reducing the adverse effects of flood hazard. It is implemented by using building codes legally to restrict certain types of development in areas of high risk. This can improve existing buildings or replace vulnerable ones gradually by more flood resistant constructions. In the case of new or/and expanding settlements, appropriate building codes must be stipulated. This should however, be helpful to reduce the risk when applied in combination with protective measures and land use zoning.

4.9.2.8 Flood Risk Mapping and Zoning

A flood risk map is a graphical representation of flood characteristics along with the topography (Mitchell 2003; Rahman 2010), while a flood risk map plots the associated potential damages. The prime objective of flood zoning regulations must be maximizing the net-benefits from floodplains, rather than aiming solely at minimizing flood damages (Tariq 2013). In Pakistan, there is lack of flood risk assessment and mapping. Although flood management policies in Pakistan recognize the importance of non-structural measures including land use planning and risk mapping but concrete steps need to be taken for its implementation.

4.10 Flood Risk Management

In Pakistan, flood risk management is carried out with an attempt to mitigate flood hazards. Flood is a complex issue and specifically calls for modern scientific experience on the part of planners. The nature of flood problem varies from province to province due to varying physiographic, climatic, demographic, and socio-economic characteristics (GoP 2012). Even the nature of catchment area varies from each other as discussed below:

In Sindh province, water once overflows the levees does not return back to the main channel. Therefore, inundation causes greater damages to wide areas and persists for a longer time even when flood is over. Moreover, Sindh is situated on a receiving end of drainage of all the rivers and if flood protection measures adopted in the upper reaches are not properly planned, severe damages are likely to occur in the Province (FFC 2012). In most reaches, flood protective embankments have been constructed on both sides of the river from Guddu to few kilometres short of Arabian Sea (FFC 2012).

Baluchistan province have arid to semi-arid climate. Most of the streams have inland drainage basin and very few fall into the Indus river system. Because of such physiographic and climatic characteristics, flash floods dominate in the region. Such floods are very destructive and cause severe damages to life and property. Government has also constructed structural measures to keep water within the channel limit. However looking to the vast undulating surface, it is hard to cater the vast region and mitigate flood with a limited financial resources.

In the province of Khyber Pakhtunkhwa, floods mainly occur in the Kabul, Swat, Panjkora, Chitral and Kurrum rivers. Most often these floods have flash flood characteristics. In addition to this, flash floods also occur in the seasonal hill torrents / nullah and heavy flow generate due to steep slope. In the entire province, riverbank erosion and changing river course are some of alarming issues for the floodplain managers. Due to short preparedness and lack of early warning, such floods cause severe damages. In critical breaching areas, marginal protective embankments and guided head spur have been constructed to mitigate the impacts of flood losses. Similar, the nature and characteristics of floods in Gilgit-Baltistan, FATA and AJK is not different than the province of Khyber Pakhtunkhwa.

The unprecedented increase in the frequency of weather related phenomenon is the direct cause of climate change. The experts co-related the three consecutive disastrous flood events of 2010, 2011 and 2012 with the changing climate consequences. The UN scientific committee on IPCC found that it is very likely that hot extremes, heat waves and heavy precipitation events will further intensify in future. The IPCC also warned that the floods of the kind that hit Pakistan in 2010 may become more frequent and intense in the future in the same region and other parts of the world (GoP 2011). Keeping in view the recent climate change scenario, the Government planning machinery has recently developed a long term Comprehensive Flood Management Plan (2012–2022), where stress has been made proactive approach. The country Flood Forecasting & Warning System will further be upgraded and expended by installation of new Weather Radars and expansion of Flood Telemetry Network Stations. All such efforts would help in flood forecasting and early warning system considerably and minimize future flood damages.

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Chapter 5
Earthquake Hazards and Risk Mitigation in Pakistan

Muhammad Shafique and Muhammad Younis Khan

Abstract Earthquakes proved to be the most devastating natural disaster with a high mortality rate and wide spread destruction. Earthquake induced ground shaking plays a key role in excessive ground deformation and infrastructure damage, and in triggering secondary hazards such as landslides, flooding, tsunamis, fire and liquefaction. The intensity and duration of an earthquake induced ground shaking depends on magnitude, depth of hypocenter, medium traversed by seismic waves; and physical and geotechnical characteristics of the site. Tools of GIS and remote sensing are frequently and effectively used for earthquake hazard, vulnerability and risk assessment and assist in developing risk reduction strategies. Pakistan is located in one of the most earthquake prone region with many devastating earthquakes in the past and active tectonic shows that there might be more earthquakes in future. Hence it is crucial to perform earthquake hazard assessment across the country and subsequently develop and implement strategies for earthquake risk mitigation. Subsequent to facing extensive devastation by the 2005 Kashmir earthquake, the government has realized the importance of earthquake management and hence encouraged the scientific research aiming for earthquake hazard assessment and strategies for risk reduction. Moreover, organizations have been established mainly dedicated for natural disaster management. However, the magnitude of prevailing earthquake induced risk needs detailed earthquake hazard assessment, design earthquake resistant structures; implement the seismic building codes and public awareness to adopt for earthquake risk reduction.

Keywords Earthquakes • Ground shaking • Seismic hazard assessment • Pakistan • Risk reduction

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_5

5.1 Introduction

Natural disasters are dynamic and uncertain processes that remain a threat to sustainable socio-economic development around the world. Increased vulnerability of global society is mainly attributed to the concentration of population in hazardous areas, poor urban planning and urbanization that resulted in eightfold increase in economic loss over the past four decades (van Westen 2002). Management of natural disasters remains a big challenge for scientists and researchers around the globe.

Some of the natural disasters, such as floods, cyclones and typhoons, can be predicted in advance, providing ample time to the authorities to minimize the potential damage. However, earthquakes remain unpredictable with the current understanding and technology; and can strike suddenly, violently at any time round the year. Moreover, among the natural disasters, earthquakes proved to be the most devastating natural disaster with a high mortality rate and a wide spread destruction (UN 2009). On annual basis, 70–75 damaging earthquakes occur throughout the world (FEMA 2007). Hence, earthquake hazard assessment and developing strategies for earthquake risk reduction is one of the active and complicated research themes for scientific community. Major achievements have been made in demarcating seismically active regions, evaluating physical factors causing amplified earthquake ground shaking, formulating earthquake mitigation and preparedness strategies, constructing shake absorbent buildings and identifying factor increasing the earthquake vulnerability and risk. These achievements have resulted in reducing earthquake vulnerability and risk mainly in the developed world, however, in most of the seismically active regions in developing and underdeveloped regions earthquake is still a major threat to the sustainable socio-economic development.

5.2 Earthquake Ground Shaking

Earthquakes are sudden slip of ground along a fault plane and lead to ground shaking. The active tectonic plates get stuck due to friction along their edges and results in accumulation of stresses along the edges. When the stress on edges supersedes the friction, there is an earthquake causing sudden slip and releases the accumulated energy (Fig. 5.1). Earthquake generates seismic waves that cause ground shaking when arrives at the ground surface.

Earthquake induced ground shaking plays a key role in infrastructure damages and triggering secondary hazards such as landslides, flooding, tsunami, fire, liquefaction and ground deformation. Intensity and duration of ground shaking are the controlling factors that determine the magnitude of earthquake devastation. Earthquake induced ground shaking is often described by amplitude, frequency and duration. Duration of ground shaking refers to the time period of sustained ground shaking, thus strongly influencing the infrastructure destruction. Magnitude of ground shaking is represented by acceleration (peak ground acceleration (PGA)), velocity (peak horizontal velocity (PHV)), and displacement. Ground shaking with higher acceleration is

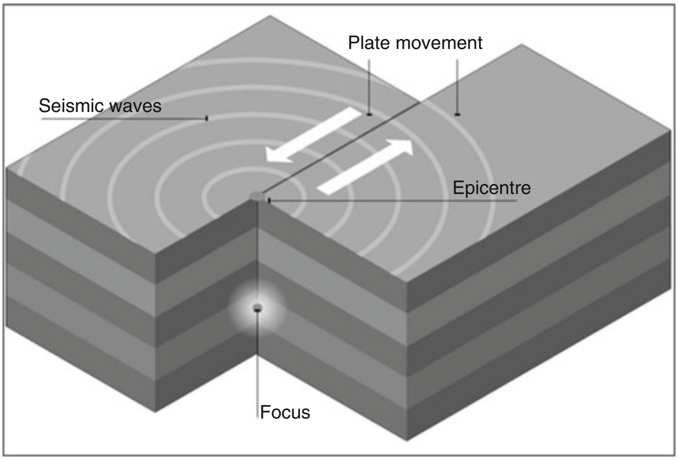

Fig. 5.1 Major features of an earthquake

predominantly considered to be more destructive than ground shaking with higher velocity and/or displacement. Instrumentally recorded higher acceleration during past earthquakes shows significant relation with higher frequencies of seismic waves and higher velocity and displacement are related to lower frequency content (Kramer 1996). As seismic waves propagate from an earthquake source, their high frequency components are scattered and decay more rapidly than their lower frequencies. As a result, the frequency content also varies with distance from the epicenter and therefore also infrastructure damage. This is, however, not always the pattern observed: local site effects can cause deviations from this generic pattern. Existing models such as USGSShakeMap (Wald et al. 2006) a product of United States Geological Survey (USGS) Earthquake Hazards Program in conjunction with regional seismic network and Prompt Assessment of Global Earthquakes for Response (PAGER) (Earle et al. 2008) respectively produce ground shaking and expected damage maps in near real time after a major seismic event. These maps provide regional overview of spatial distribution of ground shaking and damages that can be used for effective rescue and response measures. Moreover, USGS ShakeMap also generates spatial distribution of earthquake intensity (expressed in the Modified Mercalli Intensity (MMI)). USGS ShakeMap considers the magnitude, location of epicenter, distance from epicenter (Fig. 5.1), geology and variation in propagation of seismic waves because of complexities in the earth crust for prediction of spatial distribution of ground shaking (USGS 2006). However, these are preliminary maps, generated automatically shortly after an earthquake, unverified in the field and therefore are considered approximate and unreliable for local scale investigations. The intensity and duration of earthquake induced ground shaking at a site depends on earthquake magnitude, depth and location of epicenter which are denoted as source effects; the medium traversed by seismic waves which is denoted

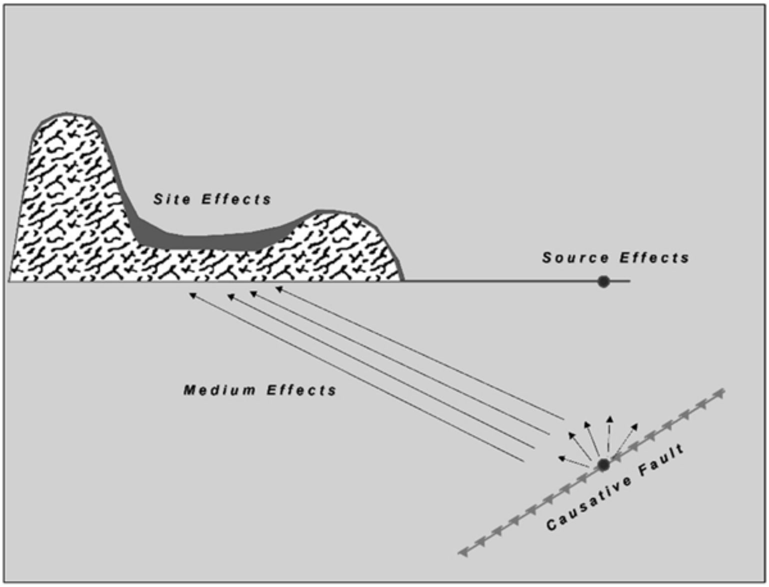

Fig. 5.2 Factors affecting the intensity and duration of seismic ground shaking

as medium effect; and physical and geotechnical characteristics of the site denoted as site effects (Fig. 5.2).

Higher magnitude, close proximity to the epicenter and shallow depth result in intensified ground shaking for longer duration. Medium through which seismic waves propagate has significant influence on the velocity and attenuation of seismic waves. A decrease in velocity of seismic waves coupled with law of conservation of energy is considered as a major factor in amplification of seismic response. Therefore amplified ground shaking and consequently intensified structural damages is often observed on regolith with low shear wave velocity than on the bedrock with higher shear wave velocity (Shafique et al. 2012). To evaluate impact of seismic source and medium on earthquake ground shaking, region specific attenuation models are developed based on instrumental ground shaking records that can be used to predict spatial distribution of ground shaking. Spatial variation of ground shaking, at local scale, is subject to site effects. Site effects are often evaluated by exploring the impact of sites specific geology, geomorphology (regolith cover) and topography on variation of ground shaking. Geology influences the shear wave velocity of the incident seismic waves (Wills and Clahan 2006) and therefore determine the impedance contrast between underlying consolidated bedrock and overlying lose surface material. The influence of geology on amplification of seismic response is often evaluated by measuring the shear wave velocity of top 30 m crust denoted as V_S^{30} (Yong et al. 2008; Shafique et al. 2012) which is found as an indicator of seismic site condition (Borcherdt 1994). Regolith thickness influences the attenuation, shear wave velocity, trapping of seismic waves and hence influence the spatial distribution of earthquake induced building damages (Assimaki and Gazetas 2004; Shafique et al. 2011c). In rough terrain, topographic variation causes trapping, diffraction, reflection and inter conversion of the incident seismic waves leading to amplification of seismic response at ridge crest (Shafique et al. 2008; Lee et al. 2009). Evaluating the site effects is of crucial importance for seismic microzonation and formulating strategies for mitigating earthquake hazard and risk.

5.3 Remote Sensing and GIS in Earthquake Hazard Assessment

Satellite remote sensing is an efficient tool to acquire spatial and temporal information of an object or phenomenon from a distance at different scales; from local to regional. Remote sensing data is available in panchromatic, multispectral images and digital elevation models (DEMs) with varying resolution and spatial coverage. DEMs provide the terrain elevation and are frequently used to compute terrain attributes that are often used in environmental studies e.g. slope, aspect, curvature etc. using different algorithms. Deriving a DEM can be the direct product of a satellite mission such as the Shuttle Radar Topography Mission (SRTM) which produced a DEM with 90 m spatial resolution or from stereo satellite images e.g. the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) satellite from which one can derive DEM with 30 m spatial resolution. Both of these DEMs (SRTM and ASTER) are freely and readily available with global land coverage and hence offer an opportunity to use for earthquake hazard and risk mitigation studies.

Remote sensing images and DEM derived topographic attributes can be used in all stages of natural disaster management i.e. preparedness, mitigation, response and recovery (Joyce et al. 2009). In pre-earthquake situation the ASTER DEM is used for evaluating topographic impact on seismic response (Lee et al. 2009; Shafique et al. 2011a; Shafique and van der Meijde 2014). SRTM and ASTER DEM derived terrain slope is used for shear wave velocity V_S^{30} based seismic site characterization (Allen and Wald 2009; Yong et al. 2011; Shafique et al. 2012). Remote sensing data shows pre-earthquake thermal anomalies that can be used for earthquake preparedness (Choudhury et al. 2006). Refinement of this technique and routine investigation may assist to earthquake warnings and predictions. DEM derived topographic attributes can be applied to model spatial distribution of regolith thickness at regional scale (Shafique et al. 2011b, c) that can be subsequently used for evaluating the impact of regolith thickness on amplification of seismic response.

In post-earthquake scenario, motivated from the potential role of remote sensing data in disaster induced damage assessment, international space agencies has agreed on an International Charter “Space and Major Disasters” (www.disasterscharter.org) to freely provide post-disaster fine resolution optical remote sensing images. Therefore often the remote sensing images of IKONOS and Quickbird of the affected

Fig. 5.3 Pre and post-earthquake IKONOS image of a Kashmir earthquake induced landslide in Muzaffarabad, Pakistan

area are provided for quick damage assessment to assist in response activities. These images are effective to provide synoptic overview of the affected area and indicate the severity of the damages at regional as well as at local scale (Fig. 5.3).

With proliferation in remote sensing technology and improvement in spatial and spectral resolution, coverage and readily available remote sensing data support near real time monitoring of seismic hazard and subsequently effective response to mitigate the devastating impacts of earthquakes.

5.4 Seismicity in Pakistan

Pakistan is located in one of the most seismically active regions on earth, with active Himalayan ranges in north, Hindu Kush mountain ranges in northwest and Suleiman mountain ranges in southwest. High seismic hazard in Pakistan and adjacent Indian and Afghanistan regions is due to northward movement of the Indian tectonic plate at a rate of 31 mm/year (Bettinelli et al. 2006) which is subducting beneath the Eurasian continent (Fig. 5.4). This collision of the Indian and Eurasian plates resulted in the development of world highest mountain ranges i.e. Karakoram, Himalaya and Hindu Kush mountain ranges (Kumar et al. 2006).

Earthquakes in Pakistan are often associated with the east west Trending regional thrust faults. From north to south these are the Main Karakoram Thrust (MKT), Main Mantle Thrust (MMT), and Main Boundary Thrust (MBT) (Sayab and Khan 2010) (Fig. 5.5). Chaman and Ornach–Nal Fault Zones (800–900 Km) marking the

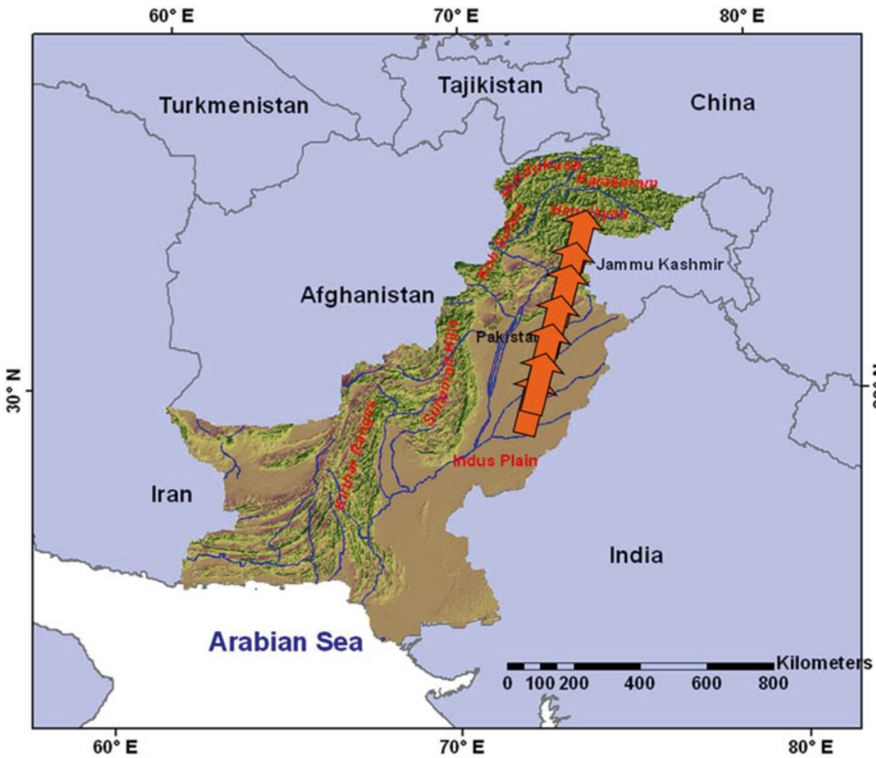

Fig. 5.4 Northward movement of the Indian plate

western boundary of Indian plate (Fig. 5.5) is the major source of seismicity in and around Quetta city of Pakistan which connects the western Himalayas in north and the Makran subduction zone in southwest Pakistan (Purohit and Prajapati 2009). Active tectonics in the region leads to the accumulation of compressional forces that are released in big and great earthquakes in past and prone to more in future (Durrani et al. 2006). Between 1897 and 1952, there was a phase of high seismicity, when 14 major earthquakes (Mw ≥7.5) occurred, including 5 great earthquakes of Mw ≥8 (Lisa et al. 2007). Some of the major earthquakes in the region include Kangra earthquake (1905, Mw 7.8), Bihar–Nepal (1934, Mw 8.1), Quetta earthquake (1935, Mw = 7.7), Makran earthquake (1945, Mw 8.3), Assam earthquake (1950, Mw 8.6), Pattan earthquake (1974, Mw 6.0), Bunji earthquake (2002, Mw ≥5.5), Batgram earthquake (2004, ≥5.5), Kashmir earthquake (2005, Mw 7.6) and Awaran earthquake (2013, Mw 7.7) (Fig. 5.6). Due to these devastating earthquakes hundreds of thousands of people have lost their lives and substantial loss to the Pakistan economy has been caused (Fig. 5.7). Moreover, theoretical studies indicate that energy stored along the Himalayan arc suggests a high probability of earthquake of Mw >8.0 in near future (Durrani et al. 2006).

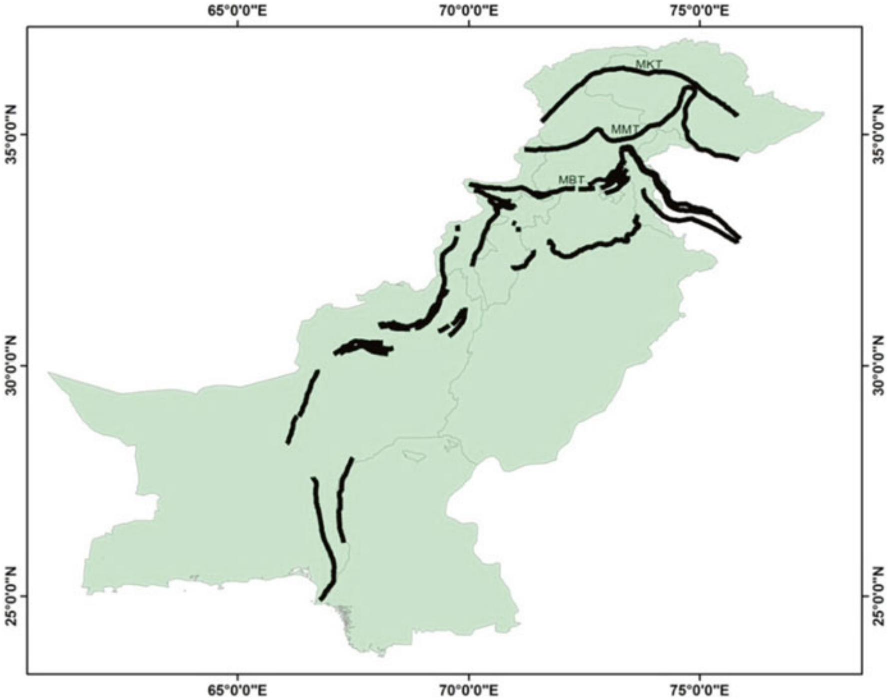

Fig. 5.5 Network of major faults in Pakistan

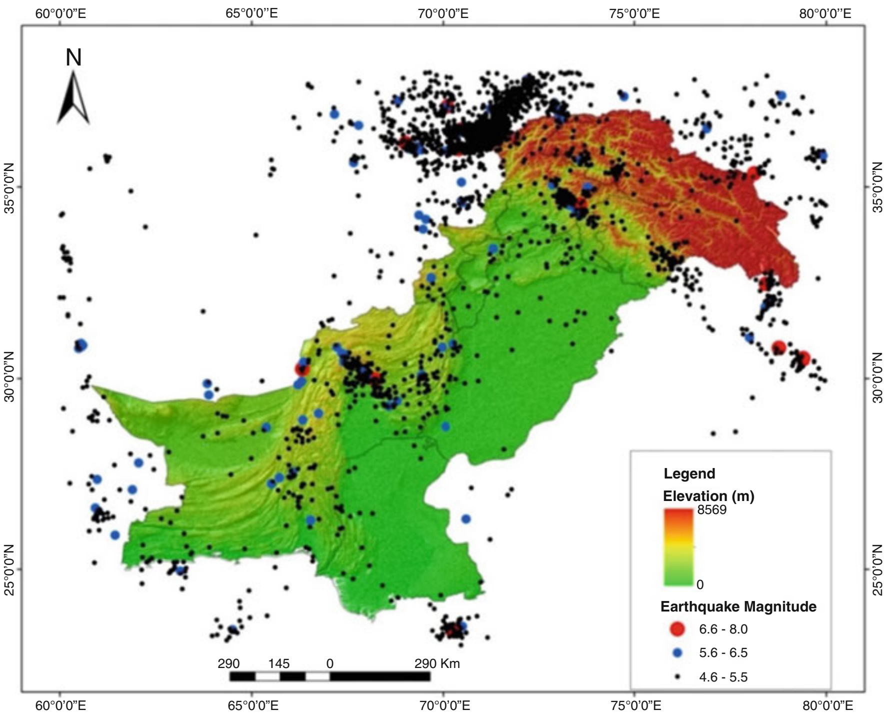

Fig. 5.6 Catalog of historic earthquakes in Pakistan (Source: USGS)

Fig. 5.7 2005 Kashmir earthquake induced structural damages in Balakot and Muzaffarabad, northern Pakistan

5.5 Seismic Hazard Assessment

Seismic hazard refers to the study of expected seismic ground motions at the earth's surface, and its likely effects on existing natural conditions and man-made structures for the consideration of public safety. Seismic hazard assessment is to quantify the expected ground shaking at a site given one or more earthquakes and mainly depends on data such as seismological, geological, geophysical, topographical and geodetic information. Seismic hazard assessment can be estimated deterministically when a particular earthquake scenario is assumed, or probabilistically where uncertainties in earthquake size, location, and time of occurrence are explicitly addressed (Kramer 1996). The crucial component of the seismic hazard analysis is the estimation of the Peak Ground Acceleration (PGA) and response acceleration (Spectral Acceleration). Seismic hazard assessment is a pre-requisite to develop earthquake mitigating strategies involving landuse planning, designing earthquake resistant structures and adopting risk reduction measures. Two techniques frequently used for seismic hazard assessment of a seismically active area include.

1. Deterministic Seismic Hazard Assessment (DSHA)
2. Probabilistic Seismic Hazard Assessment (PSHA)

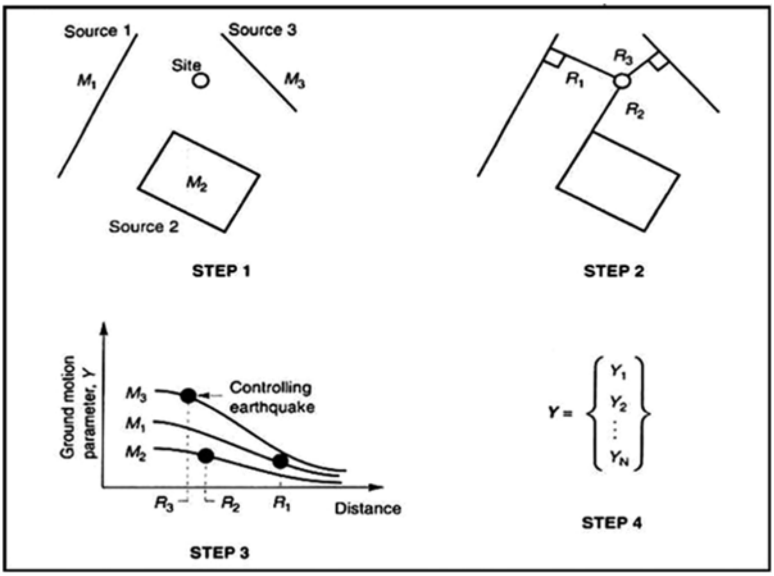

Fig. 5.8 Four steps of deterministic seismic hazard analysis (Kramer 1996)

5.5.1 *Deterministic Seismic Hazard Assessment (DSHA)*

Deterministic Seismic Hazard Analysis (DSHA) uses geology and seismic history of the target area to identify earthquake sources and to interpret the strongest earthquake each source is capable of producing. Those are the Maximum Credible Earthquakes (MCEs), the largest earthquakes that can reasonably be expected. The PGA induced by the MCEs is determined for each site of interest and should be considered subsequently to construct earthquake safe buildings.

In general, four basic steps (Fig. 5.8) are followed in DSHA:

1. Identification and characterization of possible earthquake sources
2. Determination of maximum magnitude earthquake (MCE) for each source
3. Selection empirical relationship for ground motion prediction
4. Computation of the design ground motion parameter(s).

After selecting a site, in general first step is to identify possible seismic source responsible for affecting the site by producing ground motion using different data sets (geological, geophysical and seismological). These sources are preferably represented by polygons but can also be by points and lines. Subsequently, the MCE to each source is determined. In third step an empirical attenuation relationship is used for ground motion's parameter (PGA) prediction with basic assumptions of maximum magnitude earthquakes and minimum possible distance based on the associated seismic source. Finally, parameters representing seismic hazard (e.g. PGA) are estimated by using appropriate attenuation relationship selected in step 3 associated with the controlling earthquakes (step 2) to each source (step 1). The DSHA is frequently used to assess the seismic hazard of a site or region around the world (Orozova and Suhadolc 1999; Khan et al. 2003; Moratto et al. 2007; Wang et al. 2012)

5.5.2 Probabilistic Seismic Hazard Assessment (PSHA)

Probabilistic seismic hazard analysis (PSHA) is most widely used approach for seismic hazard assessment in regions with high seismicity and limited data to perform DSHA (Romeo and Prestininzi 2000; Sokolov et al. 2009; Bhatti et al. 2011; Ordaz et al. 2014). The use of PSHA has allowed uncertainties in the size, location, and rate of recurrence of earthquakes and in the variation of ground motion characteristics with earthquake size and location to be explicitly considered for the evaluation of seismic hazard. The principle of the analysis, first developed by Cornell (1968) and later refined by various researchers, is to evaluate at the site of interest the probability of exceedence of a ground motion parameter (e.g. PGA) due to the occurrence of an earthquake around the site. This approach combines the probability of exceedence of the earthquake size (recurrence relationship), and the distance from the epicenter to the site. Each seismic source zone is split into elementary zones at a certain distance from the site. Integration is carried out within each zone by summing the effects of the various elementary source zones taking into account the attenuation effect with distance. Total hazard is finally obtained by adding the influence of various sources. PSHA involves four basic steps (Table 5.1 and Fig. 5.9) to generate seismic hazard map (Fig. 5.10).

Table 5.1 Methodology for Probabilistic Seismic Hazard Assessment (PSHA)

Step 1	Earthquake sources (small or large faults) are defined in regions with uniform seismicity pattern.
Step 2	Definition of the seismic activity due to seismic source/s described by an earthquake probability (Inverse of which is called return period for that acceleration represents in turn the seismic hazard) distribution is specified by a recurrence relationship, defining the cumulative number of events per year versus their magnitude i.e. seismicity recurrence characteristic gives the expected occurrence of an earthquake having certain size inside the source during a specified period of time. Distribution of earthquakes is assumed to be uniform within the source zone and independent of time. A maximum or upper-bound earthquake is chosen for each source, which represents the maximum event to be considered.
Step 3	In the third step the expected effect of an earthquake is estimated like DSHA, however, in the probabilistic approach, the earthquakes varying in size require a family of ground motion curves where every individual curve is associated with a ground motion parameter.
Step 4	Finally seismic hazard is determined at the site, which is substantially different from the procedure used in DSHA. In PSHA the effects of all the earthquakes from different location, sources and sizes are integrated to construct a curve. This output curve shows the probability of exceedence occurrence of ground motion having different levels such as PGA during a specified period of time at the target site.

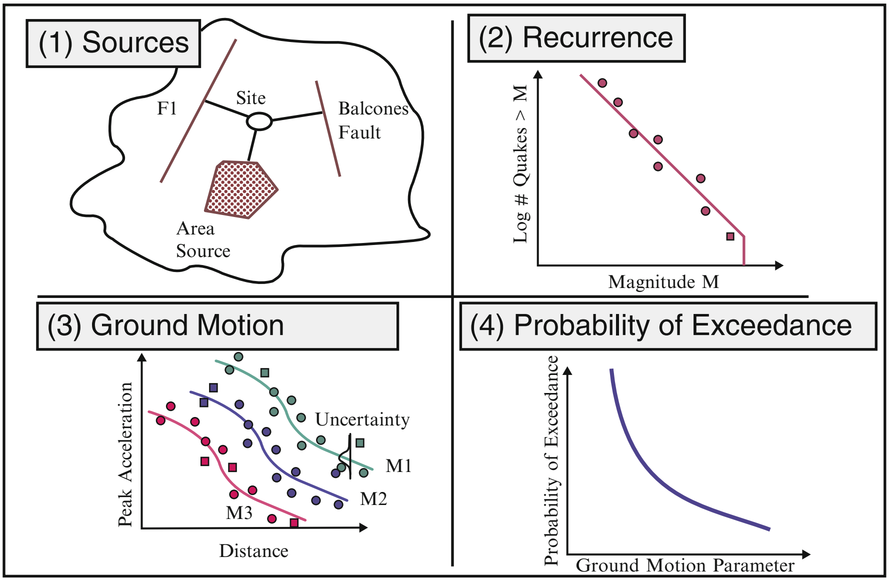

Fig. 5.9 Basic steps of Probabilistic Seismic Hazard Analysis (PSHA) (Source: USDT (2013))

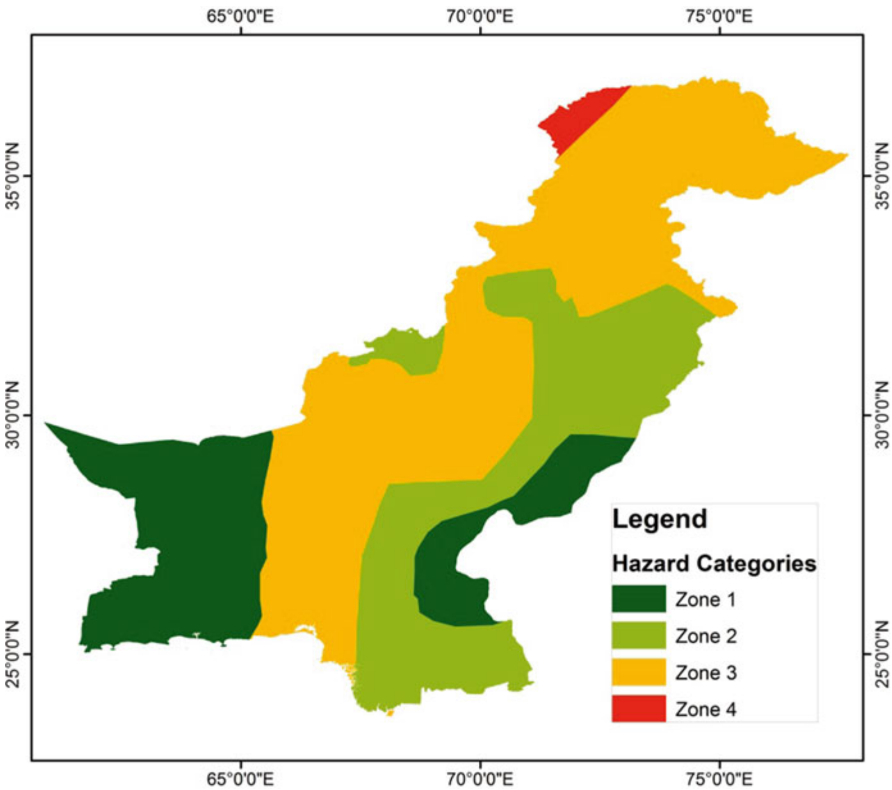

Fig. 5.10 PSHA based seismic hazard map of Pakistan

5.6 Administrative Setup for Disaster Risk Mitigation

Pakistan is severally affected by natural hazards in past and prone to more in future. Natural hazard are posing serious threats to the sustainable socio-economic development of the country. Hence it is crucial to develop and implement strategies to mitigate the disaster risk. Subsequent to facing unprecedented devastation by the 2005 Kashmir earthquake and later by the 2010 floods, the government has realized the importance of natural disaster management and established organizations mainly dedicated to the natural disaster management in the country. Currently there is an active administrative setup at national, provincial and district level, dedicated for natural disaster management. Subsequent to the 2005 earthquake, Earthquake Reconstruction and Rehabilitation Authority (ERRA) was the first body established with main responsibility of rehabilitation and reconstruction works in the earthquake affected areas. For developing strategies aiming for the natural disaster management and their implementation, National Disaster Management Commission (NDMC) was established under the ordinance of National Disaster Management on December 23, 2006 to get prepare for future disasters. Similarly, National Disaster Management Authority (NDMA) was established for monitoring, coordinating and implementing strategies for disaster management in the affected regions of Pakistan. NDMA is mainly responsible to provide technical knowledge leading towards capacity building by cooperating with provincial and district authorities at both national and provincial level to the stakeholders to formulate future strategies for disaster risk management. The NDMA is further subdivided in Provincial Disaster Management Authority (PDMA) in each of the four provinces of Pakistan. PDMA has further linked to each district by establishing District Disaster Management Authority (DDMA) (Fig. 5.11). In case of any disaster emergency situation, these disaster management authorities are actively and collectively involved initially for effective disaster response and subsequently for the rehabilitation of the affected people.

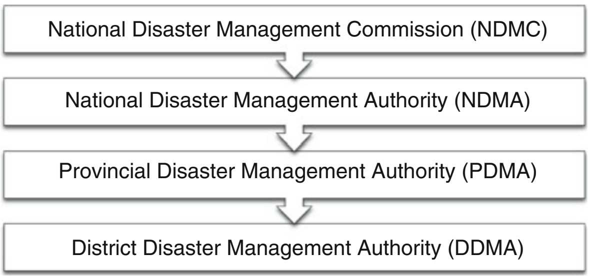

Fig. 5.11 Flow chart showing national disaster management framework in Pakistan

5.7 Causes of Earthquake Induced Damages in Pakistan

The earthquakes in Pakistan leads to unprecedented damages to life and economy that can be partly attributed to the following reasons.

1. Pakistan is located in one of the most seismically active regions in the world. However, management of the earthquakes and mitigating their devastating impacts did not get enough attention from the Government and scientific research intuitions to reduced earthquake induced risk. It was the 2005 Kashmir earthquake that has forced the government to develop dedicated organizational setup for the management of natural hazards in general and earthquakes in particular. The scientific research organizations and academia also initiated studies aiming for assessing the prevailing seismic hazard in the country and develop strategies for mitigation of seismic risk.
2. The Pakistan seismic code was published in October 1986, however, is never enforced in construction of building, except in major cities and constructing specific buildings. Hence, majority of the building constructed in the seismically areas of the country do not follow the seismic codes and hence are severally damaged or collapsed if struck by a big earthquake and leads to human fatalities and injuries. Rossetto and Peiris (2009) suggested that building codes for Pakistan should be revised and include capacity design principles, modern techniques for seismic analysis and design and strictly enforced mainly in areas located close to the seismic sources. After the 2005 Kashmir earthquake, the building codes of Pakistan is being revised in 2007 by the Ministry of Housing and Works (MOHW), Government of Pakistan to ensure safety and security of the residents. To develop the updated building code, the seismic hazard analysis has been carried out for the whole country following the PSHA techniques, also suggested by Rossetto and Peiris (2009). Moreover, building design criteria and requirements for the seismic design of the buildings has been formulated in updated building codes. In the building codes it has been ensured to do not unnecessarily increase costs or restrict the use of new materials and technology. The Government has decided to update the building codes regularly as required and approved from the concerned committees. The updated building code will be implemented by the Capital Development Authority (CDA) in Islamabad for any new constructions. The ERRA is given the task to ensure that building codes are followed in the construction works in the earthquake affected areas. The development authorities in major cities are also held responsible in implementation of the updated building codes. However, the realistic implementation of the building code across the country will remain a challenge for the government and is of critical importance to mitigate the seismic risk in the country.
3. Lack of seismic micro zonation maps for the major cities located in the seismically active regions halted to develop plan to mitigate the devastating impacts of earthquakes.
4. Earthquake preparedness for the sudden and large scale devastation by earthquakes is still lacking in the country. During the 2005 Kashmir earthquake, the country was mostly looking and relying on foreign assistance to assist in

rescue of the trapped people. Moreover, medical facilities were not enough to treat the thousands of injured people leading to more suffering and fatalities. However, subsequent to the Kashmir earthquake, the NDMA is in process of preparing and equipping itself to effectively respond to any future earthquakes.

5. There is serious lack of awareness among the public of prevailing seismic risk mainly in seismically active regions. The unplanned urbanization in the seismically active areas result in increased seismic risk.

5.8 Conclusion

Pakistan is located in one of the most seismically active region and is witnessed to devastating earthquake in past and prone to more in future. Subsequent to the 2005 Kashmir earthquake, the government has realized the importance of developing and implementing strategies for mitigation of earthquake induced risk. Many activities aiming for earthquake risk reduction has be carried out at government level including establishing dedicated organizations for natural disaster management, revising the seismic building codes of Pakistan, enforcing the implementation of building codes. Moreover, there is significant increase in scientific research in the educational institutions for earthquake risk reduction. Significant research is dedicated to the earthquake hazard assessment applying both the DSHA and PSHA to demarcate the seismically prone areas and accordingly develop and implement risk reduction strategies. There are many projects implemented and in progress funded by the government and international donor agencies aiming for mitigating the devastating impacts of earthquake. Many trainings/workshops/conferences have been arranged across the country to share the knowledge, enhance the capacity of the students and on-job professionals on techniques of earthquake risk reduction.

However, considering the magnitude of prevailing hazard and its potential to cause damages to life and property across the country, there is still need to invest in the scientific research for earthquake hazard assessment at local and regional scale, design earthquake resistant structures, strictly implement the seismic building codes of Pakistan, enhance the public capacity to adopt for earthquake risk reduction and prepare for effective seismic response and rehabilitation.

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Chapter 6
Tsunami Risk, Preparedness and Warning System in Pakistan

Mohammad Heidarzadeh

Abstract This chapter presents a review of the tsunami risk posed to the southern coasts of Pakistan and Iran by potential earthquakes from the Makran subduction zone and also presents a structure for a regional tsunami warning system. Historical data of earthquake in the Makran region shows that the region is susceptible to large earthquakes which are capable of producing destructive tsunamis. Tsunami hazard in the region can be classified into three levels based on the sizes of the earthquakes used for tsunami hazard assessments: (1) characteristic earthquake with magnitude *Mw*8.1, (2) maximum regional earthquake with magnitude *Mw*8.3, and (3) worst-case earthquakes with magnitudes *Mw*8.6 and *Mw*9.0. The aforesaid earthquakes produce wave heights up to 7, 9, 10 and 18 m at the coastlines of the Makran region. We propose a tsunami warning system in the region based on seismic waveforms and using a database of precalculated tsunami scenarios. At least 2 deep-water tsunami gauges and 50 coastal gauges are necessary for tsunami understanding and warnings in the region. Any tsunami warning system in the region needs strong international cooperation between the countries in the region.

Keywords Makran subduction zone • Northwestern Indian Ocean • Tsunami • Earthquake • Tsunami hazard assessment • Tsunami warning system

6.1 Introduction

The recent large tsunamis of 2011 Tohoku and 2004 Sumatra tsunamis have awakened the attention of international community to large hazards posed by tsunamis. The extensive destruction and death caused by these tsunamis showed that world's coastal communities are rather vulnerable to tsunamis, even in Japan where decades of tsunami education and a sophisticated tsunami warning system was in effect prior to the 2011 tsunami attack. The fact that both tsunamis occurred in tectonic settings that were not expected to produce $M9^{+}$ earthquakes (Okal et al. 2013), indicates that

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*, Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_6

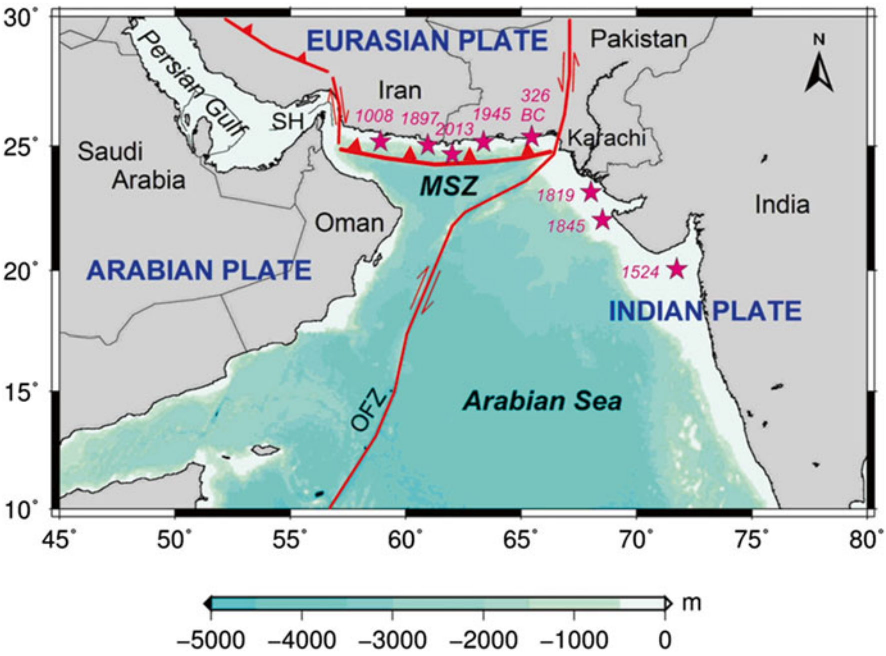

Fig. 6.1 General location map of the Makran subduction zone (MSZ) at the northwestern Indian Ocean showing the locations of past tsunamis reported in the region (*purple asterisks*). Abbreviations are: *MSZ* Makran subduction zone, *OFZ* Owen fracture zone, *SH* Strait of Hormuz (Updated from Heidarzadeh et al. 2009a)

it is too simplistic to categorize world's subduction zones into those capable and incapable of producing large earthquakes. According to McCaffrey (2007), every subduction zone is dangerous and it is wrong to focus on some and ignore some others. This is a basic lesson from the 2011 Tohoku and 2004 Sumatra tsunamis.

Makran subduction zone (MSZ), offshore southern coasts of Iran and Pakistan (Fig. 6.1), is an example of those subduction zones whose tsunami hazards were underestimated or ignored before the 2004 Sumatra large tsunami. With a length of around 1,000 km, MSZ is formed by the northward subduction of the Arabian plate beneath the Eurasian plate at the rate of around 19 mm/year (Heidarzadeh et al. 2009b). The region experienced a large tsunami which left a death toll of around 4,000 on 27 November 1945 (Heck 1947). The parent earthquake was of *Mw*8.1 (Byrne et al. 1992) which is the largest instrumentally-recorded earthquake so far in the Makran region. This indicates that the region is potentially susceptible to large tsunami-genic earthquakes. In addition to tectonic tsunamis, the region is also at the risk of meteo-tsunamis. The cyclone Gonu in 2007 caused severe inundation and damage in the region (Fritz et al. 2010). It is discussed later that other evidence of meteo-tsunamis has been found in the region. The Makran region is also susceptible to landslide tsunamis; even due to inland earthquakes. Heidarzadeh and Satake (2014) showed that an inland *Mw* 7.7 earthquake in Pakistan triggered a landslide tsunami in the Makran region.

In this chapter, we address tsunami hazards in the northwestern Indian Ocean. We first present a summary of historical tsunamis reported in the region followed by different scenarios for tsunami hazard assessment. Finally, we discuss preparedness for tsunami and tsunami warning system for the region.

6.2 Historical Tsunamis in the Region

Historical tsunamis in the region have been studied by Heidarzadeh et al. (2008a) and (2009a) which are shown in Fig. 6.1 by purple asterisks. Table 6.1 presents the details of each event. However, it should be noted that these event are coming with different levels of confidence factors. Such a high level of uncertainties about the veracity of historical tsunamis in the region shows that the available information about tsunami is poor and historical archival and paleo research is necessary for the Makran region.

Besides the fact that the data on historical events is incomplete and needs more supporting works, the current data in Table 6.1 shows that the region is susceptible to different kinds of tsunamis: tectonic, volcanic, landslide and meteorologic tsunamis (Heidarzadeh et al. 2008a). Our limited data (Table 6.1) shows that similar to other tsunamigenic zones in the world, the most common type of tsunami source is

Table 6.1 List of tsunamis reported in the northwestern Indian Ocean (Updated from Heidarzadeh et al. 2008a)

No.	Year	Location	Earthquake magnitude	Type of Tsunami source	Loss of life	Runup (m)	CF[a]
1.	326 BC	–	–	Earthquake	–	–	1
2.	1008	–	–	Earthquake	1,000[b]	–	2
3.	1524	Gulf of Cambay	–	Earthquake	–	–	1
4.	1819	Rann of Kutch	7.5–8.25	Landslide/Volcano	>2,000[b]	–	2
5.	1845	Rann of Kutch	>6	Landslide/Volcano	–	–	2
6.	1897	–	–	Volcani/ Meteorologic	–	–	1
7.	1945	63.0°E 24.5°N	8.1–8.3	Earthquake	4,000[b]	5–12	3
8.	2013[c]	61.49°E 24.62°N	–	Landslide	0	<1	3

[a]Heidarzadeh et al. (2008a) assigned a confidence factor (CF) to each event whose value indicates probability of actual tsunami occurrences. They defined it as: (1) probable tsunami; (2) definite tsunami but the generation mechanism and location are not certain, and (3) instrumentally recorded tsunami

[b]Both by earthquake and tsunami

[c]According to Heidarzadeh and Satake (2014)

the tectonic source. The archival research by Heidarzadeh et al. (2008a) showed that the event of 1897 was possibly of volcanic/meteorologic origin; similar to the cyclone Gonu in 2007 which generated large inundation (Fritz et al. 2010). Landslide sources also seem to be responsible for some tsunamis both independently (e.g., the 1819 event) and in combination to a tectonic source (e.g., events of 1945 and 2013). There have been reports that a landslide source contributed to the tectonic source of the 1945 Makran tsunami as submarine telegraph lines offshore Pakistan were ruptured following the earthquake (Heidarzadeh et al. 2008a). A landslide triggered by *Mw* 7.7 Pakistan inland earthquake, generated a small tsunami with runup heights less than 1 m in the Makran region (Heidarzadeh and Satake 2014).

6.3 Scenarios for Tsunami Risk Assessment

Tsunami hazard assessment for tectonic tsunamis strongly depends on the size of the earthquake scenario used for assessment. It is evident that the larger the earthquake size, the larger the tsunami that is produced. In this context, there are standards as per how to select the earthquake size for tsunami hazard assessment. Three different levels of earthquake sizes have been usually used worldwide for earthquake and tsunami hazard assessments: (1) characteristic earthquakes, (2) regional maximum earthquake, and (3) worst-case earthquakes (Okal and Synolakis 2008). Each of these levels can be used for some particular applications. Below, each of these classes is discussed and the resulting tsunami waves are presented.

6.3.1 Characteristic Earthquake

By definition, a characteristic earthquake is an earthquake with a certain size that occurs with regular intervals in a region. Usually, instrumental, historical and paleoseismological studies are conducted to define the characteristic earthquake for a particular region. For a region like MSZ where the available information about past seismicity is poor, the maximum recorded earthquake in the region was assumed as the characteristic earthquake (Heidarzadeh et al. 2009a). The Makran earthquake of 27 November 1945, with a moment magnitude of *Mw*8.1, is the maximum recorded earthquake in the region whose return interval was estimated in the range of 150–250 years (Page et al. 1979; Heidarzadeh et al. 2008b). According to Heidarzadeh et al. (2009a), such an earthquake is capable of rupturing about 150 km of the Makran plate boundary. Therefore, this characteristic earthquake was moved along the plate boundary and the resulting tsunamis were calculated. Figure 6.2 shows the results of tsunami coastal wave amplitudes for the characteristic earthquake (*Mw*8.1) which shows that the tsunami wave heights reach up to 6–7 m along the southern coasts of Iran and Pakistan.

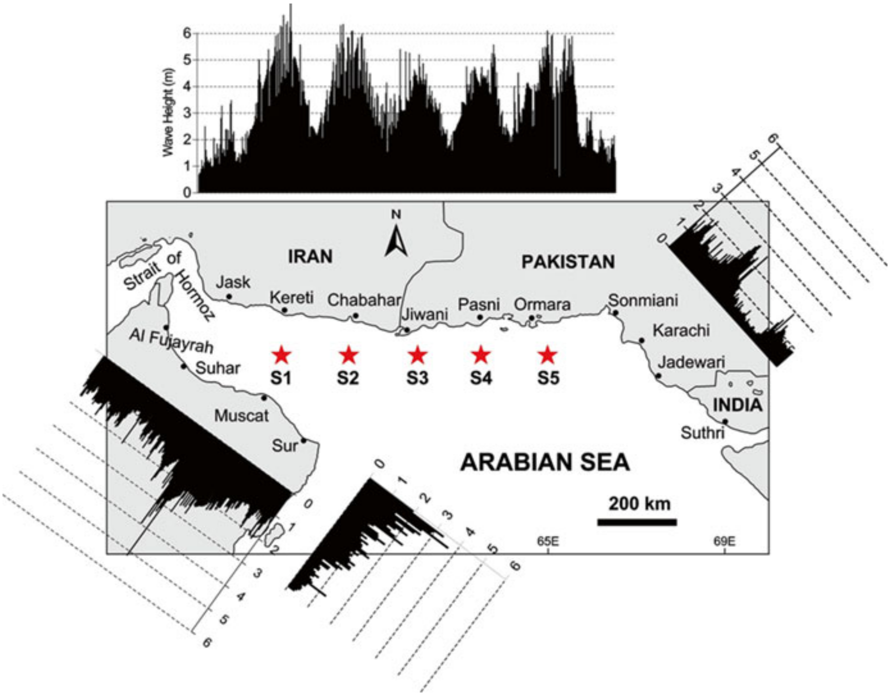

Fig. 6.2 Distribution of maximum positive tsunami amplitudes along various Makran coasts for five scenarios of characteristic earthquake. All scenarios of S1-S5 are earthquakes of magnitude *Mw*8.1 (After Heidarzadeh et al. 2009a)

6.3.2 Maximum Regional Earthquakes (M_{max})

A slightly more conservative method for tsunami hazard assessment is to base the assessment on the regional maximum earthquake (M_{max}). Probabilistic methods can be used to define M_{max} which apply earthquake catalog for any particular region to calculate maximum earthquake (e.g., Kijko 2004). A catalog of earthquakes at the Makran region has been compiled by Heidarzadeh and Kijko (2011) containing 453 events in the magnitude range of 3.0–8.1. The results of probabilistic seismic hazard assessment for the Makran region shows that the maximum regional earthquake in the region is estimated around 8.3. Such an earthquake has a return period of around 1,000 years. The probability for occurrence of such an earthquake in next 50 years is around 5 % which is a low probability. It is clear that any tsunami hazard assessment based on M_{max} is relatively conservative given the low occurrence probability of such an earthquake. According to Heidarzadeh et al. (2008b), the maximum tsunami wave height is up to 8–9 m along the southern coasts of Iran and Pakistan.

6.3.3 Worst-Case Scenarios

The 2004 Sumatra and 2011 Tohoku events are two recent examples showing that worst-case scenarios occur (Okal and Synolakis 2008). Although tsunami planning based on worst-case scenarios seems to be expensive, application of worst-case scenarios is inevitable in some cases. Two worst-case scenarios for the Makran region are studied by Heidarzadeh et al. (2009b) which consists of earthquakes with magnitudes 8.6 and 9.0 rupturing half and full subducting boundaries, respectively. According to Heidarzadeh et al. (2009b), the resulting tsunamis reach maximum heights of 8–10 and 15–18 m for the aforesaid two earthquakes, respectively.

6.3.4 Summary of Different Scenarios

A summary of tsunami hazard assessments using different levels of earthquake sizes are presented in Table 6.2. As discussed earlier, for different purposes, one of the levels of assessment can be used. For example, for planning residential areas, application of maximum regional earthquake is appropriate, but for planning the location of nuclear power plants, a worst-case scenario is preferable. Making any decision about which level of tsunami hazard assessment to be used for planning and mitigation purposes depends on local authorities and special characteristics of each coastal area.

Table 6.2 Different tsunami scenarios used for investigating tsunami hazard assessment in the Makran subduction zone and the results

Type of scenario	Earthquake size	Maximum wave height in Iran (m)	Maximum wave height in Pakistan (m)	Maximum wave height in Oman (m)
Characteristic earthquake (Fig. 6.2) (Heidarzadeh et al. 2009a)	*Mw* 8.1	7.0	6.0	5.0
Maximum regional earthquake (Heidarzadeh et al. 2008b)	*Mw* 8.3	9.0	7.0	7.0
Worst-case scenario (Heidarzadeh et al. 2009b)	*Mw* 8.5	10.0	10.0	10.0
	Mw 9.0	18.0	18.0	18.0

Heidarzadeh et al. (2008a, 2009a)

6.4 Tsunami Preparedness for the Region

A number of actions have been taken in order to provide preparedness against tsunamis in tsunami-prone regions. The most important of these actions are as follows:

6.4.1 A Tsunami Warning System

Two main tsunami warning systems, currently operational in the world, are: Pacific Tsunami Warning System (PTWS) operated by US National Oceanic and Atmospheric Administration (NOAA) and Japan tsunami warning system operated by Japan Meteorological Agency (JMA). Apart from some differences, tsunami forecast both in PTWC and JMA is based on pre-calculated tsunami databases. In JMA system, first, earthquake magnitude and epicenter is estimated using seismic waveforms and then, the database of pre-calculated tsunami scenarios are used to estimate the tsunami height along the coastlines. In fact, JMA tsunami warning system in based on seismic waveforms to forecast tsunami for the near-field. They monitor coastal tsunami wave heights to update tsunami warnings, however, tsunami waveforms does not play a major role in this tsunami warning system. This algorithm needs less than 10 min to issue tsunami warnings.

For PTWC, the pre-calculated tsunami waves are based on unit slip sources on different segments of subduction zones which are called “Green’s functions”. The subduction boundaries, with known historical records of tsunami, are divided into segments of length 50 km or less. Then, tsunami green functions are calculated at offshore locations. In case of a tsunami, at the beginning, earthquake epicenter and magnitude is estimated using seismic waveforms. Then tsunami waveforms recorded at offshore locations (DART stations) are used to constrain the tsunami source using an inverse algorithm. Such an algorithm needs around 1 h to issue tsunami warnings and is useful mostly for far-field tsunamis.

It can be seen that the vital part of each of them is earthquake magnitude estimation. The main reason for JMA’s inaccurate warnings during the 2011 Tohoku tsunami was inaccurate earthquake magnitude estimation (Ozaki 2011). In this context, the PTWC algorithm is less sensitive to earthquake estimation because any observation by PTWC is evaluated using tsunami waveforms. However, the PTWC method is not applicable to near-field tsunamis.

For the Makran region, a tsunami warning system similar to JMA seems appropriate because the only risk in this region is from near-field tsunamis. Therefore, a tsunami warning system in this region needs to be based on seismic waves. However, any tsunami in the Makran region may also cause some damages in the southern Indian Ocean because at least 8 countries are at risk of far-field tsunami hazard from this region; therefore, such a system may also provide warnings for those distant coasts (Fig. 6.3).

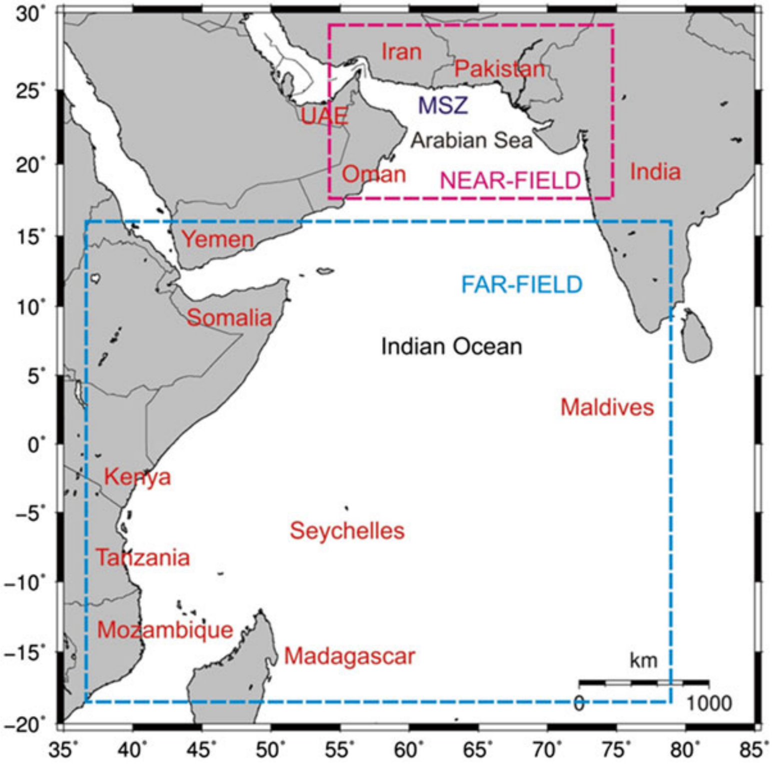

Fig. 6.3 Near-field and far-field tsunami hazards from Makran subduction zones

6.4.2 Tsunami Infrastructures

A tsunami warning system needs to be accompanied by a number of infrastructures among which are:

6.4.2.1 Deep-Water Tsunami Gauges

Deep-water tsunami gauges provide timely and refined information about tsunami. Although they may not be useful for warnings to the near-field, they are very useful for the far-field warnings. In addition, they provide useful information for tsunami research and help to better understand tsunami behavior in the region. At least two deep-water gauges are recommended; one for eastern part offshore Pakistan, and the other for the western part offshore Iran.

6.4.2.2 Coastal Tsunami Gauges

An array of at least 50 coastal tsunami gauges is necessary in the coastal areas of Iran, Pakistan, Oman, United Arab Emirates, and India. Currently, some tide gauges are available in the region; however, few of them are working well and the data is not shared between these countries. Strong international cooperation is necessary for installation of the gauges and for sharing the data.

6.4.2.3 Tsunami Inundation Maps

Tsunami inundation maps show which parts of the coast and how far from the shoreline is inundated by tsunami. It is evident that the extent of inundation depends on the earthquake scenario; the larger the earthquake, the larger the inundated area. Therefore, first, the appropriate earthquake scenario needs to be decided, and then, inundation maps can be developed. Examples of inundation maps for the region are presented by Heidarzadeh et al. (2009b) in four major cities in the region: Chabahar (Iran), Pasni (Pakistan), Karachi (Pakistan) and Muscat (Oman) by assuming a worst-case scenario with magnitude 9.0 in MSZ.

6.4.2.4 Tsunami Signage

The coastal zones at risk of tsunami need to be equipped with appropriate tsunami warning and evacuation signage. In addition, some of this signage also can give some education to local and non-local people. An example of tsunami signage is shown in Fig. 6.4.

Fig. 6.4 An example of tsunami signage (https://www.flickr.com/photos/debaird/540858467/in/photostream/)

6.4.3 *Education*

Experiences from past tsunamis have shown that education is an important part of any tsunami-resilient community (Bernard 2005). In some cases small pieces of tsunami education have saved many lives during tsunamis (e.g., Fritz and Kalligeris 2008). According to McCaffrey (2007), a 10-years old British girl in Thailand saved some lives during the 2004 Sumatra tsunami by little knowledge that she had learnt in school about tsunamis. Tsunami education is rather efficient for near-field tsunamis as the time for warning is so short. Education may be given to coastal communities in several ways including:

- information is school books
- TV and radio programs and videos
- newspapers, newsletters
- workshops, seminars and short courses
- signage in streets
- maps

6.5 Summary

A summary of tsunami hazard in the Makran subduction zone was presented. Tsunami hazard in the region can be classified into three levels based on the sizes of the earthquakes used for tsunami hazard assessments: (1) characteristic earthquake with magnitude $Mw8.1$, (2) maximum regional earthquake with magnitude $Mw8.3$, and (3) worst case earthquakes with magnitudes $Mw8.6$ and $Mw9.0$. The aforesaid earthquakes produce wave heights up to 7, 9, 10 and 18 m at the coastlines of the Makran region. We propose a tsunami warning system in the region based on seismic waveforms and using a database of pre-calculated tsunami scenarios. At least 2 deep-water tsunami gauges and 50 coastal gauges are necessary for tsunami understanding and warnings in the region. Any tsunami warning system in the region needs strong international cooperation between the countries in the region.

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Chapter 7
Drought Risk and Reduction Approaches in Pakistan

Amir Nawaz Khan and Shah Nawaz Khan

Abstract Drought is unique among all the other environmental hazards. Its uniqueness is in terms of the length of time between the first indications that a drought is developing and the point at which it begins to impact significantly upon the population of the affected areas. Drought played a significant role in reducing production of various sectors especially agriculture which has also its impact on the growth of the economy and exports. However, now it seems that it may reoccur and efforts will have to be made, to enable the system to cope effectively. Already, the two droughts in 1999–2000 and 2000–2001 have stretched the coping abilities of the existing systems to the limit and it has barely been able to check the situation from becoming a catastrophe. In all more than three fourth of Pakistan has less than 250 mm rainfall annually, and a small portion with more than 500 mm amounts to about 7 % of the area, and mostly that is mountain slopes. About 20 % of the total area has less than 125 mm. Drought has a number of short and long-term effects on the ecosystem of the affected areas in Pakistan. Agricultural productivity in most areas of Pakistan is highly dependent on rainfall. In Pakistan, the impact of drought in most areas has been controlled through its massive and unique canal network. In the drought prone areas of Baluchistan Province the traditional systems of irrigation have been developed. However, there are some special purpose authorities, mostly under Provincial Government which undertake studies and research projects for the enhancement and up-gradation of the environment in their areas of jurisdiction. The Provincial & Federal Government has various short, medium & long-term programmes for drought risk reduction in various regions.

Keywords Drought • Rainfall • Pakistan • Baluchistan • Reduction measures

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_7

7.1 Introduction

Drought has the greatest potential economic impacts. It can affect the largest number of people as compared to earthquake and floods etc. In contrast, drought affects large geographical areas, often covering whole countries or parts of continents. Drought may last for months and in some cases for several years. Droughts have a direct and significant impact on food production and overall economy. The worst crop-failures are associated with widespread drought. The problem of drought is worldwide, seriously affected man and his activities to a great extent. In Pakistan the menace is equally serious affecting almost one-third of area in varying degree. The seriously affected area amongst them is Cholistan in Punjab, Thar in Sind and Chagai-Kharan region in Balochistan. These neglected areas, if properly managed, are future land bank of the country and may be very productive. Major parts of Pakistan on the basis of latitudinal and altitudinal location as well as seasonal variation of rainfall passes through a dry spell each year particularly in May and June. However, the climatic data shows that recently the dry spell in these areas exceeded over dry conditions of the past 60 years or so. At present climatically these areas are very harsh and characterized by hyper aridity, scarce and highly variable rains, extremes of temperature, common dry spell, low humidity and high evaporation rate, especially during summer when extremely hot and desiccating wind of high velocity blow across these areas.

7.2 Types of Drought

There are three types of drought

(i) Meteorological drought
(ii) Hydrological drought
(iii) Agricultural drought

The first two types describe physical events; the 3rd type describes the particular impact of the first two types on an area of human activity, i.e., Agricultural production (Coburn et al. 1991; Reed 1992; Kemp 1994). Here a distinction will be made between these types to clarify their inter-relationship.

7.2.1 Meteorological Drought

It involves a reduction in rainfall for a specified period (day, month, season, and year) below a specified amount. To define meteorological drought one only needs precipitation statistics (Precipitation means rainfall and snowfall).

7.2.2 Hydrological Drought

It involves a reduction in water resources (stream flow, Lake Level, groundwater and underground aquifers) below a specified level for a given period of time. Its definition involves data in availability and off take operations of the system (domestic, industrial, irrigated agriculture) being supplied.

7.2.3 Agricultural Drought

Agricultural drought is defined in terms of the retardation of crop growth or development by reduced soil moisture levels. This in term may lead to economic definitions of drought, when, for example: dry conditions reduce yield or cause crop failure, leading to a reduction in income.

7.3 Quantification of Drought

There is no sharp defined onset to drought. Drought becomes recognizable only after some period of time has elapsed. Even the period of time required for appearance of drought is difficult to specify since it depends on a large number of physical and biological variables (Verstappen 1983; Tewari 1988; Khan 1991; Reed 1992; and SAARC 1992). Drought is unique among all the other environmental hazards. Its uniqueness is in terms of the length of time between the first indications that a drought is developing and the point at which it begins to impact significantly upon the population of the affected areas. The length of such "warning times" varies significantly between different societies. In many countries the warning time is in the order of several months (Verstappen 1983; Reed 1992 and SAARC 1992).

7.4 Factors Contributing to Drought Vulnerability

Following are the important factors contributing to drought:

(i) Location in arid areas where dry conditions are increased by drought.
(ii) Farming on marginal lands
(iii) Lack of agricultural inputs to improve yield.
(iv) Lack of seed reserves.
(v) Areas of low soil moisture retention
(vi) Low allocation of resources to drought hazard.
(vii) Increasing number of livestock with open grazing.
(viii) Deforestation etc.

7.5 Drought in Pakistan

In Pakistan drought has become a frequent phenomenon in the country. Pakistan experienced several drought years 1871, 1881, 1899, 1902, 1920, 1931, 1935, 1951, 2001, 2014 etc. The drought of 1998–2002 is considered worst in 50 years. According to a report issued by the Economic Survey of Pakistan, the drought is one of the factors responsible for poor growth performance. Balochistan especially the western and central parts of the province remain in the grip of drought almost all year round. When monsoon fails to deliver rains then drought emerges. Pakistan is basically a dry country of warm temperate zone. Climatic differences prevail from northern mountains down to the sea coast in the extreme south. However, the country's climatic character is that of aridity. The Annual precipitation, except in the northern highlands, averages less than 250 mm, decreasing from north to south. In all, more than three fourth of the country has less than 250 mm rainfall annually, and a small portion with more than 500 mm amounts to about 7 % of the area, and mostly that is mountain slopes. About 20 % of the total area has less than 125 mm and it should not be forgotten that lower the total rainfall, the higher its variability as rule (Ahmed 1951; Kureshy 1977; Johnson 1979). Besides this, very low and highly variable rainfall characteristics in most part of the drought-prone areas of Pakistan persist. There has been almost no rainfall situation since the last few years (Fig. 7.1).

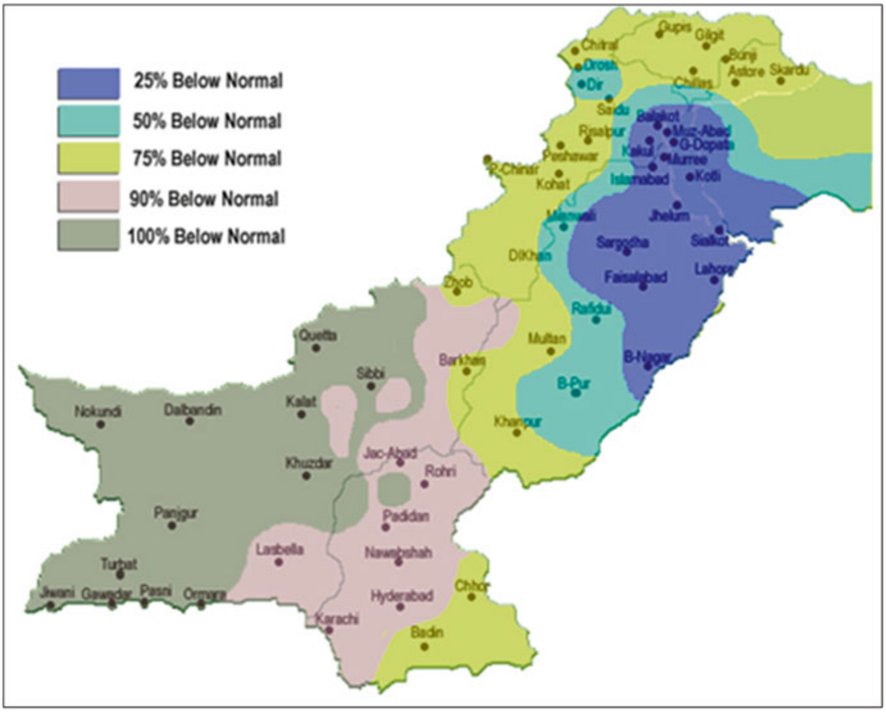

Fig. 7.1 Rainfall in Pakistan (June, July, August, 2004) (After Pakistan Meteorological Department 2004)

The temperature recorded during this period has also shown a very high increase. Now this is natural law that if rainfall occurs after regular interval, then not only the underground water increases but the moisture contents on the ground surface also remain persistent (Ahmed 1995). Here the situation is totally the other way round. The wastage of moisture contents from the surface of the earth as a result of the process of evaporation (due to increasingly high temperature) is more than the amount of water received in the form of rainfall. Besides this development the level of underground water has also go down and in the result is in the form of drought.

Drought has a number of short and long-term effects on the ecosystem of the affected areas in Pakistan. Agricultural productivity in most areas of Pakistan is highly dependent on rainfall. The effect of drought in most areas of Pakistan has been controlled through its massive and unique canal network. However, in some areas, drought remains chronic. For instance, Baluchistan Province is extremely dry. Almost half of the Baluchistan has less than 125 mm rainfall. The rest of the areas receive no more 250 mm rainfall. Annually, there is very high variability in rainfall. Drought is also severe and frequent in Thar Desert, which is located beyond the left bank flood Plain of the Sutlej and Indus rivers.

In the drought-prone areas of Baluchistan Province, the traditional systems of irrigation have been developed. Irrigation by Karez tunnel depends ultimately on rainfall to recharge the aquifers. In Quetta valley and parts of Makran, where ground water is accessible, Karez are dug from springs to lead the water to the valley floor. Long tunnels are dug, with the shafts at 50 m intervals, to tap the ground water and maximize its flow to fields, gardens and orchards. Semi nomadic and seasonal migration is a common way of life in drought affected areas of Pakistan. In the Thar and Baluchisan deserts hoarders traditionally graze livestock on desert flora and raise crops in between the dunes. From time to time, drought has forced a large number of people on migration to urban centers and other areas. There has been a wide spread loss of cattle due to reduction of fodder sources. In other part of Pakistan, because of well-developed canal irrigation system and arrangement of storage and supply of food grains, drought has not been so sever.

7.5.1 Drought Affected Areas in Pakistan

It has been reported by national and international print and electronic media that 23 out of 26 districts of Baluchistan; Thar, Dadu and Thatta in Sind; and Cholistan in Punjab have been severely affected by drought (Table 7.1). It means that more than 45 % of the landmass of Pakistan have been declared calamity hit. More than five million people are facing a famine like situation. Hundreds of people have already lost their lives and millions of families have lost their livelihood. Drought has covered 80 % area of Baluchistan (Fig. 7.2). Apart from other potential, Baluchistan is very important from livestock population point of view. It cator the need of 47 % of our livestock population. Amongst which 40 % have already perished, where

Table 7.1 Districts affected by severe droughts in Pakistan, 2003

1. Ketch	9. Ziarat	17. Kalat
2. Barkhan	10. Kohlu	18. Mohmand
3. Chagai	11. Awaran	19. Marwat
4. Sibi	12. Gwadar	20. Karak
5. Zhob	13. Pishin	21. Tank
6. Khuzdar	14. Bolan	22. Tharparkar
7. LoraLai	15. Quetta	
8. Musa khel	16. Mastung	

Source: Economic Survey of Pakistan 2003–04

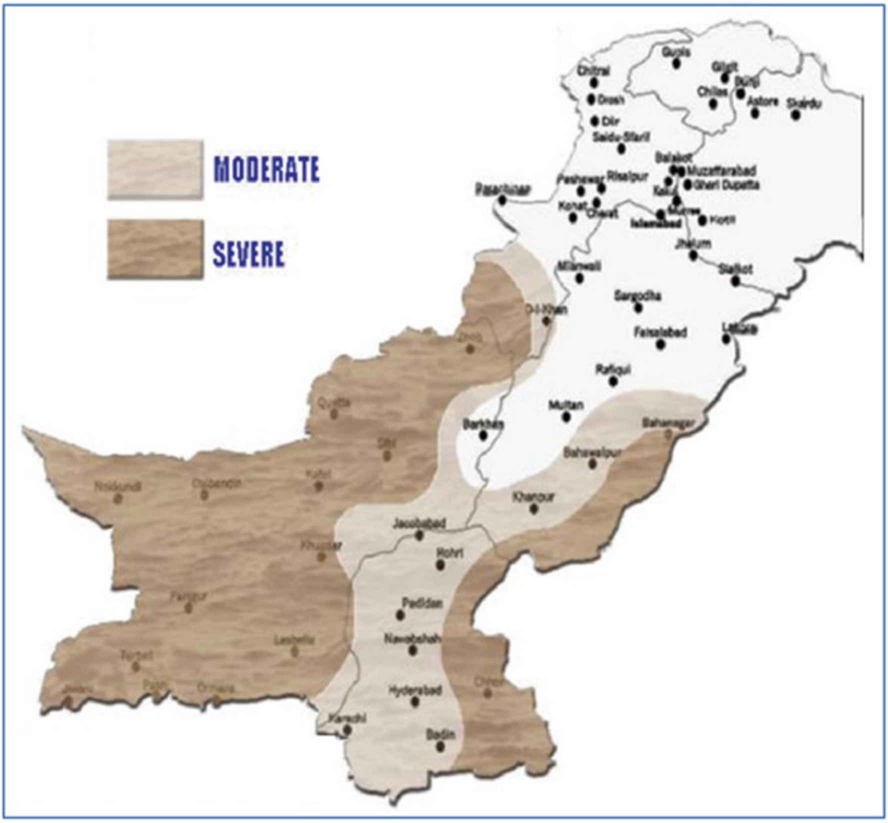

Fig. 7.2 Drought in Pakistan (After Pakistan Meteorological Department 2000)

as another 40 % is in critical position and is about to perish. As a whole, around 2.5 million animals have perished, while animal mortality rate will increase upto 60 % due to non-availability of fodder and water in these areas. A mass migration is taking place toward “safer areas”. It has been estimated that about 1.2 million people have been affected in Sind and 2.1 million in Baluchistan and upto one million in Punjab province.

7.6 Adverse Effects of Drought in Pakistan

According to the Economic Survey of Pakistan, the drought was one of the most significant factors responsible for the less than anticipated growth performance. The drought has wreaked havoc in 58 of the total 106 districts of the country, especially impacting rain-fed and rangeland areas. Causing devastation and loss of human lives in semiarid regions, the drought has eliminated US $ 247 million worth of livestock in the first few months. Given that 70 % of the entire population of Pakistan is rural based and dependent on agriculture for its livelihood, negative agricultural growth of 2.5 % has not only impacted agro-based industry, but displaced a large number of the rural poor. Massive migratory trends have been witnessed, therefore, to irrigated and urban areas. The losses of the agricultural sector will also trickle down to the banking and financial sectors, in view of farmers' outstanding loan obligations and financing needs of agro-based industries. It has been observed that drought has a number of direct and indirect impacts on the people and economy of Pakistan. Some of the typical adverse effects of drought are listed below:

1. Reduced income for farmers.
2. Reduced employment opportunities for agricultural laborers.
3. Reduced Government revenues and foreign exchange earnings as a result of a decline in agricultural exports.
4. Increased prices of staple foods.
5. Increased inflation rate with in the economy.
6. Inability of certain groups within the population to afford increased food prices resulted in their:

    (i) Switching to cheaper and less preferred foods.
    (ii) Reducing in overall food intake.
    (iii) Taking loans in order to maintain food intake.
    (iv) Selling their assets to raise funds.
    (v) Engaging in alternative income earning activities locally.
    (vi) Migrating in search of employment opportunities elsewhere.
    (vii) Migrating to a place where relief food is being distributed.

7. Increased stress and morbidity due to migration.
8. Reduced food intake led to deterioration of nutritional status and reduction in ability to resist infection.
9. Drying up of water resources led to reduction in water quality, the need to travel further to collect water and possibly to migrate to better water resources, all of which are likely to increase level of morbidity.
10. Increased competition for access to remaining water sources has led to increase incidences of local disputes/conflicts.
11. Social costs caused by migration for instance break up of communities and families.
12. Losses of Livestock etc.

7.7 Drought Risk Reduction Measures in Pakistan

Drought does not come suddenly like floods or earthquakes. It may fall upon the country in a localized way and then slowly and gradually spread throughout the whole country. The effects of drought are often for-reaching. Most often the effects are more damaging to the economy of the country than that of floods. Drought management in Pakistan is the responsibility of both Federal and Provincial government. Both have various short, medium and long-term programmes for drought management. Until now Pakistan has no integrated drought management programmes. With a very few exception, there is no regional level authority to deal exclusively with arid zone of different Provinces.

(i) It is WAPDA, which makes programme for the development of water resources and power supply throughout the country, including desert and semi desert areas.
(ii) There are some special purpose authorities, mostly under provincial government, which undertake studies and research project for the enhancement and up-gradation of the environment in their areas of jurisdiction. These authorities include Baluchistan Development Authority, Sarhad Development Authority, Arid Zone Development Authority of Sind, Cholistan Development Authority and Thal Development Authority etc.
(iii) Under short-term measures during drought periods, the Provincial Government declares drought prone areas. These drought prone areas are exempted from various Taxes such as land revenue etc.
(iv) Federal Government also provides interim relief and funds for rehabilitation of the affectees. The Federal Government through its National Logistic cell has to maintain a regular supply of food and fodder.
(v) The Provincial agriculture departments are also implementing programmes for livestock development to raise good breeds of cattle both for milk and meat

7.8 Recommendations for Drought Risk Reduction in Pakistan

Drought is an inevitable part of our climate. We have to recognize and accept it. At the same time no practical method for appreciably enhancing precipitation is yet in hand. By virtue of modern meteorological monitoring & telecommunication system it has become possible to predict drought to a great extent. Following are some recommendations:

7.8.1 Drought Control Plan

Drought control plan is necessarily the work of an interdisciplinary team, comprising economist, agriculturist, hydrologist, geographers, planners and experts in social sciences and health services and many others, as well as meteorologists. The drought control plan should contain provisions for the implementation of specific actions to detect drought and to help alleviate its effects on agricultural production.

7.8.2 Controlling Wastage of Water

In Pakistan the wastage of water which urgently needs to be controlled are of two kinds:

7.8.2.1 Flood Wastage

It has been estimated that on the average approximately 35 maf[1] of water is wasted each year the form of floods. This wastage can be conserved through feasible storage projects on the Indus as well as other rivers as per provision water accord. In this context the issue of Kalabagh Dam has assumed central position in the ensuing debate. One of the best options is the strategy of small dams like China. This could be an effective tool for self-reliance as well. Because for big dams, dependence on foreign loan, experts and companies are inevitable, whereas for smaller dams local engineers and machinery of the national industry can be sufficient. The number of these dams according to an estimate can be 30–40. In this connection the construction of two dams on the Indus at Skardu and Basha and two dams on the Jhelum river are most essential for multipurpose and as carry-over reservoirs to safeguard against drought.

7.8.2.2 Seepage

Excessive seepage from the gigantic canal conveyance system and watercourse distribution is the second most damaging and colossal wastage. The seepage is not only leading into wastage of water but also wastage of land due to waterlogging and salinity. It is all because of non-cemented canals. It has been estimated that the wastage of water due to seepage is approximately 55 maf each year. The only way to save this huge wastage is to improve the existing canal network and modernizing the irrigation system, such as consolidation of land in geometrical shape and replacement of watercourses by “pipe system”. This will help to efficiently monitor and distribute water after removing all the multidirectional chronic restraints.

[1] Maf: A measure of flow in which 1 million acre-feet of water passes a measuring.

7.8.3 Establishment of Special Purpose Regional Authorities

Hazard management at present is the domain of various uncoordinated organizations. As a result responsibilities are highly fragmented between a number of Federal, Provincial and local departments and agencies ranging from water development, afforestation, income generation, supply of food and fodder, health education and social development etc. The very few exception, where some tangible improvements have been made are Thal and Cholistan part of Punjab. A lot needs to be done in many other drought affected areas including greater part of Baluchistan, Thar, and Khyber Pakhtunkhwa. There is an urgent and greater need to adopt clear-cut policies at the national level for these dry regions of the country. If we recognize drought as a recurrent problem, then there is a need to establish special purpose regional authorities on the pattern of Sind Arid Zone Development Authority. These special purpose authorities should be well equipped with expertise and resources to work for a permanent and long-term solution of this problem.

7.8.4 Integration of Hazard Education in the Curricula

In order to educate the public about the adverse effects of drought and other hazards, it would be worthwhile to incorporate hazard information in the curricula of educational institutions. A long-term hazard educational programme at school and College level should be made mandatory. It should in fact put emphasis in the actual hazards, such as drought, floods, earthquakes and landslide. This clarification is important because many government organizations and NGO's as well important documents like Pakistan National Conservation Strategy have confused hazards with municipal problem such as solid waste, drains and plastic bag problems. These issues are tackling as municipal problem in the west but we consider them as the basic issues. This hazard education will enhance community participation in all government programms related to hazard reduction. It would also be of great help to control deforestation, illegal quarrying, over grazing and similar infractions, which deform the environment and trigger hazards of different types.

7.8.5 Revitalization of Karez System and Check Dams

To bring the water table to normal position tube well be discouraged near the mother-wells of karez and the age-old karez be revitalized again. If possible new karez be added to the system. The aerial photographic survey of the drought-prone regions also reveals that there was a wide network of check dams for the enhancement of infiltration of the run-off water of highly variable and occasional rainfall. These check dams are now abundant. There is therefore, an urgent need to renovate and rehabilitate these ancient check dams as well.

7.8.6 Coordination, Training and Research

Pakistan is a hazard-prone country. Planning and management of such a hazard-prone country requires the co-ordinates expertise of earth sciences, environmental planning and governing officials. The coordination amongst official as well as professionals is badly lacking at present. Therefore, there should be proper co-ordination among the experts in the related fields and concerned authorities to combat the recurrent environmental hazards in a sustainable way. It is recommended that to deal with the natural hazards in a professional manner, training courses and extension work must be organized at various levels. Natural hazards Research Centers must be established to deal with all aspects of Natural hazards. Emphasis should be placed on the establishment of climate research groups to monitor continuously the occurrence and progress of drought at least on a seasonal basis. Such monitoring of drought could be used to forewarn farmers, and the government agencies of possible severe drought.

7.8.7 Desalinization Plants

Desalinization plants can be established in the coastal areas of the country, which could not only be used for pure drinking water but also for the production of salt. If we can manage these plants on a larger scale the water available can also be used for irrigation purposes as well.

7.8.8 Short-Term Measures

The major problem to tackle in the short- term measure is that of food to eliminate the occurrence of famine. To reduce the risk of temporary food insecurity due to drought, it is necessary to protect people's access to food through the following steps:

(i) Ensuring the availability of food in the affected areas.
(ii) Protecting the entitlements of all groups within the affected population.
(iii) Some of the measures for maintaining food security during drought area:
    (a) Price Stabilization
    (b) Food subsidies
    (c) Employment creation programs
    (d) Special programs for livestock's and pastorals populations (Fodder Issues)
    (e) Complementary water programs (Railway Water tanks)
    (f) Complementary health programs

7.8.9 Typical Post Disaster Assistance Needs

The drought hazard affected population must be assisted to replace assets lost during the period of temporary food insecurity, to re-establish their livelihood. The severity of this food insecurity will determine the nature and scale of the rehabilitation requirements. For instance, if migration to camps and significantly increased mortality has occurred, then a comprehensive rehabilitation program will be required. This may involve health care, counseling, assisting the migrants back to their homes and material support to re-establish their homes and productive activities. Such provision may include seeds, tools, cooking utensils, blankets and support until households are capable of supporting themselves. It is responsibility of the government to make sure that the actual affectees have access to the relief help. Rehabilitation needs should therefore be carefully assessed and interventions tailored to particular situation.

7.9 Conclusion

Drought is one of the most serious atmospheric hazards. It affects large geographical areas often covering whole countries or parts of continents. Generally, the major causes of drought are low rainfall as well as some intensifying factors. Drought has adverse effects on the physical and socio-economic environment. Meteorological drought is a reduction in rainfall for a specified period (day, month, season, and year) below a specified amount and Hydrological drought involves a reduction in water resources (stream flow, Lake Level, groundwater and underground aquifers) below a specified level for a given period of time whereas, Agricultural drought is defined in terms of the retardation of crop growth or development by reduced soil moisture levels. Impacts of drought are very severe on the socio-economic environment of Pakistan. The drought of 1998–2002 is considered worst in 50 years. Drought has covered 80 % area of Baluchistan Province. In Baluchistan, drought-prone areas traditional systems of irrigation have been developed. The government and affected communities must work together to overcome the problems. It has been observed that drought has a number of direct and indirect impacts on the people and economy of Pakistan In Pakistan the menace is equally serious affecting almost one-third of area in varying degree. The seriously affected area amongst them is Thal and Cholistan in Punjab, Thar in Sind and Chaghai-Kharan region in Balochistan. These neglected areas, if properly managed, are future land bank of the country and may be very productive. There are some special purpose authorities in Pakistan, mostly under Provincial Government which undertake studies and research projects for the enhancement and up-gradation of the environment in their areas of jurisdiction. These authorities include Baluchistan Development Authority, Sarhad Development Authority, Sindh Arid Zone Development Authority, Cholistan Development Authority, and Thal Development Authority etc. The government should involve the affected communities not only in the planning process but it is also necessary to arrange some awareness programs workshops, etc. Assistance should be provided in an equitable consistent and predictable manner to all without regard to economic circumstances, industry or geographic region. There should be financial resources to maintain operational programs and to initiate research required supporting drought assessment and response activities. A monitoring /early warning system can helps to provide decision makers at all level with information about the onset, continuation, and termination of drought condition and their severity.

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Chapter 8
Landslide Risk and Reduction Approaches in Pakistan

Amir Nawaz Khan and Shah Nawaz Khan

Abstract The landslide hazard like other extreme natural hazards occurs frequently in Pakistan. There are various causes of landslides, but the major causes are immature geology, wide variation in climate & degradation of the natural resources and intense deformation. The landslide prone areas are mainly comprised of inter-bedded sand stone, siltstone & shale. Landslide occurs in different forms which has seriously disrupted human being and his activities in Pakistan. Considerable damages have occurred to housing, roads, communication lines, electricity and water supply, as well as retaining structures. Different approaches have been adopted to reduce losses from landslides. This chapter focuses on landslide risk and different approaches which are used to mitigate the landslide risk in Pakistan.

Keywords Landslide • Pakistan • Human activities • Impacts • Himalaya • Bioengineering • Soil bioengineering • Biological methods

8.1 Introduction to Landslide

The extreme natural events like landslide, wind and earthquakes are hazardous only when they prove determental to man and his activities, therefore, without man, there is no concept of natural hazard. The concept of natural hazard has variously defined by many researchers (Burton and Kate's 1964: Burton et al. 1978; White 1974). The word landslide has been used from very long time to denote the movement of the earth material varying in magnitude and origin. Landslide ranges from near surface disturbances of weather zone to deep seated displacement large rock masses. Their impact will depend upon their types, depth of material, rate of movement, stresses from environment, volume of material invaded and proximity of that slide etc.

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*, Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_8

The concept of landslide has been discussed and defined by a great deal of geomorphological literature (Eckel 1958; Sharp 1960; Zaruba and Mencl 1969; Varnes 1978; USGS 1981, 1982; Costa and Baker 1981; Coates 1985; Crozier 1986; Cooke and Doornkamp 1990; UNDRO 1991). According to these studies, landslide is a process which results in the downward and outward movement of slope-forming material composed of natural rocks, soil, artificial fill or a combination of these materials, under the influence of gravity. Although landslide technically speaking is a category of the continuum of the process called mass movement or mass wasting, most authorities on the subject are of the view that it is really more inclusive than the term implies. Landslide is a general term covering a wide variety of mass movements (from the very rapid ones to those difficult to detect), therefore traditionally it has been widely used as a collective term for most of the mass movement types (Varnes 1978; Coates 1985; Crozier 1986; Atta-ur-Rahman et al. 2010). The material that does not have the stability to resist the force of gravity, response by rolling, sliding, falling or flowing down slope, stopping at the point where there is enough support to resist the gravitational pull or at the bottom of the slope (Alexander 1993).

There are six basic type of slope movement i.e. fall topples, slides (transactional & rotational), lateral spreads, flow and complex movement (combination of two or more principle type of movement) have been widely used. It may take place independently or in conjunction with earthquakes, floods or volcanoes etc. Landslides are a major threat each year to human settlements and infrastructure, and cause more property loss than any other geological event. Landslide occurs as a result of changes, either sudden or gradual, in the composition, structure, hydrology, or vegetation on a slope. These changes can be due to vibrations from earthquakes, blasting, machinery, traffic and thunder. Some of the most disastrous landslides have been triggered by earthquakes. Changes in water contents caused by heavy rainfall and rise in ground water levels, removal of lateral support by erosion, previous slope failure, construction, excavation, deforestation or loss of stabilizing vegetation, decrease in strength of rocks and soil over time with weathering or other physical or chemical action are some other causes of landslide phenomena. Landslides in most urban areas are often induced by human actions, Interruption of water courses and change in the water table, new construction involving "cut and fill" methods which disrupt slope stability. Generally landslides are considered to natural phenomena triggered by natural factors. However, many landslides are as development of an area as well as for settlement reclamation of cultivable land, construction of road, widening of existing road or excoriation for other civil and engineering purposes.

8.2 Landslides in Pakistan

Pakistan, like many other parts of the world, has been frequently subjected to variety of environmental hazards. Apart from the vast alluvial Indus basin, which is prone to frequent devastating flooding and desertification (including waterlogging), a major part of the country is covered by rugged and geomorphologically active mountains.

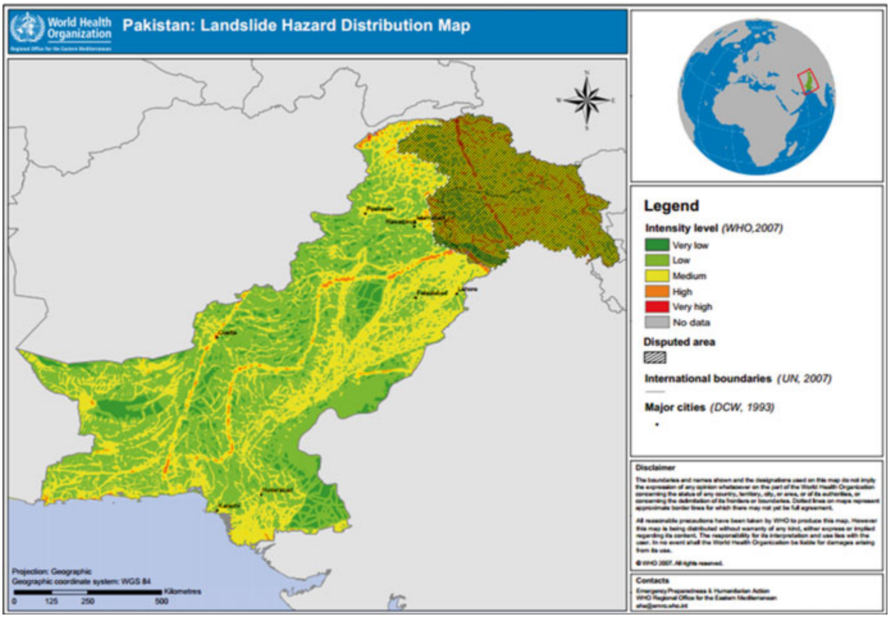

Fig. 8.1 Pakistan landslide hazard distribution (Source: WHO 2007)

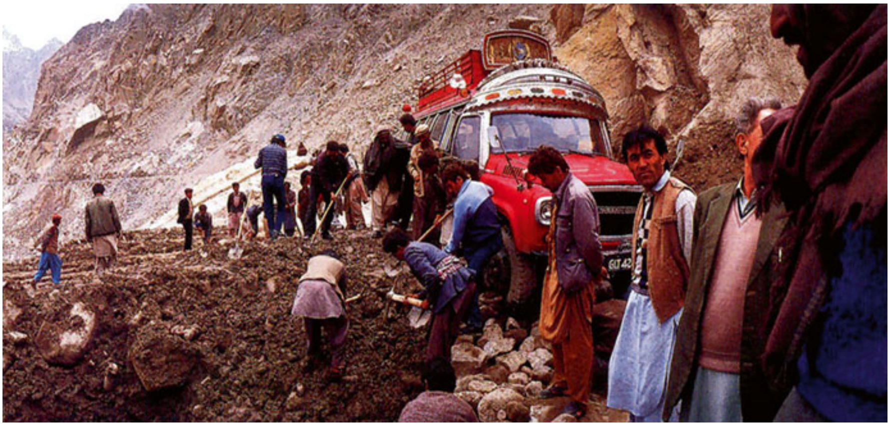

Fig. 8.2 Landslide in northern Pakistan

It is this mountainous part where people and their belongings are vulnerable to serious environmental hazards like earthquake, landslides, snow avalanches, flash floods and several others (Atta-ur-Rahman et al. 2010). Amongst these the landslides and related slope failure processes (Fig. 8.1) are the most damaging because they are an ever-present and frequent danger for the people and their property (Fig. 8.2).

Most of landslides were identified, documented & investigated for analysis & statistic distribution in Pakistan. Mass wasting and landslides are very common phenomenon throughout its mountainous region of north and northwest. In hilly areas of Pakistan landslides and slope failure is common phenomena particularly in monsoon season. These hilly areas are honeycomb for population which creates immense pressure on natural resources particularly on the land resources.

The most slide-affected areas in Pakistan lie in Himalayan region. Deforestation has accelerated soil creep in the hilly areas of north and northwest region. The Himalaya Mountains, which constitute the youngest and the most dominating mountain system in the world have a history of landslides having no comparison with other mountain range in the world (Khan and Atta-ur-Rahman 2006). During the rainy season, landslides take place along the highways built in the mountain terrains such as the Muree hills, Pir Punjal and Hindu Kush. There is no systematic and detailed study to determine the extent of the problem has been undertaken in Pakistan.

8.3 Causes of Landslides in Pakistan

Natural processes like earthquakes and rainfall have their role in initiating the landslide problem. The recent increase in the occurrence of the landslides and related processes suggest that the major causes contributory to the problem are mainly the changing human activities, recently increasing socio-economic pressures and environmental deterioration. Because there is no reason to suppose that nature is becoming more severe. Improper infrastructure schemes, housing, deforestation, overgrazing and inadequate agriculture practices are those primary causes which destabilized the slope and as a result landslides occurs in Pakistan. These landslides not only damage life, property and environment, but also cost huge economic lost due to damaging the communication and infrastructure network systems. The rapid removal of vegetation cover and ground-holding trees, overgrazing, ruthless deforestation, blasting for road construction, and extension of agriculture coupled with residential development and rapid urbanization from the valleys to steep slopes and more marginal areas, have not only speeded up erosion, flooding and silting of bottom lands but also rapidly increased instability of the slopes. This means that traditional, ecologically sound practice has been replaced by more exploitative approaches. Inherited causes like particular composition, structure, texture and similar other properties of rock type, and external forces which leads to an increase in the shear stress of earth materials. The most obvious external force in the case of landslides is the gravity. In addition to this, geology, climatic situation, water contents, vegetation factor, and the impact of human activities are some of the important external forces contributing to the problem. The growing urbanization is also an important factor because it has been experienced that before these modern developments and land use landslides were very rare. Some of the most disastrous landslides have been triggered by earthquakes, changes in water contents caused by heavy rainfall and rise in ground water levels, removal of lateral support by erosion, previous slope failure, construction, excavation, deforestation or loss of stabilizing vegetation in Pakistan. Activities such as dam construction and open pit mining have also resulted in landslides. In recent times the unscientific exploitation of the Himalaya i.e deforestation, and discriminate construction, mining and quarrying activities in combination with its immature and complex geology, seismic activity and heavy rainfall and flash floods have created slope instability problems never witnesses before. Landslides in the form of very slow moving, soil creep is also common in Baluchistan and hilly areas of Sindh province. The main cause of soil creep in the arid zone is the erotic nature of rainfall and wind action.

8.4 Impacts of Landslides in Pakistan

In Pakistan landslide is dry for the most part of the year, but during monsoon rain burst a number of small streams. The processes of slope failure, among the geologically young, rugged and jagged foothills of the Himalayas have very adverse effects both directly and indirectly, on the living conditions of the people in this area since long. Landslides in the region frequently cause losses of life, destruction of houses, roads, crops, and various other properties. These deteriorating processes in the mountains environment have not only far reaching impacts on the mountainous population but also negative affects on the people of the plain areas, and more particularly the people living in the adjacent lowlands. Landslides and other related processes are also one of the great source of sediments into the water of the Indus and its several tributaries in the mountain catchment areas. It has been suggested that the sediment load in the Indus is greater and one of the highest in the world.

The direct impacts of steep-slope failure or landslides in the mountainous part of Pakistan are the loss of life, the collapse and partial destruction of houses and their infrastructure, the frequent disruption of roads and other means of communication, damage to pipe lines, irrigation channels and connecting links of water resource system, and sometimes the entire human settlements. Apart from the rapid flowage which are sudden movements, and which cause to the collapsing of houses, there are some slow flowage movements like soil creep occurring in the area, which slowly and steadily destroy the houses right from their foundations. Farm village homes, on or at the head of steep slopes, carried away or undermined. Widespread, massive loss of terraced fields, either by collapse, or removal in landslides from above. Bomb-like impact of rock falls upon buildings sited on lower slopes or on valley floors. Damage to extensive networks of channels and wooden pipes carrying water to the fields, villages and mills. Failure of slopes which supported roads and pathways, or the dumping of landslide debris onto them.

8.5 Landslide Risk Management in Pakistan

The federal forest, highway and mining departments are undertaking research and programme to prevent different types of landslides through engineering measures, regulations and aforestation etc. The concerned provincial and local level agencies as well as municipalities are also making efforts to mitigate the landslide hazard in Pakistan. No significant progress has, so far been achieved in mapping of hazard-prone areas. As far as regulations are concerned planning regulations do not permit settlements in slide prone areas. Chopping down of trees and quarrying is also strictly prohibited in these areas. Implementation, however, is a big problem. Aforestation is very important, because for the Himalayan slope surface to be stabilized. Unfortunately, no designated authority for landslides management in Pakistan. In Pakistan, no planned effort to prevent landsliding has so far been made. No study covering the entire country and the area affected by landslide is available. Some work has been done by the Geological Survey of Pakistan (G.S.P) and by some university departments. There is a need to evolve standard plant culture practices, particularly in adverse environmental zones, and to develop these practices, into an economically viable activity. No institutional arrangement exists either at Federal or Provincial levels to implement, monitor and evaluate projects concerning prevention and relief work. Training facilities in this field are almost absent. No systematic study on mapping landslides in the country. The landslide hazards management needs comprehensive methods approach as the problem nature is complex. Technical knowledge availability, appropriate method selection and cultural setup are critical issues in the landslides hazards management. The integrated approach of engineering, bioengineering, soil bioengineering and biological is most recent approach in landslide hazards management.

8.5.1 Bioengineering Methods

Landslide bioengineering management is the use of engineering principles and designs for landslide hazards management through biological methods (medium). Following are some important methods of bioengineering.

(i) Retaining Walls
(ii) Vegetated crib wall
(iii) Vegetated concrete block wall
(iv) Vegetated geo-textile walls
(v) Vegetated gabion walls
(vi) Live brushwood wall
(vii) Check Dams
(viii) Single row post live brush

(ix) Wood check dams
(x) Double row post live
(xi) Brushwood check dams
(xii) Palisades

8.5.2 Soil Bio-engineering Methods

The soil bio-engineering is use of living plant material to do some engineering work. The soil on the landslide is loose and without any vegetation cover. Planting on such loose soil on steep slopes is not successful because the planted seedlings at the head of the landslide are uprooted and seedlings planted at toe of the landslides are buried with moving soil mass from above. Some Engineering structures are needed for temporary fixing the loose soil on the slide before a successful plantation is established. Some important methods are:

(i) Brush Wattles
(ii) Brush Layering
(iii) Hedge Layering
(iv) Brush hedge layering
(v) Brush fences
(vi) Semi-dead fences with live
(vii) Hedges
(viii) Hedges
(ix) Sodding

8.5.3 Biological Methods

Nature has designed' vegetation as a means to blanket and stabilize the slopes. In the subtropical Chir pine Forest and moist Temperate Forest zones this has evolved into confer forest comprising complex multi start a canopy, from big trees, shrubs and leaf litters, covering the organic humus rich top soils that offer excellent overall protection. Examples of biological methods are:

Planting

(i) Planting Bare Rooted Seeding
(ii) Planting of Tube Plants
(iii) Planting of Cutting/Stump
(iv) Planting of Root-shoot Cuttings
(v) Tuft Planting of Grasses

Sowing

(i) Sowing of Local Trees Species Seed
(ii) Sowing of Local Bush Species Seed
(iii) Sowing of Native Grass Species Seed
(iv) Encouragement of Natural Vegetation Regeneration.

8.5.4 Vegetated Soft Gabion Retaining Wall

The soft gabions consist of jute or synthetics fiber bags being used for fertilizers and sugar packing in Pakistan. The filled bags are used as building blocks as if they are bricks to construct retaining walls (Fig. 8.3).

8.5.5 Vegetated Timber Crib Wall

These are beneficial for easy drainage of seepage water from the landslide mass. The crib walls become more effective for the stabilization of the landslides if combined with vegetation treatment because brush layering treatments provide better drainage and also reinforce the soil mass of the landslide (Fig. 8.4).

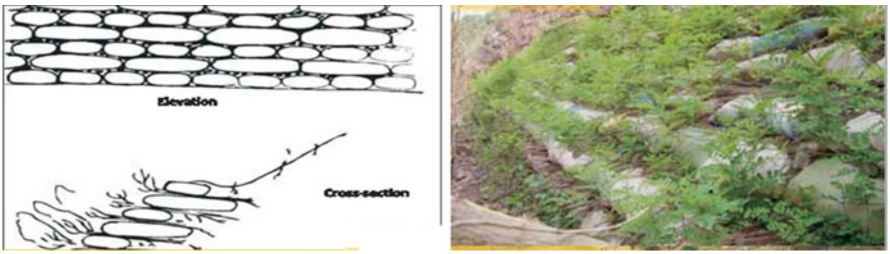

Fig. 8.3 Retaining wall

Fig. 8.4 Vegetated timber crib wall

8.5.6 Vegetated Concrete Block Retaining Wall

The vegetated concrete block retaining walls are economical as compared to full concrete walls and it is occupied by soil and vegetation (Fig. 8.5). The vegetated concrete block retaining walls are useful because there is free drainage from the landslide mass.

8.5.7 Brushwood Retaining Wall

Nature's concept of soil reinforcement is shown to good effect in the root network of a banyan tree here stabilizing a near-vertical cut in colluviums (Fig. 8.6).

8.5.8 Vegetated Loose Stone Wall

Loose stone retaining walls are commonly constructed for stabilization of small slips. If the loose stone retaining walls constructed in combination with vegetation then the loose stone walls become quite strong due to reinforcement of soil with the strong root system of the vegetation.

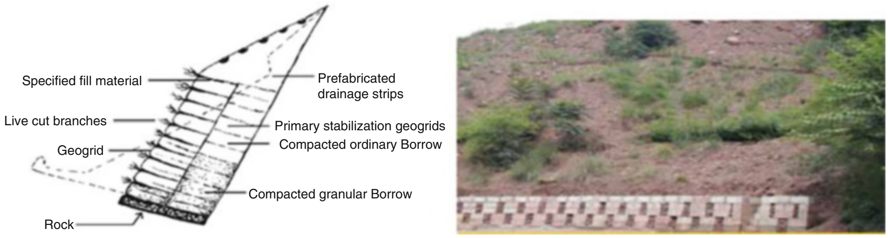

Fig. 8.5 Block retaining wall

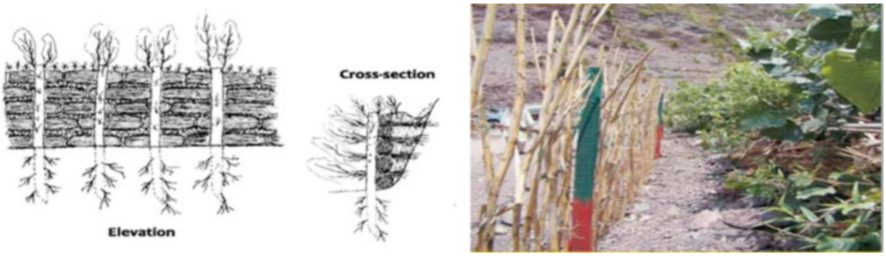

Fig. 8.6 Live brushwood retaining wall

Fig. 8.7 Live brush check dams

8.5.9 Live Brush Check Dams

For treating the gullies on the fill slopes and the drains on the landslides live brush wood check dams are more beneficial and economical for erosion control (Fig. 8.7).

For the construction of live brush wood check dams freshly cut wooden poles having 8–12 cm diameter of willow, poplar, mulberry or any other local tree species which can be propagated through vegetative methods are driven in the soil in the centre of the trench at 50 cm spacing across the gully.

8.5.10 Palisade Check Dam

Palisades are also live check dams in which live poles are used in place of brush wood. Where fresh poles are available near the site, palisades are preferred. Palisades are alternates for the live brushwood check dams and are constructed in the drainage lines on the active landslides, in the gullies on fill slopes and the narrow gullies developed on steep slopes.

8.5.11 Vegetated Poles Check Dams

Vegetated pole check dams are constructed on the landslides and in the gullies in the forest area where the poles are available free of cost and stone are not available. The vegetated pole check dams are established by placing the poles across the gully with brush layering treatment. The poles are placed across the gully by fixing their ends in the trench dug out in the banks of the gully.

8.5.12 Grass Sowing and Tuft Planting

To cover the loose soil on the landslide with vegetation it is better to sow the native grasses of the area. For landslide stabilization program it is better to collect the seed of the native grasses in the months of October – November for sowing on the landslide area.

8.5.13 Horizontal Sodding Treatment

For Sodding 30–40 cm square slabs of local grasses are excavated from the nearby area along with their root system and soil. The grass sods are contour on the slopes. The sod treatment can also be given in a checkerboard fashion on the slope. The sods are pressed so that the roots of the grasses are in close touch with the soil of the slope for the successful establishment.

8.5.14 Brush Wattle

Contour-wattling is the placing of bundles of brush wood (twigs) in a prepared trench and buying them across the slope at regular contour intervals resulting in a lightly terraced slope. All work starts at the base of the slope. Wattles are constructed by the laying of fresh brush wood (branches) in alternate directions to form a bundle 20–30 cm in diameter.

8.5.15 Brush Layering

Brush layering is useful for slopes that are over steepened that will benefit from reduced slope angle. A flat bench is excavated by hand using pickaxe and shovel, at the base of the slope. The bench is extended to the full length of the slope, usually meter in width having reverse slope of about 10 %. The brush wood is placed side by side (about 10 cm apart) on this bench with the tips facing outward and with a 15 cm overhang.

8.5.16 Hedge Layering

In the case of brush-hedge layering the treatment is the same as described for brush layering above with the only difference that along with placement of brushwood, rooted seedlings of tree species suitable for the area are also placed at 30–60 cm spacing. It ensures the establishment of the live hedges.

8.5.17 Brushwood Fence

For establishing brush wood fences, trenches are excavated along the slopes as is done for brush wattles construction. Pegs having 80–100 cm length and 10 cm diameter are prepared from the poles of tree species, which have the quality of vegetative propagation. Pegs are driven in the centre of the trenches as 50–70 cm spacing. Fresh flexible branches are woven around the fixed pegs alternately as is done for preparing baskets.

8.5.18 Semi-dead Fence

The brush wattles, brush layering, brush hedge layering and live brush fences treatment can be given only in dormant season (winter) or early spring. Some time it becomes necessary to start the slope stabilization in the active season. In such situation, dead brushwood fences can be used for temporarily fixing the loose soil before planting. The brushwood of any species easily available can be used for establishing the fences with the fresh pegs of willow.

8.5.19 Live Hedges

The slopes which are not too steep can be stabilized with lives hedges of different grasses species. Different large bunch farming grasses can be used to establish hedges along the contour on the critical slope which act as mechanical carrier. The selection of grasses can be made according to the soil condition and ecological zone of the site. The successful hedges can be established of the following grasses.

8.5.20 Hedges of Farming Grasses

The slopes which are not too steep can be stabilized with lives hedges of different grasses species. Different large bunch farming grasses can be used to establish hedges along the contour on the critical slope which act as mechanical carrier. The selection of grasses can be made according to the soil condition and ecological zone of the site. The successful hedges can be established of the following grasses.

8.5.21 Dry Seeding

Seed of the native grass species is broadcasted manually on fill slopes during winter or early spring which can be germinated and established with the moisture of low intensity rains or snow fall. Dry seeding is not successful during summer hot months and monsoon season because the seeds are blown away with strong winds and washed away with the surface runoff with the high intensity rainfall. Dry grass seed and fertilizer is applied immediately after completion of earthwork, while the soil is friable (loose and open). This method can be used effectively even on quite steep slopes.

8.5.22 Hay Seeding

The second method for sowing of grasses is by spreading hay along with seeds on the critical slopes. The grasses are cut when the seeds are mature and spread manually on the slopes. The hay act as mulch by conserving moisture and protect the loose soil on the slopes from raindrop splash erosion and at same time protect the seed from washing away with runoff.

8.5.23 Narri (Arundo donax) Hedges

One of the common and successful grass species is Arundo donax which is commonly used on the landslides and the critical slopes. The species is tested and have potential for using it for establishing hedges on the critical slopes.

8.5.24 Mot Grass Hedges

Hedges of mot grass are established by panting its tufts/cuttings in the trenches excavated horizontally along the slope. In the active season only tufts should be planted while in the dormant season cuttings can also used for establishing hedges. Comparatively large size trenches are excavated for collection and conservation of water for establishment of most grass as it requires more moisture. Before excavating the trenches stones will be removed and placed on the downhill side of the trench.

8.5.25 Kana (Saccharum munja) Hedges

Kana (Saccharaum munja) is another tough grass which grows naturally in different parts of Pakistan under varied climatic and soil conditions. It is fast growing and is palatable at very young stage but after 2 months of growth it becomes tough and is not palatable. There are many species of Saccharum which grow in different ecological zones.

8.5.26 Vetiver Grass Hedges

The role of Vetiver grass in soil conservation particularly in tropical countries is well known. India is pioneer in introducing the Vetiver grass for soil conservation in the different countries. Vetiver (Vitiveria zizanioides) is a unique grass with its penetrating root system that extends vertically down underground up to 3–4 m depths thus offers an equivalent if not faster and better alternative for trees.

8.5.27 Planting of Cuttings/Root Shoot Cuttings

Poplar and willow are mostly propagated through cuttings. The seedlings (nursery plants) of local poplar and willow species are not available. It become necessary to plant cuttings of polar and willow species. Populous ciliate, Palba, Pnigra are mostly planted with the cuttings.

8.5.28 Sowing of Tree Species

It is better to sow the native tree species along with the planning of the fast growing tree species. In the scrub zone sowing of Acacia modesta, Dalberia sissoo, Dodenaia viscose is successful and their seed should be sown in the same pits used for planting of fast growing tree species.

8.6 Conclusion

Natural processes like earthquakes and rainfall have their role in initiating the landslide problem. Landslide is a general term for all those processes, which induced transportation of materials in response of external and internal forces. Landslide occurs as a result of changes, either sudden or gradual, in the composition, structure, hydrology, or vegetation on a slope. The landslide hazard is a common phenomenon in Pakistan. The most landslide prone areas in Pakistan lie in Himalayan region. Hilly areas are honeycomb for population which creates immense pressure on natural resources particularly on the land resources. Improper infrastructure schemes, housing, deforestation, overgrazing and inadequate agriculture practices are those primary causes which destabilized the slope and as a result landslides occurs in these areas. These landslides not only damage life, property and environment, but also cost huge economic lost due to damaging the communication and infrastructure network systems. Landslides are a major threat each year to human settlements and infrastructure, and cause more property loss than any other geological event.

Landslides in Pakistan frequently cause losses of life, destruction of houses, roads, crops, and various other properties. In recent times the unscientific exploitation of the Himalaya, deforestation, and discriminate construction, mining and quarrying activities have combined with its immature and complex geology, seismic activity and heavy rainfall and flash floods to create slope instability problems never witnesses before. During the rainy season, landslides take place along the highways built in the mountain terrains such as the Murree hills, Pir Punjal and Hindu Kush. There is no systematic and detailed study to determine the extent of the problem has been undertaken in Pakistan. The direct impacts of steep-slope failure or landslides in the mountainous part of Pakistan are the loss of life, the collapse and partial destruction of houses and their infrastructure, the frequent disruption of roads and other means of communication, damage to pipe lines, irrigation channels and connecting links of water resource system, and sometimes the entire human settlements. Apart from the rapid flowage which are sudden movements, and which cause to the collapsing of houses, there are some slow flowage movements like soil creep occurring in the area, which slowly and steadily destroy the houses right from their foundations. The federal forest, highway and mining departments are undertaking research and programme to prevent different types of landslides through engineering measures and regulations etc. Afforestation is very important, because for the Himalayan slope surface to be stabilized. Landslide bioengineering management is the use of engineering principles and designs for landslide hazards management through biological methods (medium). The soil bio-engineering is use of living plant material to do some engineering work. Whereas vegetation covers (Biological Methods) stabilize the slopes.

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Chapter 9
Desertification Risk Reduction Approaches in Pakistan

Amir Nawaz Khan and Amjad Ali

Abstract Desertification is a serious global problem and more acute in the case of Pakistan. In Pakistan almost 3/4th of the land is either already affected or likely to be affected by it. Desertification process has been active since historical times in areas now-a-days constituting Pakistan. Amongst the factors affecting desertification in Pakistan, the fundamental factor is population pressure. Other major immediate physical cause of ecological degradation includes: excessive felling of trees, inadequate reforestation activities, inappropriate cultivation practices in hilly and rain fed farming area, uncontrolled and excessive livestock grazing in forest and rangeland. Inadequate efforts with regard to watershed protection and management in the catchments areas of reservoirs lead to sever soil erosion. Irrational irrigation practices also enhance land degradation. As a result of such activities vegetation cover is destroyed, and it also leads to prevent regeneration of grasses and trees etc.

The Desertification occur in both rain fed as well as irrigated lands. Pakistan is mainly a dryland country, where 80 % of its land is arid and semi-arid. Two-third of its human population depends on these drylands to support their livelihood. Like many other developing countries, Pakistan is severely affected by land degradation and desertification. Unsustainable land management practices are causing enormous environmental problems, including soil erosion, loss of soil fertility, flash floods, sedimentation of canals and water courses, deforestation and associated loss of carbon sequestration capacity and biodiversity. In recent years, number of Federal and provincial agencies are engaged to combat desertification. However, the efforts made by the originations and departments along with non-government organizations hardly fill the gap between its increasing intensity and disaster risk reduction measures to control desertification.

Keywords Desertification • DRR • Land degradation • Dryland

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*, Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_9

9.1 Introduction

Desertification is a process or set of processes which cause diminishing of the biological potential of land which ultimately lead to desert like conditions and complete loss of production and resources. The resources include land use and land cover, crop production, forest cover, livestock, soil etc. The phenomenon of desertification is a gradual deterioration. It is therefore not easily identified with accuracy and precision. That is the reason that amounts of desertification are not easily estimated, as at least a decade may be required effort it can adequately be distinguished from drought. However, the annual loss of land is thought to be about 60,000 km^2 distributed among about 100 countries. Of these countries, 27 are in Africa, and since 1925 on the southern fringe of the Sahara more than 650,000 km^2 of land has ceased to be productive. It is estimated that 600–700 million of the world's population live in areas of threatened dry lands, whereas more than 60 million people are already affected by desertification. To a greater or lesser extent, one third of the land surface and one seventh of the population of the world are affected directly. But the rest of the global population must bear the indirect effects of diminished food production and increased suffering which must be alleviated by international aid. As the phenomenon is one of gradual deterioration, it is vital that it be monitored effectively in order to detect serious changes as they occur. Sequential satellite image can help to do this. Agriculture production figures are also useful for determining the location and severity of desertification. It is estimated that desertification costs the world economy at least 26,000 million dollars each year. It is also estimated that it could cost 90,000 million dollars to halt current towards ever greater loses of land productivity. It has also been observed that each incidence of desertification needs as individual strategy to ameliorate it. In much degraded dry lands, retrenchment may be the only solution and recovery may be out of the question in the short term. In less damaged ecosystems rotational cropping, redistribution of ownership rights, fallowing, careful ploughing or the establishment of irrigation may be appropriate strategies. If land is so damaged that it cannot be put to productive use, then proportionately more investment will be required. Unfortunately, unless there is considerable out mitigation, the pressure of population on the land may remain the same during this period (Brown et al. 2008; Kolmannskog 2008; United Nations Decade for Deserts and Fight against Desertification [UNDDD] 2014; United Nations Environment Programme [UNEP] 2014).

The decline of Indus valley civilization with great cities of Moenjodaro and Harappa has been attributed to prolonged process of desertification. In more recent time, with all the modern technologies in land, the process has been once again activating taking heavy tolls on the economic and social life of the area. Amongst the factors affecting desertification in Pakistan, the fundamental factor is population pressure. Other major immediate physical cause of ecological degradation includes: Excessive felling of trees, and inadequate reforestation activities, uncontrolled and excessive livestock grazing in forest and rangeland. As a result of such activities vegetation cover is destroyed, and it also leads to prevent regeneration of grasses and trees etc. Some other causes of such ecological degradation include inappropriate cultivation practices in hilly and rain fed farming area (Ahmad et al. 2004; Akbar et al. 1996; Khan 2010).

Out of 79.6 million ha total land of the country, only 20 million are suitable for agriculture (16 million for irrigated farming and 4 million for rain fed agriculture). About 5.2 % of Pakistan's land area in covered by forests, whereas both environmental and economic standards suggested that the country should have at least 20–25 % area under forests. Around 3 % of forest cover is shrinking annually and woody biomass by 5 %, further aggravating the desertification process. About 11.2 million ha mostly northern mountain regions are affected by water erosion. As a result, 40 million tons of sediments are brought into the Indus basin each year, which has reduced the soil productivity in the area and shortens the lifespan of major upstream reservoirs. According to an estimate, about 2 million ha are affected by water logging and around 6 million ha by salinity and sodicity. These problems are more acute in some irrigated areas of Punjab, Sindh, and Baluchistan resulting into low soil fertility, decline in crop yields, and loss of biodiversity. About 3–5 million ha of land is affected by wind erosion in arid regions of Punjab (Cholistan), Sindh (Tharparkar), and Balochistan (Chagai Desert and sand areas along the coast). Some of the areas have 0.5–4 m high moving sand dunes, posing danger to cultivation land and local infrastructure. Almost 60 % of the country is classified as rangelands. According to an estimate about 48 % of rangelands are degraded. Degradation of rangelands reduces ecosystem functions and services. It affects local livelihoods and increases poverty (Akram 2012; United Nations Combat to Desertification [UNCD] 2011; Akbar et al. 1996).

9.2 Major Causes of Desertification in Pakistan

In Pakistan, land degradation mainly encompasses deforestation and desertification, salinity and sodicity, soil erosion, water logging, depletion of soil fertility and negative nutrient balances.

9.2.1 Deforestation

Pakistan has a total forest area of about 12 million ha. Out of that, the total forest, scrub, and planted trees spread on 4.2 million ha, natural and modified coniferous scrub, riverain and mangrove forests spaced 3.5 million ha, tall tree forests encompass 2.4 million ha, scrub forest exist on 1.1 million ha, and plantations occupy 0.7 million ha. The forest area of Punjab is only less than 3 % per cent whereas in Sindh it becomes even half of that. The continuous destruction of forests is causing a substantial loss. The declining rate of woody biomass is the second highest in the world. It ranges between 4 and 6 % per year. Almost 7,000–9,000 ha are deforested every year and this rate is especially severe in the north where the per capita consumption for fuel wood is 10 times higher due to the ruthless winters. Due to increase in population, the consumption of household firewood would probably go up to 3 % per year. Pakistan's woody biomass may be totally consumed within the next 10–15 years. The lopping of trees for commercial purposes has also greatly accelerated forest depletion. Unrestricted livestock grazing is also a severe threat. Regional case studies also portray a dismal picture. About 5.2 % (4.2 m ha) of Pakistan's total area is under forests. Pakistan is losing forests at a 3 times the rate of other South Asian countries. About 3.1 % of forest cover is being lost every year and woody biomass is disappearing at an annual rate of 5 % as the majority of households continue to use firewood for cooking and heating (Food and Agriculture Organization of the United Nations [FAO] 1989; Khan Forthcoming Nov 2014).

Illegal and excessive chopping of trees has resulted in severe soil erosion, flood damage and desertification in many areas. This activity leaves the soil exposed and less able to absorb rainfall which does occur. Water, therefore, runs off and causes soil erosion, speeding-up the process of denudation and eventually leading to desertification. The removal of top soil is also resulting in low production of forage, fodder, fuel wood, timber, cereal crops and grains and, as a result, exacerbating poverty (Atta-ur-Rahman and Khan 2013; Khan 2010).

A study of the Siran project area, Hazara, Khyber Pakhtunkhwa, shows a 52 % decline in the resource between 1967 and 1992. Similar cases are present in the Kaghan Valley and Allai Valley. The mangrove forests of the Indus Delta has halved from 2,600 km^2 in the late 1970s to 1,300 in the 1990s, due to the grazing by camels. Almost 50 % of the original riverine forests have been degenerated beyond economic viability. More than 60 % of the natural grazing areas of the country have production levels lower than one third of their biological potential. More than one-third of the country area has been classified as under risk of desertification. Deforestation, over cultivation, excessive cutting of fuel wood and incorrect irrigation practices all have a share in this problem. The data reported for a 5 years period, from 1997–1998 to 2001–2002, revealed that the extent of area afforested and regenerated is more or less stagnant as it only increased 3,900 ha from 21,400 to 25,300 ha (The United Nations Educational, Scientific and Cultural Organization (UNESCO) 2009; UNCD 2011; FAO 1989; United Nations Environment Programme [UNEP] 2014).

9.2.2 Poor Irrigation and Drainage Practices

Pakistan has one of the largest canal irrigation systems in world and this system operates on the principles of flood irrigation. The overall poor management of irrigation, both at the system and farm levels, is contributing to water logging and salinity in cultivated areas. Excessive percolation of water from the canal system builds up the ground water level. Human activities such as the obstruction of natural drainage through construction of roads, improper alignment and poor maintenance of irrigation channels, insufficient drainage of excessive rainwater etc. all add to water logging problems. About 11 million ha of arable land in Pakistan is affected by water logging, while over 3 million ha are affected by salinity and sodicity. In majority of the soils of plains in Pakistan, the rainfall is usually low and the evapotranspiration is higher than the annual precipitation resulting in buildup of salts in the soil profile and their accumulation on the soil surface. At country level, 6.28 million ha of area is affected with salinity and sodicity. The majority of salt-affected soils are saline-sodic in nature. These salt affected soils are causing potential reduction in yield (Akram 2012; Khan 1993a; UNESCO 2009).

9.2.3 Soil Erosion

Soil erosion implies loss or removal of surface soil material through the action of moving water, wind or ice. The total area affected by water erosion is 13050.2 ha. Area affected by different types and extent of water erosion in Pakistan are 61,200 ha, 3,635,000 ha, 5,640,700 ha 3,446,500 ha with slight (sheet & rill erosion), moderate (sheet & rill erosion), severe (rill, gully and/or stream bank erosion) very severe (gully, pipe & pinnacle erosion), respectively. About 13.05 million ha of area is affected by water erosion and about 6.17 million ha is affected by soil erosion. Soil erosion is taking place at an alarming rate and is mainly due to deforestation in the north. Water erosion is prominent on steep slopes such as the Potohar track and surrounding areas, an area extensively used for cultivation. The highest recorded rate of erosion is estimated to be 150–165 tones/hectare/year. The Indus River carried the fifth largest load of sediment (4.49 t/ha) in the world in 1990. According to some estimates the Indus is adding 500,000 tons of sediment to the Tarbela Reservoir every day, reducing the life of the dam by 22 % and the capacity of reservoir by 16 %. Wind erosion has a relatively lower impact than water erosion. However, the combination of the two is more devastating. This reduces the productivity of the land by 1.5–7.5 % per year. This affects almost one-fifth of the Punjab (Shah and Arshad 2006; Bell 1999).

9.2.4 Water Logging

The total affected area by waterlogging in Pakistan is 1,427,200 ha. In cultivated areas of Pakistan, the water table depth 100–150 cm and 50–100 cm covered area is 318,300 ha and 292,800 ha, respectively. In uncultivated area with water table depth less than 150 cm the covered area is 142,700 ha. The figures are based on the surveys which were completed about 15 years ago. It appears that problem of water logging may not be as serious now as it was in the past. The problem has reduced due to prolonged drought and excessive mining of ground water (Akram 2012; Khan 2010; UNEP 2014).

9.2.5 Depletion of Soil Fertility and Negative Nutrient Balances

The fertility status of Pakistani soils is rapidly depleting. The data generated by the public and private organizations in the country reflect the general agreement about the deficiency of nitrogen in 100 % soils. Same is the situation with organic matter content, which is on around average 0.5 % only. In case of phosphorus, more than 90 % soils are deficient. Potassium deficiency in Pakistani soils, which was not a soil fertility problem earlier, is increasing rapidly due to the discriminate use of only nitrogenous and phosphatic fertilizers. Various public and private organizations in the country are reporting a soil potassium deficiency in the range of 20–40 %. For that reason, Nitrogen, Phosphorous, Potassium (NPK) formulations for various crops have also been introduced in Pakistan. Among micronutrients, field scale deficiencies of economic significance prevail in case of zinc, boron, and iron. The nutrient balance in Pakistani soils reflects a severe mining trend. All the provinces show negative nitrogen balance, although in Punjab the deficit is declining. Over the decade, negative phosphorus balances did not change significantly in Punjab but worsened in the other three provinces. In 1985–1986, the level of deficit was highest in Punjab. However, in 1995–1996 they were all fairly similar. Potash balances deteriorated over the decade (FAO 1989; Khan Forthcoming Nov 2014; UNCD 2011; Khan 1993b).

The estimated loss of productivity as a result of land degradation is US $ 353 million annually, and the loss to rangeland productivity is between US $ 90–160 million/year. All of the above environmental issues are summarily heading Pakistan towards more economic instability. According to a conservative estimate, the impacts of degradation and biodiversity loss on productivity and public health are in the tune of 3 % of GDP per year. It would be higher if toxic waste disposal, biodiversity, river and coastal resource depletion were taken into account. It is therefore very necessary for the sustainable economic future of Pakistan and a friendly environment to cope with land degradation problem on war-footing bases. Productive lands and healthy environment are the only gift worth passing to our next generations (Bell 1999; Khan 2010; Shah and Arshad 2006; UNISDR 2004; UNDDD 2014).

9.3 Desertification in Rain-Fed Areas

The total area under rain fed cropland in Pakistan is about 5 million ha which is about one fourth of the total cultivated area in the country of these 3.2 million ha in sub-humid regions. Over the past two decades approximately 25 % of the rain fed cultivated area has decreased due to erosion, and introduction of canal irrigation system. Soil erosion in the rain fed and hilly areas is big problem which limits the agricultural production. Due to water erosion in northern uplands, millions of tons of fertile top soil is getting washed away, where as in southern areas, shifting of sand dunes due to wind storms, damages crops, chocks up water courses and blows away fine particles of sand leaving behind infertile sandy wastes. It is estimated that there is a total of 1.2 million ha of eroded land at present in the country (Akbar et al. 1996; Alan and Macdonald 2012).

9.4 Desertification in Irrigated Lands

The total area under irrigation in Pakistan is about 15 million ha, out of this irrigated land 9.6 million ha is arid, 3.8 million ha is semi-arid, 1.0 million ha is sub humid and the remaining 0.6 million ha is in transitional climatic zones. Desertification is affection irrigated ecosystem in the form of water logging and salinity. The extensive and continuous use of surface irrigation has altered the hydrological balance of the Indus basin by substantially raising the ground water table. The water table has risen to within 6 ft over 25 % of the basin and to within 10 ft in over 1/3 of the entire Indus plain. This is the outcome of perennial canal irrigation which was introduced to combat aridity. With perennial canals it possible to water the crops whenever the need was felt. As a consequence of seepage of water from the unlined canals and the percolation of water from the irrigation field, the water table began to rise. When the water table rose to 5 ft below the surface, the saline water reached the surface by capillary action. With a further rise of water table, water logging took place. It is estimated that 26 % of the irrigated area of Pakistan is affected by salinity, of which 8 % is severely affected. Sindh is the worst affected province where 48 % of the soil is saline, of which 18 % is strongly saline. As a whole in Pakistan more than 40,000 ha of irrigated land are lost each year to agricultural production due to water logging and salinity. They vary from season to season and year to year, depending in past on the strength of the monsoon and the spatial and temporal distribution of rainfall (Akram 2012; Asian Disaster Preparedness Center (ADPC) 2008; Shah and Arshad 2006; Government of Pakistan (GOP) 2007).

Crop damage varies according to the water and salt sensitivity of the particular plant. Now within these limitations, surveys conducted by WAPDA in 1980s revealed that about 21 million ha of land has been severely affected by water logging. The total population affected is about 3 ½ million. Salinity has also taken heavy toll by affecting about 4.2 million ha of land. According to 1980s WAPDA surveys 1.3 million ha of 4.2 million ha is very strongly saline. Pakistan cannot effort this kind of deterioration of land in the wake of fast growing population. Therefore, it is important not only check further growth of water logging and salinity of land but to reclaim the land already damaged. As a remedial measure it has been decided to bring down the salinity below the danger level and to flush away the salt from the soils. For this the country has been divided into a number of salinity control and Reclamation Project zones (SCARP). The reclamation work has been started phase-wise. The water table is lowered by pumping water out by tube wells. This plan proved a success but brought in its wake other problems. Ground water in some areas, particularly sindh is saline. It cannot be used for irrigation; therefore, it cannot be drained into the canals. The safest way of disposal is to drain the water into the sea. This involves new engineering problems and added cost. In addition to this tube well installed began to wear out in a few years. They needed repair and in some cases installation of new tube wells was required. Furthermore installation of thousands of tube wells resulted in a heavy pressure on electricity which is already in short supply. Long spells of load shedding also create problems. Above all the whole plan involves a heavy expenditure, but the work of SCARP is continuing as no better alternative is known (GOP 2010a, b; GOP 2013; Shah and Arshad 2006; UNESCO 2009; UNISDR 2004).

Besides WAPDA the activities of the Punjab Land Utilization Authority (PLUA) also follow the same premises. PLUA is undertaking efforts to rehabilitate, or otherwise return to economic use approximately five million in most cases is crop land abundant due to water logging or salinity. The PLUA's charter does not preclude activities designed to facilitate waste land utilization for purposes other than crop agriculture. However, the forest department differs with this view. Forest officials argue that various tree species could grow on land no longer suitable for crop cultivation because of water logging and salinity. However, no serious official attempt has been made so far to assess the technical potential for, and the economics of, farm forestry on such land, and to weigh this against the cost and benefits of further capital intensive reclamation for crop cultivation. It is important to note in this context that a significant number of the owners of land reclaimed under PLUA projects have in fact, for technical as well as economic reasons, switched from wheat cultivation to various farm forestry and orchard operations, including the bamboos and the establishment of tree nurseries. It might, therefore, be worthwhile to try same in other areas as well (Akbar et al. 1996; Khan 2010; Khan 1993a, b).

9.5 Desertification in Rangeland

There has been an adverse effect on rangeland due to overgrazing. The ecological system throughout the rangeland has a very fragile set of relationships which can be easily disturbed. Since generations Man's livestock in the area through overgrazing have reduced some species of plants. As a result recovery is no longer possible in the short run and desertification is imminent. It has been suggested that the area most seriously affected by this process are those closest to watering points, because livestock must come regularly to drink water, especially during the hot season (Johnson 1979). Unfortunately in the arid zone, man's technological skill has sometimes outrun his ability to consider the consequences of his actions. After, about 40 years of experimentation and reviews, there still is no effective leadership for managing the country ranges and natural pastures and very little effective activity in this respect. A number of range management and improvement projects were initiated in the 1950s and early 1960s. But by the end of 1960s almost all projects had ended in virtual failure in large parts. The failure was because of the fact that these projects were over ambitious, lacked clear objectives, and paid inadequate attention to prevailing socio-economic constraints. The single most important cause of failure was, in fact, sociological rather than technical: i.e. inability to deal effectively with the human population of the ranges, rather than the absence of, or inability to apply, technical solutions. In May, 1973, a National Range Management Committee issued a comprehensive report, containing wide-ranging recommendations for both the short and long-term:

(i) Promulgation of a comprehensive National Range Policy and Provincial Range Management Acts,
(ii) Creation of provincial Range Management Agencies
(iii) Assignment of co-coordinative lead function to I.G. forest, and creation of a Directorate of Range Management in the I.G. forest's office.
(iv) Establishment of a Federal Range Management Fund for preparation and implementation of range management schemes.
(v) Formation of grazing associations to facilitate effective range management.
(vi) Effective training, education and research in the range management.
(vii) Effort to reduce unproductive live stock.
(viii) Improvements in livestock and livestock products marketing
(ix) And establishment of a livestock feed industry and livestock feedlots.

Although some steps were taken to implement a few of these proposals, most of the major recommendations have never been implemented. There is no effective co-ordination among the various agencies involved. Funding for range management and improvement remains extremely limited, Livestock numbers have increased further and the sector's productivity and contribution to national income has declined further (Akbar et al. 1996; Collins 2009; Khan Forthcoming Nov 2014; Shah and Arshad 2006).

9.6 Rolling Sandy Areas in Pakistan

A considerable part of Pakistan is occupied by wind reworked sand. The notable rolling sandy areas are: Cholistan (1.8 million ha) Punjab Province; Thal Doab (2.3 million ha) Punjab Province; and Thar (2.8 million ha) Sindh Province. Other similar desert patches are D.I. khan in Khyber Pakhtunkhwa and the Kharan dessert in Baluchistan. The surface relief of these areas generally comprises of variety of sand dunes. The sub-soil water over most of the area is brackish and is unfit for agriculture and for human or livestock consumption. The average annual rainfall varies from about 80 to 200 mm. The rainfall is mostly collected in ponds to sustain livestock for a short period and on its drying the livestock is moved to settle areas. The people in these areas live in small hamlets and their main profession is livestock grazing. The potential of rangeland and other development in these areas is very low because of the moving nature of the sand dunes. Moving sand dunes are a major threat to settlements, agriculture land and physical infrastructure facilities in Pakistan (Ahmad et al. 2004; Akbar et al. 1996; Shah and Arshad 2006).

In a number of locations, successful efforts have been made to stabilize shifting dunes by planting suitable species of shrubs and grasses in the inter-dunal spaces, on the leeward and windward dune slopes. The species used have demonstrated a considerable ability to withstand drought and to regenerate naturally, once they have firmly taken root. The technology developed is effective and replicable on a large scale, provided funding and labour are available. The cost/acre is not very high, but the areas still requiring treatment are extensive. Where successful work has been undertaken, the local population is convinced of its benefits, interested in further dune stabilizing, and willing to co-operate in protecting newly planted areas against grazing and firewood extraction. It would be desirable to continue further dune stabilization work. For achieving successful results however, it is necessary that firstly, a thorough evaluation should be carried out of past and ongoing projects, to search for more effective techniques under different conditions, and find the cost effectiveness of approaches alternate. Secondly dune stabilization efforts should be combined with effective efforts to introduce sand range management techniques in the adjoining range areas, where increasing desertification causes dune creation and movement, so as to permit range vegetation to regenerate naturally and provide resistance to further wind erosion. Thirdly the local population is the area to be treated should be effectively mobilized both for providing the labour needed for initial planting and for subsequent maintenance and protection of the stabilized areas and adjoining range lands (Akbar et al. 1996; UNESCO 2009; UNEP 2014; UNCD 2011; UNISDR 2010).

9.7 Measures for Combating Desertification

The Government of Pakistan has adopted medium and long term DRR measures to control desertification. Different projects have been lunched for DRR measures to control desertification by various agencies organizations and departments at Federal and provincial levels. The important organizations and departments at Federal and provincial levels involved in DRR measures to control desertification are: Pakistan Agricultural Research Council, Pakistan Council of Research in Water Resources, Water and Power Development Authority, Forest Departments, Irrigation Departments, Agriculture Departments, Sindh Arid Zone Development Authority, Cholistan Development Authority, Arid Zone Research Institute, Drainage and Reclamation Institute of Pakistan, Pakistan Desertification Monitoring Unit, Soil Conservation Departments, Agricultural Universities, Irrigation Research Institute, Center of Excellence in Water and Resources Engineering, National Institute of Agricultural Botany etc. These measures of DRR for desertification can be summarized as afforestation; soil and water conservation; reclamation of salt affected and waterlogged areas; and range development and sand dune stabilization (GOP 2010a, b, 2007, 2013; Shah and Arshad 2006; Bokhari 2014; Khan 1993a, b; UNISDR 2010). Some of the examples of these DRR measures for desertification are discussed as below:

(i) Afforestation and reforestation through planting more trees that reduced the negative impacts of climate change and slowly reduce the desertification.
(ii) Watershed management for control of soil erosion in mountainous areas of Pakistan.
(iii) Combat the effects of the wind by constructing barriers and stabilizing sand dunes with local plant species
(iv) Restore and fertilize the land by preparing compost with organic matter. Composting is a simple and cheap way to fertilize and regenerate the soil.
(v) Creation of a desertification prevention culture through awareness raising and change in attitudes
(vi) Protection of vegetative cover to prevent wind and water erosion
(vii) Introduction of policies that create incentives for rehabilitation of degraded land such as capacity building, capital investment and institutional support.
(viii) Community involvement in planning and implementation of rehabilitation programs
(ix) Promotion of integrated land and water management practices
(x) Promotion of Sustainable Land Management options

9.8 Conclusion

Desertification is the persistent degradation of dryland ecosystems. It affects the livelihoods of millions of people. In 2000, drylands, which occupy 41 % of Earth's land area, were home to a third of the human population. A significant portion of drylands are already degraded, and the ongoing desertification threatens the Pakistan's poorest populations and hinders the prospects of reducing poverty. Therefore, desertification is one of the greatest environmental challenges today. It is a major barrier to meeting basic human needs in drylands and leads to losses in terms of human well-being. The causes of desertification include social, political, economic, and climatic factors that contribute to an unsustainable use of scarce natural resources. The magnitude and impacts of desertification vary greatly from place to place and change over time in Pakistan. A wide gap remain in our understanding and monitoring of desertification processes, gaps which sometimes prevent cost-effective actions in affected areas. Pakistan is blessed with diverse physiographic, climatic and cultural conditions. This situation leads to all environmental degradation agents for desertification. Although, number of organizations and departments at government as well as at non-government level working for remedial measures of desertification. However, the variety of causes and socioeconomic conditions certainly restrain the effects of these measures of DRR.

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Chapter 10
Sea Level Change, Causes and Impacts: A Case Study of Pakistan

Shamshad Akhtar

Abstract Sea level change is not a new phenomenon. Sea-level rises and falls locally for short duration due to tidal effect, storm surges and generation of tsunami. Glacio-eustatic and tecto-Eustatic mechanisms have remained important to explain long term global and local changes in sea-level. The phenomenon of global warming due to human induced greenhouse gases and resulting sea-level rise has gained attention during last three decades particularly after the release of IPCC assessment reports. Environmentalists by and large have consensus that sea-level rise is a serious concern for coastal environment and human settlements. Like other coastal countries sea-level rise phenomenon is also a concern for the coastal environment of Pakistan but its intensity of danger is much less as compared to low-lying coastal countries and islands like Bangladesh and Maldives. Pakistan has about 1,600 km long coast. Several geomorphological and archaeological evidences confirm the glacio-eustatic and Tecto-Eustatic change of sea-level in the Pleistocene and the Holocene epoch. The evidences of current sea level rise reveal that tectonic mechanism and intrusion of sea in the deltaic region of the River Indus is due to reduction of river inflow not because of global warming phenomenon, are the main factors of sea-level change along the coast of Pakistan.

Keywords Sea-level change • Glacio-eustatic • Tecto-eustatic • Global warming

10.1 Introduction

During the last three decades environmentalists have shown deep concerns over the global and local phenomenon of sea level rise. They have considered it a disaster for human settlements and coastal environment. This aspect of sea level change gained much attention when Intergovernmental Panel on Climatic Change (IPCC) first presented his assessment report in 1990 about global rise of mean surface air temperature and consequently global rise of sea level (IPCC 1990). According to IPCC reports

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_10

issued 2007 global mean surface air temperature has increased by 0.3–0.6 °C since the late nineteenth century (IPCC 2007). As a result of melting of glaciers and polar ice sheets global sea level has risen by 15–20 cm over the past 100 years and much of the rise may be related to the increase in global mean temperature. The IPCC reports were criticized and serious questions were raised by climate scientists on the reliability of data and models used by IPCC researchers about global warming and consequent sea level rise. Despite the controversies in IPCC findings about sea level rise the topic of sea level rise has remained important for researchers particularly in collection of evidences and explaining Pleistocene and Holocene glacio-eustatic and tectonic causes of sea level change and its impacts on coastal environment.

10.2 The Mechanisms of Sea-Level Change

The sea level surface is not uniform. It is affected by many short-term influences such as wind-waves or tides. Therefore defining sea level as the mean surface elevation of the sea, the effects of short term variation in sea level must be taken an account. For example atmospheric pressure over the sea surface may affect duration of hours to months cause – 0.7–1.3 m change in sea level (Barnett 1984). Similarly winds (storm surges) may influence sea level from 1 to 5 days cause rise of sea level up to 5 m. Similarly evaporation and precipitation may also change the volume of sea water. Movement of oceanic currents and change in water density may change the sea level up to 1 m from days to weeks (Biham 1991). The factor of El Nino in rising of sea temperature has been estimated up to 0.6 m and retains its effects up to 6 months.

Seasonal variation in sea level has also been noted caused by seasonal water balance among oceans, changes in sea water density caused by temperature and salinity, upwelling currents and discharge of river runoff and flood water, for example River Ganges can raise sea level in the Bay of Bengal by up to 1 m during the monsoon season. The short-term effect of rise of sea level can also be affected by tsunami which is up to 10 m. If the effects of all of these perturbations are excluded then any long-term progressive variations in sea-level may be observed. In most locations throughout the world such local and short-term factors rise the sea-level roughly 1–2 mm per year (Pethick 1984). The two fundamental causes of progressive long-term sea-level change are:

(i) Tectonic and Isostatic mechanism
(ii) Eustatic mechanisms

10.2.1 Tectonic and Isostatic Mechanism

Relative sea level can change because of tectonic and isostatic movements, resulted upward and downward of the Earth's crust, mountain building, change of shape of oceanic basins, formation of oceanic ridges and subduction of ocean floor etc.

(Bindschadler 1985; Douglas 1991 and Chao 1994). Evidences of neo-tectonic reveal that as a result of tectonic uplift oceanic floors have emerged in ocean as islands and in form of raised beaches. In many coastal areas lands have submerged as a result of earthquakes and sea proceeds toward land. Isostatic movements are adjustments in the earth's crust resulting from loading or unloading of the surface. Areas laden by the accumulation of river derived sediments in estuaries may cause isostatic submergence and rise of relative sea level in the region.

10.2.2 Eustatic Mechanism

The term Eustatic was first introduced by Suess in 1906 when it was assumed that such changes were equivalent throughout the world's oceans, but it is now realized that there have been regional discrepancies in the amount of sea level rise or fall on particular coastlines. Sea level rises when the volume of water in the ocean basins increases and falls when it is reduced. These changes are world-wide because the oceans are interconnected. There are several mechanisms involve in the eustatic change of mean sea level like thermal expansion of sea water, rise of sea-bed due to sedimentation, glacio-eustatic mechanism and current century anthropogenic mechanism of global warming and melting of glaciers and ice-sheets (Flemming 1969; Gornitz 1990 and Flather and Khandker 1993). Let us examine these factors briefly.

10.2.2.1 Thermal Expansion

An increase in atmospheric temperature results in warming and expansion of the oceans, and sea level rises, whereas if the oceans cool they contract, and sea level falls. It has been calculated that a rise of 1 °C in the mean temperature of the oceans would increase their volume so that sea level would rise by about 2 m. Estimates of Pleistocene variations of mean ocean temperature (based on palaeo-temperature measurements on fossils found in ocean floor deposits) are within 5 °C of the present temperature, so this could only account for sea level oscillations up to 10 m (Peltier 1989).

10.2.2.2 Sedimentation

Sea level can also rise because of a gradual reduction in the capacity of the ocean basins resulting from the deposition of sediments carried from the land to the sea, whether by rivers, melting glaciers, slope runoff, landslides, wind action or coastal erosion (Roemmich 1992 and Tanner 1992). For example it is estimated that the River Indus discharges 300 million tons sediments annually into the Arabian Sea while Mississippi River transports three times more sediments into sea (Kazmi 1997). The sedimento-Eustatic rise of sea level is quite slow process. It is estimated that transference of all the land above present sea level into the ocean basins would raise the level of the oceans by more than 250 m, but present estimates of denudation rates account for a sea level rise of only about 3 mm per century (Bird 2008, P. 41).

10.2.2.3 Glacio-Eustatic Mechanism

Major rise and fall of sea level accompanied the expansion and recession of the Earth's ice cover as a result of cold (glacial) and warm (interglacial) phases of climate change in the Quaternary Epoch. These sea level changes are termed glacio-eustatic. During glacial phases the Earth's hydrological cycle was interrupted when the climate cooled sufficiently for precipitation to fall as snow, which accumulated as glacial ice and persistent snowfields in Polar and mountain regions. Retention of large amounts of water frozen on land depleted the oceans, and there was world-wide lowering of sea level. In the interglacial phases water released from melting snow and ice flowing back into the ocean basins to produce a world-wide sea level rise, the sea at times extending above its present level.

More detailed evidence comes from deep-sea cores in which the relative proportion of the two oxygen isotopes in the skeletal material of deep-sea has been analysed. The difference of these two isotopes during cold and warm periods indicates the amount of water removed from the ocean. This indicates the maximum range of fossils coastlines up to 120 m. The exact number of glacial events occurred during the Pleistocene is controversial, 17–20 major glacial and interglacial events have been identified while number of minor events which are called stadia and interstadia have also been identified (Baker 1993). During the Last glacial phase most probably occurred in the late Pleistocene or end of Pleistocene, sea level fell about 140 m, but about 18,000 years ago the polar ice sheets and mountain glaciers began to melt, initiating a world-wide sea level rise. It continued into Holocene times (10,000 years ago) and came to an end about 6,000 years ago when the sea attained approximately its present level.

10.3 Human Induced Sea Level Rise

During the last two decades human-induced factors have been brought main causes of sea-level rise during the last 100 years. The issue of global warming due to man-induced increase of the amount of carbon dioxide in lower atmosphere has been very much focused by environmentalists, resulting rise of global mean sea-level (Alley and Whillans 1991). A part from this global atmospheric factor, minor local factor like extraction of sub-surface water from aquifers in coastal areas has caused of land subsidence and local or relative sea-level rise. This has contributed to a relative sea level rise in the Venice region, and around Bangkok in Thailand. Relative sea level has risen where oil or natural gas has been pumped from underground strata, as in southern California and the Ravenna region in Italy. Similar submergence has occurred due to the loading of coastal land with building structures, land reclamation schemes, construction of artificial islands etc.

10.3.1 Global Warming and Sea Level Rise

Climate scientists agree that the global average surface temperature has risen over the last century (since the end of little ice age in 1880s). Within this general agreement, some individual scientists disagree with the scientific consensus that most of this warming is attributable to human activities. The scientific consensus was summarized after the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) as follows:

(i) The global average surface temperature has risen 0.6 ± 0.2 °C since the late nineteenth century, and 0.17 °C per decade in the last 30 years
(ii) "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities, in particular emission of the greenhouse gases carbon dioxide and methane" (IPCC, 2007)
(iii) If greenhouse gas emissions continue the warming will also continue, with temperatures projected to increase by 1.4–5.8 °C between 1990 and 2100. Accompanying this temperature increase will be increases in some types of extreme weather and a projected sea level rise 9–88 cm

Most of the scientists agree with the first point, they disagree with point no. 2 and 3 (that is cause and the 100-year temperature forecast). Over the IPCC reports on climatic change and sea level rise, a considerable number of scientists have raised questions which can be summarized as follows:

(i) Believe global warming is not occurring or has ceased
(ii) Believe accuracy of IPCC climate projections is questionable
(iii) Believe global warming is primarily caused by natural processes
(iv) Believe causes of global warming is unknown

(i) Believe global warming is not occurring or has ceased

Scientists like Timothy F. Ball, former Professor of Geography, University of Winnipeg believes that the world's climate warmed from 1680 up to 1940, but since 1940 it's been cooling down. The evidence for warming is because of distorted records. The satellite data for example, shows cooling and warming episodes. Temperatures declined from 1940 to 1980 and in the early 1970s global cooling became the consensus. By the 1990s temperatures appeared to have reversed and Global Warming became the consensus. It appears another trend of cooling will occur. The dispute is, what causes and of course the argument that human CO_2 being added to the atmosphere is the cause just simply doesn't hold up (Bromwich 1995).

(ii) Believe accuracy of IPCC climate projections is questionable

Antonino Zichichi emeritus professor of nuclear Physics at the University of Bologna and president of the World Federation of Scientists: "models used by the Intergovernmental Panel on Climate Change (IPCC) are incoherent and invalid from a scientific point of view".

(iii) Believe global warming is primarily caused by natural processes

Khabibullo Abdusamatov, a mathematician and astronomer at Pulkovskaya Observatory of the Russian Academy of Sciences: "Global warming results not from the emission of greenhouse gases into the atmosphere, but from an unusually high level of solar radiation and a lengthy – almost throughout the last century – growth in its intensity" (Bird, 2008)

(iv) Believe cause of global warming is unknown

Petr Chylek, Space and Remote Sensing Sciences researcher, Los Alamos National Laboratory: "carbon dioxide should not be considered as a dominant force behind the current warming…how much of the temperature increase can be ascribed to CO_2, to changes in solar activity, or to the natural variability of climate is uncertain" (Gornitz 1994).

10.3.2 Melting of Glaciers, Ice Sheets and Thermal Expansion of Sea Water

Glaciers and ice sheets are large, slow-moving assemblages if ice that cover about 10 % of the world's land area. The melting back of this ice can lead to indirect contributions on sea level rise. It is estimated that if all the ice in the world were to melt the present day sea-level would rise by 40–60 m (Bintanja 1995). The threat of melting of glacier and rise of sea-level has been much highlighted on the basis of IPCC released data in 2007 that global mean sea level has risen 15–20 cm over the last 100 years. The thermal expansion over the last 100 years is estimated to the 2–7 cm while rise of sea level due to retreat of glaciers and ice sheets for this period is estimated about 2–5 cm. The present sea level rises at rate estimated on the basis of satellite data is 1.8–2.8 mm per year. On the basis of one of the IPCC projected model that sea level would rise up to 38–55 cm by the year 2,100 (IPCC 2007).

10.3.3 Possible Hazards and Challenges of Sea-Level Rise

The IPCC last 100 years estimates and projected forecast of sea-level rise has shown global concerns, challenges and threats of possible environmental hazards on the coastal countries. The United Nations warn nations and Governments of coastal countries to combat this challenge through effective coastal zone management policies. More than 600 million people live in coastal areas that are less than 10 m above the sea-level, and two-third of the world's cities of over five million populations are located in these risk areas. Low lying coasts and islands have serious threats of submergence like coastal areas of Bangladesh, Italy, London, Maldives islands etc. Coastal environments such as beaches, barrier islands, wetlands, and estuarine systems are closely linked to sea level. Many of these environments adjust to increasing water level by moving towards land. Submergence of coastal land, beach erosion, conversion of wet land, present estuaries and creeks into open sea and loss of subsurface aquifers and croplands due to sea-water intrusion and increasing salinity in estuaries are possible challenges that the coastal countries have been facing. Unfortunately many of countries facing these challenges belong to Less-Developed nations have neither resources nor have properly motivations and awareness.

10.4 Sea-Level Change Along the Coast of Pakistan

Pakistan has about 1,600 km long coastal region. The geomorphic and archaeological evidences in the Makran coast, Balochistan and the coastal areas of Sindh reveal that sea-level change occurred in the Pleistocene and Holocene epoch (Snead 1967; Haq 1984; Kazmi 1997). The current rise (during last three decades) in sea-level has been noticed in the Indus estuary, Badin and Karachi. However the causes of these changes in sea-level are local rather than global. The main problem to monitor the mean sea level change during last 100 years is lack of data. Therefore we have to rely on the evidences collected through areal photographic coverage at a scale of 1:40,000 made by the Hunting Survey Corporation in 1952–1954, geomorphological field surveys conducted by Snead (1967), Khan (1979), Kazmi (1997) and archaeological survey of Dales (1960) and Biaji (2006). The author also conducted several field surveys to collect evidences in 1996, 2003 and 2012 in Keti Bunder (Indus Estuary), Karachi Coast, Gadani and Somiani Coast of Balochistan.

10.4.1 Geomorphology of the Coast

The coastline of Pakistan stretches in the west from the Iranian border at the mouth of the Dasht River eastward at the eastern edge of the Indian border at the eastern edge of the Indus delta. Geomorphologically, the coast can be divided into three broad parts (Fig. 10.1). The first part consists of about 168 km of steep, rock cliffs interspersed with small pocket beaches. On the east several mountain spurs come directly to the coast. Farther west uplifted folded and faulted mountain ranges, aligned in an east-west direction parallel to the Arabian sea are being slowly denuded. The second major part comprises 328 km of coastline, consists of wide, sandy beaches backed by extensive desert alluvial plains. Most of these wide

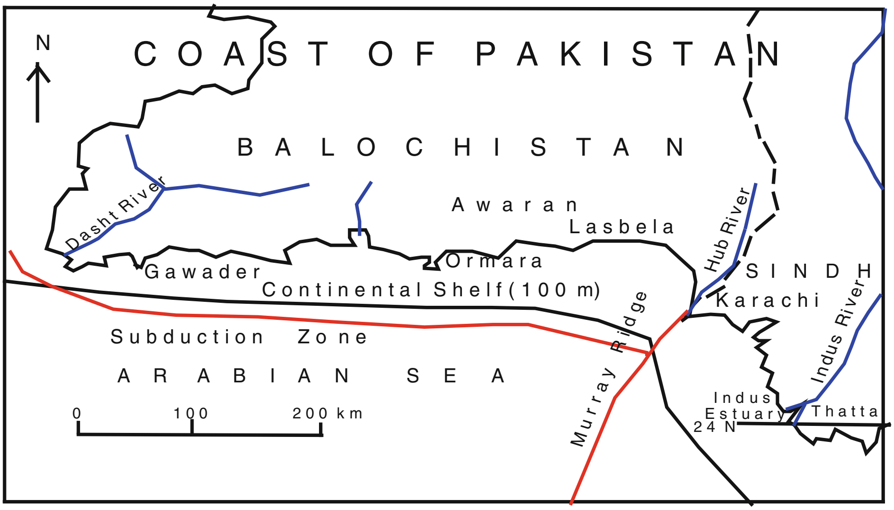

Fig. 10.1 Coast of Pakistan

beaches and plains are found scalloped bays which have formed between the eroded mountain ranges. The third major division is the Indus Delta coastline which is 120 km long. Instead of a network of tidal channels, the finer silts and clays are carried into playa flats and shallow lagoons and coarser sediments from dunes and sand flats. Outside the large Indus Delta plain there are two very arid plains extending inland from the Makran coast. One of these is the Las Bela Valley, some 30 km west of Karachi. The other plain, near the Iranian border, is the Dast River plain, which is 30 km wide at the coast and extends inland over 150 km.

10.4.2 Tectonic Evidences of Sea-Level Change

Evidences of uplifting in the tertiary and quaternary landforms have been associated with Himalayan orogenic system and subduction of sea floor which continues till today. Evidences of uplift are most striking in the large individual fault blocks which had risen as islands directly off the coast. Two of these massive blocks had subsequently been connected to the coast by tombolos. One of these is called Ras Ormara and other fault block is called Gawader, rising to an elevation of 476 ft, is also connected to the mainland by a large tombolo. Two small rocky islands formed off the Makran coast as a result of the November 1945 earthquake. Snead (1967) reported that along with anticlinal folding and scattered fault blocks, horizontal rock platforms had been uplifted. Pleistocene shell conglomerates and sands lie on the series of tertiary rocks. Near the Hingol River there is strand platform capped by a resistant shell conglomerate that had been uplifted to about 85 ft above present sea-level. Across the surface of this platform, numerous shells and barnacles are attached. Without dating of marine benches on most of the headlands time of deposition and uplift is difficult to mention. In the south end of Haro ridge recent un-weathered oyster beds exist 10–14 m above sea level can be correlated with similar oyster beds exist 3–4 m above sea level northeast of Sonmiani, and 2–3 m above sea level near Karachi. All three sites possibly pertain to Pleistocene and Holocene epochs but difficult to find out the exact causes of their presence either because of sea-level rise or because of uplifting or both. Snead (1967) observed that at several locations it appears that sea level changes have had more influence upon the coastline than tectonic movements.

Inland from the coast, evidence of both gradual and sporadic coastal emergence exist in form of entrenchment of drainage and rejuvenation of streams in Lasbela and Karachi Valleys. Old alluvium and conglomerate terraces pertain to Pleistocene have been found in many areas of Karachi and Lasbela.

Geological studies (Kazmi 1997) in the Indus delta reveal that the lower Indus Plain contains a good record of the events and sediments of the Late Pleistocene. The Tandojam formation with coarse gravelly alluvial sand in the lower part and fine medium alluvial sand in the upper part represents a 150–200 m deep channel filling. This channel was apparently formed as a result of the degradation of its course by the Indus due to the lowering of sea level during the last glacial period. As large portion of the continental shelf were exposed due to the falling sea level, the Indus may have extended its course across the emerging sea floor right up to the edge of the continental shelf. Towards the end of the last glaciation, as the sea level began to rise once again, the Indus aggraded its course and during the late glacial period deposited sands and gravels of the Tandojam formation. The evidence of sediments from shallow wells dug in the deltaic flood plain show non-bedded flood plain deposits of silt and clay containing abundant mollusc shells underlies the present deltaic flood plain.

Along the coast of Karachi erosional coastal features like steep cliffs, stacks, arches, sea caves and blow holes have been found. It appears that slow uplift of continental shelf continues in the coastal areas, which was also confirmed by Snead in his conclusion that "the Makran coastal region is not only tectonically active, but the movements indicate a continuing uplift. This uplift results in the formation of rock headlands and exposed portions of continental shelf. Protected pocket bays and lagoons between the nearly formed headlands, rapidly filled by alluvial deposits. Once material was brought to the coast, currents and winds take over as the main agents in the formation of the wide, sandy beaches and extensive barchans dune masses".

10.4.3 Evidences Collected During Field Visits

During the period 2010–2013 several field visits in Gadani, winder, Daun, Dam and Somiani in the Makran coast of Balochistan, Rehri, Cape Monze (Ras Malan), Sona Pass and Hub River of Karachi coast and Keti Bunder and Jati in the lower Indus delta were conducted and found evidences of Pleistocene, Holocene and present status of sea-level change phenomenon.

10.4.3.1 Short-Term Sea-Level Change

The short term sea level rise had been observed in the coast of Karachi (Sindh) and Gadani (Balochistan) in the period of daily and spring tides, sea surges in monsoon season (July and August), and tropical cyclonic condition in June were studied. During the daily tidal phenomenon of rising sea level was observed in the lagoons of Gadani Harbour, Dam Bunder and Kaka Pir Island. During high tide sea level starts to rise about 1 pm and reaches at the height of about 1–2 m at 2.am than it drops which again rises about 7.am. During the time of high tides fishermen sail their boats and small ships. During the period of spring tides it reaches up to 2–3 m from the normal sea level. During high tides roots of mangroves sink under water while when sea level drops they are exposed. Sea-level also rises during monsoon season and period of tropical cyclone. Due to strong monsoon winds sea becomes violent and high surge of sea waves can be observed. It was observed that during monsoon season sea level rises up to 3–4 m from normal while due to tropical cyclones sea-level rises up to 3–5 m. The sea level rise can be observed from the height of transported sediments and marks of sea waves on cliffs (Fig. 10.2).

10.4.3.2 Risk of Tsunami and Sea Level Change

The tectonic history of Pakistan, presence of number of onshore and offshore active faults from Kutch to Gawader and occurrence of high magnitude quakes reveal that the coastal areas of Pakistan is a vulnerable region of tsunami (earthquake generating sea waves). Pakistan had a bad experience of tsunami when on November 28, 1945,

Fig. 10.2 Marks of sea surge on the cliff and derived sediments at Paradise Point, Karachi during short term rise of sea

a severe earthquake of 8.1 magnitude hit the coastal areas of Pakistan. The epicentre was located in the Arabian Sea near Ormara, generated about 12–17 m high sea waves which caused temporary rise of sea level and destroyed coastal settlements of Makran coast and fishing villages of Karachi and Badin. About 4,000 people died including 300 deaths which occurred due to tsunami.

10.4.3.3 Glacio-Eustatic Change of Sea-Level

During the Pleistocene and early Holocene epoch, evidences of global change in sea level were collected in the coast zone of Karachi and Gadani. During glacial periods, sea level dropped up to 140 m below the present shore line. It is estimated that present shore along the Makran coast and Sindh receded up to 120 m, the vast continental shelf exposed. As a result of change of base level, rivers drained into sea rejuvenated, extended their channels up to the edge of exposed continental shelf, eroded channels deep and deposited bed-loads. Similarly in the interglacial periods sea-level rose up, exposed continental shelf re-submerged into water and shoreline proceeded. Abandoned channels of rivers and old distributaries of River Indus submerged into sea water and formed creeks along the coast. Like Gharo creek which is an old abandoned channel of the Indus River (Fig. 10.3). This also happened in small streams like Gizri creek, the mouth of the Malir River and Hub creek, the mouth of Hub River (Fig. 10.4).

Along with glacio-eustatic change of sea-level, the coast was also tectonically active. As a result of uplifting, old bed loads also uplifted. The remnants of conglomerate terraces of Hub Rive can be seen along and near the present course of Hub River (Fig. 10.4).

Fig. 10.3 Gharro Creek, Thatta, old distributary of the River Indus

Fig. 10.4 Uplifted conglomerate terrace of Hub River (3 km inland from shore)

Fig. 10.5 Pleistocene loess deposits, eroded by sea-wave at Karachi coast

During the glacial periods when continental shelf exposed wind derived fine sand and silts moved and spread out over the coastal areas in thick consolidated loess form or in form of unconsolidated deposits, formed coastal dunes. Due to uplifting these loess deposits are located about 30–60 m above sea-level. Along the shore due to sea waves erosion loess-deposited surface have formed cliffs and formed sandy beaches (Fig. 10.5).

Fig. 10.6 Raised beach in Mubarak village, Karachi coast

Fig. 10.7 Ripple marked rocky raised beach at Karachi coast

10.4.3.4 Tectonic Change of Sea-Level

The presence of uplifted Pleistocene sand and gravels beach deposits at the height of 12–25 m above sea level, raised sea platforms and rocky headlands (Figs. 10.6 and 10.7), and oyster beds indicate that the coast of Pakistan was tectonically active in the Pleistocene and Holocene epoch. In Rehri village of Karachi coast prints of mangrove leafs and fossils of mangrove shells in clay beds were collected at the

Fig. 10.8 Oyster shells deposited at the top of cliff along Karachi coast

Fig. 10.9 Oyster shell deposits found in the eroded hill along Karachi coast

height of 16 m above sea level show coastal uplift. Similarly presence of ripple marked rocky platform and headlands just along the shore confirms this Pleistocene uplifting (Fig. 10.7).

In the Ras Malan coast of Karachi huge deposits of Oyster shells were found at the top of cliff and eroded hills. These oysters beds were most probably deposited on the beach or continental shelf and then uplifted most probably in early Holocene (Figs. 10.8 and 10.9).

Fig. 10.10 Harapan site near the mouth of the Hub River, Karachi coast

10.4.3.5 Archaeological Evidences

Archaeological evidences are good sources of information about the Holocene sea-level change in the coastal areas of Karachi and Lasbella. Dales in 1960 identified pre-historic Harapan site of Kot Bala near Winder, at the height of 20 m and 8 km inland. He claimed it as Harapan port. Snead (1967) rejected that uplifting of coast about 2,500 B.C which was too early. Khan A.R, Italian Archaeologist Paolo Biaji and the author found no marine evidences there. In 1979 Khan A.R discovered a Harapan port Settlement on the conglomerate terrace near the mouth of the Hub River (Fig. 10.10). Several marine shells were collected during field visits.

Along the coast at Sonari, a Neolithic and Pre-Harapan sites were also discovered by Khan (Khan 1979). During field visits the author found shell maidens, dated about 4,000–5,000 B.C located at 4 m high hillock (Fig. 10.11). In Daun and Lake Sirinda, shell maidens dated 5,000–6,000 B.C were collected (Biaji 2006). These two sites are located not at the height of 3 m above the shore. The archaeological evidences reveal that no major uplifting of coast were recorded during the last 8,000 years ago. All Harapan, pre-Harapan and Neolithic sites were developed on terraces or on hillocks lifted up before their existence.

Fig. 10.11 Shell maddens at the Pre-Harapan site at Sonari, Karachi coast

Fig. 10.12 An island emerged at Gawadar off shore as a result of Awaran earthquake of 7.7 intensity on 1st Oct., 2013

10.5 Current Sea Level Rise and Its Impacts

The evidences found in the off shore and on shore regions of the coast of Pakistan reveal that the region has been tectonically active. During October 2013 Awaran earthquake a small island has emerged at Gawader offshore (Fig. 10.12). This also happened as result of 1945 offshore earthquake and in 1997. Because of the small size of emerged island, no significant rise of sea-level has been reported. It has been investigated through local fishermen of Karachi and Lasbela that no permanent rise of sea level took place during last 60 years in Karachi-Lasbela coast.

In South Badin due to submergence of lands in Rann of Cutch during the period 2002–2003 sea water intruded into cultivated lands. This happened possibly because the southern areas of Badin and Thatta were affected by 2002 Gujarat quake, when lands in many areas submerged and sea water came up on ground. Farmers and fishermen left their villages and their cultivated lands. Subsidence of lands in the southern areas of Badin is also continue. The extraction of natural gas from subsurface strata may be the other cause of land subsidence.

Environmental degradation of Indus estuary and deltaic plain has been linked with sea water intrusion. There is no doubt that salinity in the tidal channel has increased up to the level of sea water. The covering area of Mangrove forest has reduced during last 40 years. Rise of salinity and intrusion of sea water has badly affected the quality of freshwater in the downstream of Kotri Barrage. The main reason of sea water intrusion in the Indus delta has been considered reduction of Indus water inflow which has reduced after construction of barrages over the Indus River. Because of the presence of active faults like Allah Bund fault in the region threat of submergence of present estuary exist however satellite images of last 20 years have not shown any significant submergence of the estuary and its conversion into open sea (Fig. 10.13).

Sea water intrusion can also be observed in small rivers like Hub River. Hub River is about 200 km long perennial river. After the construction of Hub dam and large reservoir in 1985, down reservoir water flow has nearly stopped. As a result seawater has intruded into the channel (Fig. 10.14). The threat of land subsidence

Fig. 10.13 Estuary of the Indus river

Fig. 10.14 Mouth of the Hub river

and sea-level rise also exist along Clifton beach. During last 20 years a large number of high-rise buildings have been constructed in the area as well as off shore lands have been reclaimed for housing purposes. It is important for urban developers to restrict such large-scale construction works along the beach.

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Chapter 11
Climate Change Risk and Reduction Approaches in Pakistan

Mohammad Aslam Khan

Abstract Pakistan is one of the most vulnerable countries facing the risk of climate change, despite contributing very little to the global greenhouse gas emissions. The 2010 Global Climate Risk Index of Germanwatch ranked it first among some 180 nations of the world. The country's vulnerabilities are high due to heavy dependence of its economy on agriculture, which is highly climate sensitive; water supply of its rivers from the Hindukush-Karakoram-Himalayan glaciers, which are reported to be receding due to global warming; and increased risks to its coastal areas (particularly to Karachi, its largest city and the hub of its industrial activity and international trade) and the Indus deltaic region due to sea level rise and increasing cyclonic activity. Compounding the problems are the extreme weather events, which have enhanced in their frequency and intensity in the country. An analysis of data from 52 meteorological stations in Pakistan over a 40-year period (1961–2000) shows that the frequency of highest daily temperature and heaviest rainfall events have increased by the passing decades. Moreover, at the turn of the century, the country experienced the worst drought of its history and in the first decade of the twenty-first century saw several extreme weather events including the history's worst flood in 2010. In terms of risks, climate change poses a major threat to all dimensions of sustainable development, economic, social as well as environmental. It is likely to have widespread impacts across various sectors and ecosystems such as food, water and energy; forests and biodiversity; coastal and marine environment; as well as on the occurrence and intensity of climate related hazards such as floods and droughts. This Chapter examines first the climate variability trends that Indicate continuous warming. It then evaluates vulnerabilities and risks posed by climate change, which are increasing with time particularly in terms of enhanced climate related hazards. Finally, it analyzes the key approaches and measures that have been adopted to reduce the risks posed by climate change.

Keywords Climate change • Climate variability • Vulnerability and risk • Observed impacts • Response approaches

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_11

11.1 Introduction

Pakistan has been ranked as highly vulnerable by Indices that have been devised to gauge the vulnerability of countries to climate change. For example Maplecroft's (2011) Index of vulnerability to climate change ranked Pakistan 16th among 170 nations of the world. Global Climate Risk Index (GCRI) of Germanwatch 2012 (Harmeling 2011) ranked it even higher – eighth among over 180 nations of the world. Earlier, in 2010, GCRI had ranked it first. The irony is that while the country is to be hard hit by climate change, it contributes very little to the global greenhouse gas (GHG) emission – ranking 135th in the world in terms of per capita GHG emissions.

This chapter has been organized to give the climate variability trends in Pakistan first, highlighting the observed temperatures and precipitation patterns and the likely future scenario; which are indicating a change in climate. The next section highlights the risks related to climate change following which the paper focuses on observed impacts that are also signalling an increase in risks particularly in terms of magnitude and frequency of extreme weather events. The next section discusses the approaches that have been adopted in the country to reduce risks posed by climate change through policies, institutional development as well as mitigation and adaptation strategies. The concluding section highlights the findings.

11.2 Climate Variability Trends

11.2.1 Past Scenario

The studies conducted by Global Change Impact Studies Centre (GCISC 2009a, b, c) and Pakistan Meteorological Department (Farooqi et al. 2005; Husain et al. 2005; Gadiwala and Sadiq 2008; Zahid and Rasul 2009; Ahmad et al. 2010) indicate that climate in Pakistan has varied considerably. These studies show that in agreement with the global trend, the average annual temperature in the country increased by 0.6 °C.

The warming trend during 1901 and 2007 is evident from the time series of area-weighted annual mean temperatures of Pakistan (Afzaal et al. 2009) as shown in Fig. 11.1. While the total change in temperature was 0.64 °C, the temperature has been rising at the rate of 0.06 °C per decade, which is significant at 95 % confidence level with cycles of increase and decrease over the period.

There was a sharp rise in temperature from 1933 to 1945; the rise being 0.6 °C in 12 years. Then it began to fall at the rate of 0.03 °C per decade up to 1993. However the average temperature in the later period was 21.8 °C while in the former period it was 21.6 °C, which still indicates a warming by 0.2 °C. The increase in temperature after 1993 was quite sharp that continued to the end of the time series. During this last period, the temperature climbed at the rate of 0.53 °C per decade. The average temperature in the last decade was 22.3 °C.

Fig. 11.1 Pakistan: area weighted mean annual temperature trend 1900–2007 (Source: Afzaal et al. 2009)

The rate and nature of temperature change in Pakistan has not only varied over time but also regionally. The observations show that temperature increases over northern part of the country was higher than over southern part (0.8 °C versus 0.6 °C) over 1900–2000 period. A more revealing fact is that the Himalaya-Karakoram-Hindukush region of Northern Pakistan, which hosts world's third largest ice mass and is the life blood of water supply to Indus has warmed up more than 1.5 °C during the last three decades – nearly double the value (0.76 °C) of warming in remaining parts of the country (Rasul et al. 2012) with serious implications for glacier melting.

In terms of temperature extremes, during the 1951–2000 period, cold days, cold nights and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent. It is important to point out that more than 75 % of the stations in the Greater Himalayan Region recorded an increase in the extreme temperatures, which indicates a higher likely rate of snow and glacier melt.

11.2.1.1 Precipitation

Pakistan has two major rainy seasons – in winter and in summer. In winter, under the influence of westerly winds northern half of the country receives substantial rainfall in plains and snow in the mountains. Monsoon rain in summer contributes about 60 % of the annual total rainfall from July to September. Pre-monsoon months of May and June are very hot and dry while autumn is also the dry season without summer or winter rains. The country's total annual precipitation is between 500 and 800 mm. The northern part receives higher amounts (from both winter and summer precipitation) compared to southern half, which receives hardly 50 % of the northern one because neither monsoon establishes well nor winter precipitation approaches with generous downpours. Precipitation in the northern half accumulated over the mountains in winter in association with the glaciers feed the Indus and its tributaries in pre-monsoon period.

In terms of precipitation variability, there is a slightly increasing trend in the country as shown in Fig. 11.2. However, on the countrywide scale, there was a 61 mm increase in total over 109 years. Hence, the average rate of increase was around 0.6 mm per year, somewhat negligible in terms of its quantitative impacts.

The rate and nature of change however, had regional and seasonal variations as shown in Table 11.1. There was an increase in monsoon precipitation with a

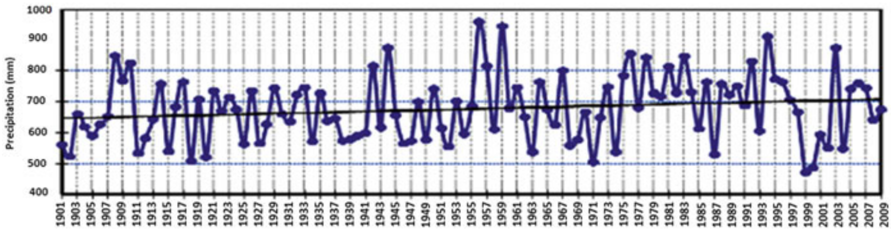

Fig. 11.2 Pakistan: inter-annual variability of precipitation 1901–2009 (Source: Rasul et al. 2012)

Table 11.1 Pakistan: region-wise precipitation trends 1951–2000 (changes in mm/year)

Region/seasons	Annual	Monsoon (Jun–Sep)	Winter (Dec–Mar)
Zone I (a): Greater Himalayas (Winter dominated)	0.49	1.73	–0.04
Zone I (b): Sub-montane Region and Monsoon dominated	0.30	0.38	0.53
Zone II: Western Highlands	–0.02	0.22	0.00
Zone III: Central and southern Punjab	0.63	0.57	0.99
Zone IV: Lower Indus Plain	0.22	0.45	–0.27
Zone V (a): Balochistan Province (Sulaiman and Kirther Ranges)	1.19	1.16	1.14
Zone V (b): Balochistan Plateau (Western)	0.10	–0.20	–0.40
Zone VI: Coastal Belt	–0.83	–1.34	0.00

Source: GCISC (2009a)

few exceptions. The highest increase in monsoon rain was recorded in the Greater Himalayan region (86 %), while the coastal region and the Western Balochistan experienced a decrease in precipitation.

Sub-montane areas, Central and Southern Punjab and in zone V (a) of Balochistan Province winter rains increased significantly. Decrease in precipitation was recorded in the Western Balochistan Plateau, Lower Indus Plain and Greater Himalayan region during winter (GCISC 2009a).

The frequency of extreme monthly precipitation events during the second half of the previous century increased substantially in the mountainous north, where 7 out of 9 meteorological stations of the Greater Himalayan Region and 8 out of 11 in the sub-montane region recorded such events. Extreme wet events also increased over the whole of Balochistan Province indicating a change in the distribution pattern of rainfall with many adverse implications not only in terms of flash floods but also for recharge of the underground aquifer because extreme rainfall disappears as run-off.

11.2.2 Future Projections

The Intergovernmental Panel on Climatic Change (IPCC) 4th assessment, based on the projections of future world climate with the help of various Global Circulation Models (GCMs) predict somewhat higher temperature increases in the region where Pakistan is located as compared to average global temperature increase (IPCC 2000a, b). Research at the Global change Impact Studies Centre (GCISC 2009b; GOP 2010) in Pakistan has shown a strong correlation between the projections of the IPCC and modelling based on historical weather in Pakistan predicting that the average temperature over Pakistan will increase progressively by 2.8–3.4 °C up to 2100. Studies based on the ensemble outputs of several Global Circulation Models (GCMs) project that the average temperature over Pakistan will increase in the range of 1.3–1.5 °C by 2020, 2.5–2.8 °C by 2050, and 3.9–4.4 °C by 2080, compared to an increase of 2.8–3.4 °C in the average global surface temperature by 2100. Precipitation is projected to increase slightly in summer, and decrease in winter, with no significant change in annual precipitation. Furthermore, it is projected that climate change will increase the variability of monsoon rains and enhance risks by increasing the frequency and severity of extreme weather events such as floods and droughts (GCISC 2009b).

11.3 Vulnerability and Risks

The climate change and its implications are no longer a myth for Pakistan. The scientific evidences of temperature changes as well as occurrence of frequent floods, cyclones and droughts have proved beyond doubt that the risks posed by climate change are real. The factors making the country particularly vulnerable to climate change risk include:

- Its location in a geographical region, where the temperature increases is likely to be higher than the global average;
- Its largely arid and semi-arid climate (about 60 % of the area receives less than 250 mm of rainfall per year and 24 % receives between 250 and 500 mm);
- Its rivers, which derive water from the Hindu Kush- Karakoram-Himalayan (HKH) glaciers (reported to be receding due to global warming);
- Its mainly agrarian economy, which is highly climate sensitive;
- High variability in its monsoon rains, which cause large floods and extended droughts:
- Its extended coastal areas (which also houses Karachi, Pakistan's largest city and the hub of its industrial activity and international trade and the Indus deltaic region) due to sea level rise and increasing cyclonic activity in the Arabian Sea.
- Its predominantly mountainous terrain highly vulnerable to glacier lake outburst floods (GLOFs) and landslides;
- Its scanty forests (about 5 % of the land area is under forest cover) due to forest fires as well as reduced regeneration under rapidly changing climate conditions.

Risks posed by climate change encompass all dimensions of sustainable development – economic, social as well as environmental.

11.3.1 Economic Vulnerability and Risks

Economically direct detrimental impacts of climate change will be across diverse sectors including water, energy, food and agriculture, forests, and fisheries. The most serious risks of climate change relate to food, water and energy security. Water security has crucial importance for the economy as it is bound to have impacts on all economic sectors. Future increase in population and the need for economic development is likely to increase the demand for water substantially. Currently, the biggest user of water in Pakistan is agriculture sector, where demand for water is likely to increase much faster due to enhanced evapotranspiration as a result of elevated temperatures in the wake of climate change. In terms of supply, both main sources the Glaciers of Hindu Kush – Karakoram – Himalayas (HKH) and precipitation will be affected due to melting glaciers (first increasing the water and then decreasing) and erratic rainfall respectively. Hence, the efficiency of water use will need improvement in all the sectors of the economy, particularly agriculture, where average water delivery efficiency due to age, overuse, and poor maintenance of canals and consequent seepage has reduced substantially from the canal head to the root zone (GOP 2014).

Moreover, water conservation strategy will also need improvement. At present on average, about 128 billion cubic meter (BCM) of the water flows, in Pakistan is diverted to the canal system. The minimum outflow to the sea below Kotri was as low as one BCM (in 2000–2001) and the maximum was as high as 113 BCM in 1994–1995 (GOP 2005a). Water going to the sea in low flow years is so low that it is unable to prevent intrusion of seawater into the Indus deltaic region (IPOE 2005). The future sea level rise due to climate change will enhance the problem by increasing the minimum flow requirements. At present on the average 43 BCM of water flows to the sea annually during flood season. There is a need to conserve every drop of this water to use it later in maintaining optimal ecological flow into the sea (GOP 2007) and for combating the droughts.

The energy security will be affected by both direct and indirect impacts on the energy sector. Directly by affecting the timing and amount of water availability for hydropower generation or thermal power plant cooling, increased rate of sedimentation of major reservoirs, enhanced transmission and distribution losses or damage to the energy infrastructure located in coastal areas due to sea level rise. Indirectly the ripple effect could originate from impacts of climate change on other sectors such as water, industry, agriculture and infrastructure. For example higher temperatures by increasing evapotranspiration may demand energy for pumping ground water to compensate for water losses. Increase in demand for space cooling may also increase.

Food security will be affected through impact on the agricultural productivity. Crops and livestock production will be affected due to heat stress and other adverse impacts of changes in climatic parameters including uncertainty in timely availability of irrigation water due to river flow changes as a result of glacier melting and altered precipitation pattern; increased intensity and frequency of extreme weather events like floods and drought that damage crops and may destroy livestock; greater preponderance of insects, pests and pathogens in a warmer climate that may damage the crop and livestock; degradation of rangeland as well as already deteriorated cultivated land particularly those affected by water erosion, wind erosion and water-logging and salinity; and intrusion of sea water particularly into the arable Indus Deltaic Region. Considerable efforts will be needed to combat these climate-related risks in view of the time required for crop, livestock and fishery production systems to adapt. Success will hinge upon factors relating to biology, ecology, technology and management regimes.

The widespread risks posed by climate change to various economic sectors need evaluation in monetary terms, because this would give some idea to the national planners and policy makers on the total costs that the country would need to incur on the coping mechanisms such as adaptation measures (GOP 2010).

11.3.2 Social Vulnerability and Risks

Climate change also has social impacts such as risks to health. In addition, enhanced extreme natural events such as floods and droughts or sea level rise carry the risk of displacement of people, drastic cut in their income and loss of hundreds of jobs. It may also result in inflation of food prices and increase the number of people at risk of food security and hunger, which may trigger migration and civil unrest. In terms of health, warmer temperatures and greater humidity would increase water- and food-borne, as well as vector-borne diseases. Increase in extreme weather conditions caused by climate change will also increase incidence of pneumonia, heat strokes and heart attacks.

The capacities of individuals, communities and societies in Pakistan to effectively face such risks will depend upon a combination of natural, human, social, financial and physical factors. For example coastal communities and small farmers will be at greater risk. Rural houses constructed from mud and thatch will be more at risk compared to better quality houses in urban areas. The poor and downtrodden will have problems due to the increased cost of living as a result of reduced food security, enhanced health related expenditure and increase in energy prices.

11.3.3 Environmental Vulnerability and Risks

Climate change also carries biophysical/environmental risks as it may change the ecology and habitats; quantity and quality of available land, soil, water and biotic resources; level of the sea and ocean temperature and salinity. It may also enhance the occurrence of weeds and pests, which in turn may exacerbate environmental changes. Greater risks will be posed to Pakistan's coastal and marine environment, forest and biodiversity, and other vulnerable ecosystems such as rangelands, degraded lands and mountain ecosystems.

With a coastline of about a thousand kilometres, Pakistan has been grouped by the UNEP's Oceans and Coastal Areas Programme Activity Centre among the countries which are most vulnerable to the effects of sea level rise (GOP 2003). According to studies carried out at the National Institute of Oceanography (NIO), the sea level along the coast of Pakistan has been rising approximately at 1.2 mm per year; somewhat lower than the average global rise of 1.7 mm per year over the last century. However, even at this rate, coastal zones and marine ecosystems, in particular in the Indus delta, could be damaged from increased saline water intrusion due to sea level rise and increased storm events. The NIO is of the view that the ground subsidence rates in the Indus deltaic region due to lack of sediment flux and excessive ground water extraction are probably in the range of 2–4 mm per year. The ground subsidence has already resulted in the seawater intrusion upstream of the delta extending up to 80 km in the coastal areas of Thatta, Hyderabad and Badin districts (Panhwar 1999; Inam et al. 2007). The primary impacts of sea level rise on the coastal zone include the risk of erosion of beaches, flooding and inundation of wetlands and lowlands, salinization of ground and surface waters, and adverse impact on coastal agriculture. The Indus Delta covers approximately 600,000 ha with a coastline of 250 km, bordering the city of Karachi in the northwest. The main factor responsible for intrusion of seawater into the Indus deltaic region is an insufficient flow of Indus water downstream of Kotri Barrage.

11.4 Observed Impacts as Indicator of Risk Aggravation

11.4.1 Extreme Weather Events

The observed impacts of climate change in Pakistan further highlight the increasing aggravation of risks. The most significant is the enhancement of extreme weather events such as recent floods. The most devastating among these was the flood of 2010, which affected one fifth of the country and wiped off 5.8 % of the national GDP causing a loss of some 10 billion dollars (World Bank 2010a). These floods resulted from a rain intensity that reached 300 mm in a 36-h period contributing to the highest water levels in 110 years in the Indus River in the northern part of the country. The unprecedented floods affected more than 20 million people (Refugee International 2010). "Most experts are still cautioning against tying any specific event directly to emissions of greenhouse gases. But scientists at the World Meteorological Organization (WMO) say there's no doubt that higher Atlantic Ocean temperatures contributed to the disaster." (Gronewold and Climatewire 2010). According to Director of the World Climate Research Programme of WMO, "Atmospheric anomalies that led to the floods are also directly related to the same weather phenomena that caused the record heat wave in Russia and flooding and mudslides in western China" (Gronewold and Climatewire 2010).

Pakistan has become one of the most flood prone country in South Asian region. Even prior to twenty first century, the country was hit by a number of floods that resulted in significant damages in 1950, 1992 and 1998. However, the first few years of the twenty-first century have seen devastating recurring floods in 2010, 2011, 2012, 2013 and 2014. Besides floods, Pakistan has also seen many other extreme weather events in the past few years (Table 11.2). The country has experienced dry seasons, with the most susceptible regions experiencing drought 2 or 3 years every decade (World Bank and GFDRR 2012).

The drought of 1998–2001 caused staggering losses. In the financial year 2000–2001 alone, the drought reduced economic growth rate from estimated 5 % to 2.5 % (Ahmad and others 2004). In Sindh and Balochistan, the drought is estimated to have affected over 3.3 million people, including thousands who became refugees and hundreds who died of thirst and starvation. It was also reported that about 30 million livestock were affected, including over two million that perished. Many cyclones also hit the country during the last 40 years. These were particularly damaging in the coastal areas, as this low- lying belt allows them to move hundreds of kilometers inwards and, destroy crops and livelihoods on their way. Cyclone Yemyin in 2007 alone caused damage amounting to US$ 674 millions (ADB-WB 2007). Overall, climate related disasters have dominated the disaster scenario in the country (Fig. 11.3 and Table 11.3).

All in all, Pakistan is vulnerable to risks from a range of climatic hazards including avalanches, cyclones/storms, droughts, floods, fogs, glacial lake outbursts, heat waves, landslides, and tsunami. As discussed above high priority hazards in terms of their frequency and scale of impact have been floods, droughts and cyclones.

Table 11.2 Pakistan: extreme weather events of twenty first century

2013	Flash floods affected nearly 1.5 million people, almost 80,000 houses, and 1.5 million acres of crops. 234 people were killed. More than 4,100 people were housed in 408 relief camps
2012	Floods affected 5 million people, 14,270 villages and 1.1 million acres of crops. Almost 270,000 people were housed in 478 relief camps. More than 465,000 houses were damaged
2011	Floods in Pakistan's southern province of Sind affected 22 out of 23 districts claiming 500 lives. Nearly 2.2 million ha cropland was damaged and 72 % of crops were lost in the worst affected areas. 1.6 million homes were destroyed
2010	Monsoon rainfall of 300 mm over a 36-h period resulted in swelling of rivers and caused the history's worst flood in Pakistan. The unprecedented flood submerged 20 % of the country's area
2009	Karachi received 205 mm of rain at Masroor Airbase and 143 mm at Airport on 18th and 19th July. The previous heaviest rainfall recorded at Karachi Airport was 207 mm on 1st July 1977. Normal rainfall at Karachi Airport for the periods 1961–1990 and 1971–2000 was 85.5 mm and 66.2 mm respectively
2007	A record heat wave gripped Pakistan during June 2007. The temperature reached 48 °C on 9th June at Lahore, repeating the record of 78 years earlier on 8th June 1929
2007	Two super cyclones Gonu (02A) of Cat-5 and Yemyin (03B) of Cat-1 developed in the Arabian Sea during June 2007 and hit Makran coast of Pakistan and adjoining countries. Not ever before two such events occurred in the same month in the Arabian Sea
2006	Monsoon-related flooding in Pakistan resulted in more than 185 deaths between late July and mid-August 2006. In neighbouring eastern Afghanistan, heavy rainfall generated flooding that claimed at least 35 lives
2005	Heavy rain caused flooding in parts of Balochistan, Khyber Pakhtunkhwa and Afghanistan during March. There were more than 30 fatalities in south-western Pakistan
2005	During June, unusually warm temperatures in the mountainous areas of northern Pakistan occurred, accelerating snowmelt and causing extensive flooding along the Kabul, Swat, Kunar and Chitral rivers
2003	Heavy rain and snow produced flooding during February (around 17th) and was responsible for more than 60 deaths in Balochistan province. Flash floods washed away parts of roads and highways
2003	Seasonal monsoon rains affected at least one million people in southern Pakistan. Heavy rains caused 162 deaths, 153 in the Sind province
2003	During early June, a heat wave caused maximum temperatures to reach 52 °C at Jacobabad on the 5th of June; normal highs in early June are around 44 °C
2001	621 mm rainfall in Islamabad during 10 h period on 23rd July; it caused flooding in Lai Nullah (rivulet)
1998–2001	History's worst drought gripped southern parts of Pakistan and parts of surrounding countries

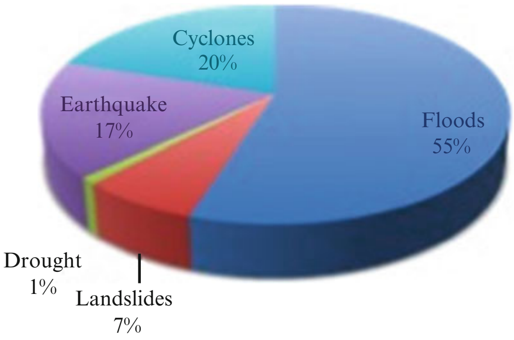

Fig. 11.3 Percentage distribution of reported disasters in Pakistan (1900–2014) (Source: CRED 2014, EM-DAT note: cyclones include storms as well)

Table 11.3 Disaster related damages in Pakistan 1900–2014

Disaster type	No of disasters	No of casualties		No of affected people		Damage (000 US$)	
		Total	Average per event	Total	Average per event	Total	Average per event
Flood	77	16,161	210	75,201,880	976,648	18,968,178	246,339
Drought	1	143	143	2,200,000	2,200,000	247,000	247,000
Earthquake	28	143,445	5,123	6,772,571	241,878	5,329,755	190,348
Landslide	10	222	22	29,719	2,972	18,000	1,800
Tropical cyclone	7	11,555	1,651	2,599,940	371,420	1,715,036	245,005
Total	123	171,526	1,395	86,804,110	705,724	26,277,969	213,642

Source: CRED (2014), EM-DAT

Landslides particularly through Glacial Lake Outbursts have also caused widespread damages and losses in the past. Overall, the incidence of climate related disasters particularly flash flooding and extreme flooding, severe drought and cyclone have greatly increased in the last two decades and are likely to continue in future, there is a need therefore to greatly strengthen the capacity of National Disaster Management Authority (NDMA) to manage disasters.

11.4.2 Outcomes of a Community Survey

The findings of a community-level surveys (Oxfam 2009a) in three selected areas (Badin District in Sindh, Rajanpur in the Punjab and Khuzdar in Balochistan) also indicate that risks posed by climate change are real and growing significantly.

The results of the survey, a summary of which is given below, show that the environmental problems in the three districts are getting serious and socio-economic vulnerability and risks are also becoming more pronounced.

Physical and Climate Related Parameters

- There has been an increase in the incidence, frequency, and intensity of extreme weather events: more intense and heavier rainfall in coastal areas, more intense cyclones, more intense flooding in flood-prone areas along the Indus, and more pronounced droughts in the arid areas of Khuzdar.
- In coastal areas, the sea has intruded inland due to excessive water withdrawal upstream and the sea level rise is likely to aggravate the problem.
- Rainfall has become erratic in some areas, making it difficult for inhabitants to assess rainfall patterns.
- Summers have become hotter and winters much warmer and the length of the cropping period has shrunk perceptibly in southern Punjab and Balochistan, with a forward shift in time for sowing and an earlier harvest.

Exacerbated Environmental Problems

- Fish and prawn catches in coastal areas (freshwater fisheries) have shrunk due to seawater intrusion and the increase in sea surges and cyclones (which bring seawater into land depressions far inland). This leaves the high-sea fishing as the only option, but most communities cannot afford the necessary equipment.
- Groundwater quality has deteriorated (become brackish) in the coastal area.
- The groundwater table is falling very rapidly in the drought prone areas such as Khuzdar.
- There has been widespread land degradation from salinity in coastal areas.

Deterioration of Socio-economic Situation

- The area of rangeland available for the open grazing of livestock has shrunk, and the quality of grassland has deteriorated due to the scarcity of water resources.
- The traditional coping mechanisms, which were used to deal with water shortages, declines in fish catch, and reduced agricultural produce, are no longer enough to counter the immense impact of climate change.
- Seasonal emigration has been observed in the areas studied, implying that incomes from traditional sources are no longer enough to support families.

11.5 Risk Reduction Approaches

Pakistan has undertaken effort to reduce risk posed by climate change through a three-pronged approach – policy and institutional development, introduction of mitigation and adaptation measures and promoting approaches to disaster risk reduction.

11.5.1 Policy Approach and Institutional Development

11.5.1.1 Policy Approach

Pakistan's commitments to combat climate change finds expression in its national policy frameworks such as the Climate Change policy of Pakistan (GOP 2012), Framework for Economic Growth (2011), National Environmental Policy (GOP 2005b) as well as the National Energy Conservation Policy (GOP 2005c). These documents clearly describe how the Government intends to honour its national and international commitments towards reducing risks posed by climate change.

The National Climate Change Policy approved by the Federal Cabinet in September 2012, provides a framework for coping with the threats of climate change. It aims to promote climate resilient approach to development and ensure that the measures to combat climate change are mainstreamed in the economic and social development plans. The coping measures recommended cover wide ranging sectors from water, agriculture, livestock and forestry to human health, disaster preparedness, transport and energy. Envisaged financing options for projects under the climate change policy include procurement from the international Green Climate Fund that has a target to raise $100 billion by 2020 and a proposed National Climate Change Fund.

"The Framework for Economic Growth" (long-term growth strategy of Pakistan) also gives great importance to climate change in view of its grave negative consequences for the country (GOP 2011). The Framework under the subtitle, "Ensuring economic growth is sustainable and climate resilient" highlights approaches to combat climate change under various themes. The first theme on protecting growth from the risk and costs of climate change-induced disasters, stresses integration of risk reduction and management concerns within the planning process. The second theme related to climate proofing economic growth from the impacts of climate change in particular covers the agriculture, water and energy sectors. The third theme focuses on mitigation by green growth through investment in low carbon technologies. The Framework pledges provision of adequate resources for the Government's climate change policy and related action plan.

In terms of approach to the implementation of multilateral environmental agreements on climate change, Pakistan acceded to the United Nations Framework Convention on Climate Change (UNFCCC) as a Non Annex-I Party in June 1994. Subsequently the country adopted the Kyoto Protocol in 1997 and acceded to it on 11th January 2005. Pakistan submitted the Initial National Communications on Climate Change to UNFCCC in 2003 (GOP 2003). The country also announced and implemented the CDM National Operational Strategy (GOP 2006) as a signal for its entry into the global carbon market.

In order to identify and implement various approaches to climate risk reduction, a high level Task Force on Climate Change was established, which submitted its report (GOP 2010) in 2010. In addition, the Government in collaboration with UNFCCC commissioned a National Economic and Environmental Development Study (NEEDS). The study aimed to bring out approaches in priority areas for possible mitigation of climate change risks while drawing out the probable future course of Pakistan's growth and the costs associated with moving along a low carbon development pathway. The study also gives strategic options and approaches for adaptation along with preliminary cost estimates (GOP and UNFCCC 2011).

At global level, the Government has also been active in negotiations right from the inception of the debate on climate change. As the chair of the G77 negotiating group in 1992 and 2007, Pakistan spearheaded consensus building on various approaches to combat climate change including the basic founding principles of the UNFCCC as well as agreement on the four building blocks – Mitigation, Adaptation, Technology and Finance, which have framed the climate change debate ever since.

11.5.1.2 Institutional Development

Institutional development is a very important component of climate change risk reduction approach. The Cabinet Committee on Climate Change was the first institution formulated in Pakistan in 1995 to provide a policy coordination forum for dealing with climate change. In 2004 this was changed to the Prime Ministers Committee on Climate Change (PMCCC), which also aimed to establish high-level inter-ministerial linkages and proved to be extremely effective in initiating the country's entry into the global carbon market. The Global Change Impact Studies Centre (GCISC), an autonomous institution, was also established to act as the secretariat of the PMCCC. Today, it is the primary scientific research body engaged in conducting research on impacts of and adaptation of approaches related to climate change risk reduction in the country.

The Climate Change Division of the Government, which also looks after the Environment, is the designated Federal focal point for UNFCCC and the Kyoto Protocol. The Division has been coordinating with other concerned agencies and institutions on various technical aspects and approaches, including the National Energy Conservation Centre (ENERCON), the Alternative Energy Development Board and the Pakistan Council of Renewable Energy Technologies. GCISC is also working under the umbrella of Climate Change Division.

Other major relevant organizations in the country working on research in climate change risk reduction or sea level rise include the Pakistan Meteorological Department, the Water and Power Development Authority (WAPDA), the National Agriculture Research Centre (NARC), the National Institute of Oceanography (NIO) and the Space and Upper Atmosphere Research Commission (SUPARCO). There are several other organizations including universities in the country, with mandates and activities that cover climate change related issues and risks as well as related projects. Oxfam (2009b) published the results of a survey of these organizations in a report.

11.5.2 Mitigation and Adaptation Approaches

Mitigation and adaptation approaches are basic to climate change risk reduction. There are a number of priority sectors and areas, which need coordinated mitigation and adaptation approaches. The energy, water, transport, industries, agriculture/livestock, and forestry together with natural hazards are the key sectors/areas among these that have a two-way interaction with climate change, whereby they not only have implications for future increase in GHG emissions or enhancing risks related to climate change in the country but their productivity is also directly affected by climate change risks.

The energy sector is the single largest source of carbon emissions. Therefore, it also has the greatest potential for mitigation or GHG reductions along with positive synergies for sustainable development in such areas as the energy conservation, efficiency enhancement and promotion of renewables. In terms of adaptation, agriculture, the mainstay of the economy and a major commodity-producing sector has serious risks due to shift in climate patterns and changes in precipitation. Hence, it is a key sector that demand effective adaptation approaches to deal with the climate change. Mitigation wise also there is a substantial "win-win" opportunity in this sector in terms of conservation of valuable inputs such as water and agrochemicals, which can promote cost savings as well as reduce GHG. In terms of forestry, Pakistan suffers from an alarming rate of deforestation. The sector offers a great potential for mitigation approaches such as tree cover enhancement as a sink of GHGs, while utilizing innovative financial instruments such as UN-REDD (The United Nations Collaborative Programme on Reducing Emission from Deforestation and Forest Degradation in Developing Countries).

In the water sector, which is both the engine and the primary agent of development in the country, there is a need to focus on approaches related to flood management, water conservation and increasing the efficiency of irrigation system as well as enhancing the water storage capacity through small and large dams.

11.5.2.1 Mitigation Approaches and Their Costs

Pakistan is presently a small GHG emitter but its emissions are bound to increase with growing energy needs for development. The country, however, has the concerns to contribute to the global GHG mitigation efforts without compromising on its basic minimum energy and food needs consistent with its socio-economic developmental requirements, energy security considerations, and existing financial and technological constraints (GOP 2010).

These concerns, according to the NEED Study (GOP and UNFCCC 2011), get aggravated in a scenario that sees Pakistan's energy future being driven by coal. It can be seen in Table 11.4 that the overall GHG Emissions (Mt CO_2 eq.) are projected to increase from 347 in 2011 to 4,621 in 2050 under approaches that

Table 11.4 Pakistan: sector wise GHG emissions 2011–2050 (Mt CO_2 equivalent)

Sector	2011	2020	2030	2040	2050
Energy	176	295	560	1,250	2,730
	(50.7)	(53.0)	(53.5)	(58.0)	(59.1)
Agriculture	134	210	408	812	1,765
	(38.7)	(37.7)	(39.0)	(37.7)	(38.2)
Industry	20	30	52	61	75
	(5.8)	(5.4)	(5.0)	(2.8)	(1.6)
LULUCF	10	13	15	20	35
	(2.9)	(2.3)	(1.4)	(0.9)	(0.8)
Waste	7	9	11	13	16
	(1.9)	(1.6)	(1.1)	(0.6)	(0.3)
Total GHG Emission	347	557	1,046	2,156	4,621
	(100)	(100)	(100)	(100)	(100)

Source: GOP and UNFCCC (2011)
Note: Figures in parenthesis indicate percentages

use Business as Usual (BAU) scenario. These emissions are linked with and based upon the projected sectoral GDP estimates for agriculture, large-scale manufacturing, energy and transport. Among various sectors, energy will remain the highest contributor to overall emissions, with its share reaching 59 % in 2050. The agriculture sector is to maintain a constant share but that of industry will see a decrease perhaps based on an approach that uses underlying assumption of efficiency in production techniques and availability of greener technologies (GOP and UNFCCC 2011).

The NEEDS (GOP and UNFCCC 2011) indicate that the low carbon development scenarios projected for the country estimate additional investment costs for mitigation approaches ranging between US$ 8 billion to US$ 17 billion by 2050, as progressively cleaner coal and a higher percentage of renewable energy technologies are employed. It is considered feasible to reduce emissions by 40 % from the BAU scenario by employing cleaner technologies. The Energy Security Action Plan 2005–2030 (GOP 2005d) already, envisages large roles for hydropower, renewable energy technologies (in particular windmills), nuclear power and imported natural gas in future energy supplies. Approval has already been given for the construction of the 4,500 MW Bhasha dam and construction of a mass transit system (circular railway) for Karachi metropolitan area. National Energy Conservation Centre is also implementing a number of projects using such approaches as energy efficiency improvement, energy conservation and use of decentralized renewable energy technology. In terms of carbon sequestration, several afforestation endeavours like the Rachna Doab Afforestation Project is underway. Tree-planting campaigns are launched each year during spring and monsoon seasons (as many as 541,176 saplings were planted in 1 day on 15 July 2009, which is a world record).

11.5.2.2 Adaptation Approaches and Their Costs

Vulnerability and risks due to climate change have necessitated use of a number of adaptation approaches in the country in water, agriculture, livestock, and forest sectors particularly in coastal areas including the Indus Deltaic Region, and other vulnerable ecosystems. Present efforts in the water sector are concentrated on increasing the storage capacity through a series of large hydropower projects to add 22 BCM of new storage by 2030, to the existing 15 BCM capacity, (which is decreasing by 247 million cubic meters annually due to siltation). As stated above, approval has been accorded for the construction of Bhasha Dam, which besides generating electricity will have a water storage capacity of about 8 BCM. The large storages are to be complemented by a comprehensive construction programme of small and medium dams as well as measures for recharging underground reservoirs and investigations for using groundwater aquifers as water storage facilities. Among water conservation approaches a major programme underway is for lining the water channels and continuously monitoring the movement of glaciers in northern Pakistan.

Adaptation approaches for agriculture are focused on securing agricultural productivity in a sustainable manner. For productivity risk reduction due to climate change, the planned approaches include: (i) development through biotechnology heat-stress resistant, drought- and flood-tolerant, and water-use efficient high yielding crop varieties, (ii) increasing irrigation water availability by reducing losses in the irrigation water supply network, (iii) implementing "More Crop per Drop" strategy through improved irrigation methods and practices, as well as water saving techniques in combination with the use of high yielding and water-efficient crop varieties, and (iv) increasing milk and meat production by improving animal feedstock and by developing animals breeds which are less vulnerable to climatic change (GOP 2010).

For the coastal and marine environment, the approach is to implement the recommendations of a study by local and foreign experts (IPOE 2005) to identify what minimum water flows below Kotri Barrage are required (a) to keep seawater intrusion in check and (b) to address other environmental concerns. Moreover, a major intervention is underway to use brackish water for aquaculture.

In terms of cost estimates, existing global studies on costs related to adaptation approaches provide a wide range of estimates. According to the widely acclaimed Stern report (Stern 2006) the cost of climate change impacts is estimated at 5–20 % of the global GDP annually, in the absence of adaptation. The World Bank (2010b) estimates that up to 10 % of domestic and foreign direct investment (FDI) flow in developing countries, and up to 40 % of ODA and concessionary finances might be at risk from climate-related damages. UNDP (2008) estimates that 24.9 % of all estimated global costs of adaptation would have to be spent in Asian developing countries alone. Irrespective of varying absolute values, the research on adaptation unequivocally suggests that cost-effective and timely adaptation strategies and approaches, which are fully compatible with development objectives are crucial for coping with as well as reducing future climate risks (Agrawala and Fankhauser 2008; Mishra and Markandya 2010; Oxfam 2007; Parry and others 2009). In their absence,

Table 11.5 Pakistan: comparison of adaptation cost estimates (in billion US $)

Methodology	Time period	Cost of adaptation/annum (Billion US$)
Actual	One year (2010)	9.7
As a percentage of GDP	2010–2050	10.71
Per capita basis	2010–2050	7.12–14.0
Disaster modelling (Floods only) multiplication factor of three	2010–2050	6.09–11.28

Source: GOP and UNFCCC (2011)

countries will be forced to implement reactive unplanned adaptation measures and approaches, which will cost much more.

The National Economic and Environmental Development Study (GOP and UNFCCC 2011) has estimated adaptation costs for Pakistan ranging from US$ 7 to US$ 14 billion per year using various approaches (Table 11.5). According to the study, the actual forced adaptation costs that Pakistan had to bear in 2010 owing to floods triggered by climate change were about US$ 9.7 billion. The total adaptation costs however, according to the study, would be more than this figure as it was just related to the flood damage and did not factor in the costs of other climate related impacts that the country had faced like the drought of 1998–2001. Calculations, which derived adaptation costs as a per cent of future GDP projections (Table 11.5), indicated an annual average amount of US$ 10.71 billion over the 2010–2050 period. The per capita based approach arrived at annual adaptation costs for the country at US$ 7 (in 2010) to 14 billion (in 2050) using a per capita figure of US$ 40.

The basic aim of the cost estimation by NEEDS was to provide a reasonable first approximation-using top down approach, which can be refined over time particularly in terms of disaggregation of data, as an average across the country hides a very uneven distribution of the burden of adaptation across regions. The total estimated costs on adaptation approaches for Pakistan, however are too high and raise the need for developed countries to meet their commitments made under the December 2007 Bali Action Plan, adopted at the United Nations Climate Change Conference. Under this plan developed countries have agreed to provide "adequate, predictable, and sustainable financial resources and the provision of new and additional resources, including official and concessional funding for developing country parties" (UNFCCC 2008) to help them adapt to climate change.

11.5.3 Disaster Risk Reduction Approach

Regarding disaster risk reduction (DRR) due to Climate Change, a comprehensive DRR Governance System has been established and made responsible for adapting approaches both for preparedness and management in respect of all major disasters including climate related ones. It was established through the National Disaster

Management Ordinance In December 2006. The Ordinance provided for the establishment of a supervisory National Disaster Management Commission; the National Disaster Management Authority to act as the implementing, coordinating, and monitoring arm of the NDMC as well as provincial disaster management authorities (PDMAs) and district disaster management authorities (DDMAs). A permanent Act of Parliament replaced the ordinance in 2010. Other major steps taken in that direction were development of a disaster management framework and formulation of a DRR Policy. The policy aims at the creation of a resilient nation by introducing a proactive and anticipatory approach. It lays special emphasis on risk assessment, prevention, mitigation and preparedness. The Government is presently faced with two major challenges in this endeavor. Firstly to translate the Disaster Management Policy and Plan into effective disaster management systems particularly through enhancing the capacities of the governance system and secondly to create fiscal resilience through sustained investment from domestic resources as well as development of innovative financial instruments and mechanisms.

11.6 Conclusion

Pakistan is facing serious risks from climate change despite contributing very little to global greenhouse gas emissions. The observed extreme weather events of the twenty first century such as the droughts and particularly recurrent floods since 2010 already depict the impact of climate change. The floods of 2010 alone affected one fifth of the country and wiped off 5.8 % of the national GDP. These devastating floods and other climatic hazards have demonstrated that climate risk reduction is no longer an option for the country; it has become an unavoidable reality. The potential risks due to climate change are wide-ranging and likely to affect all dimensions of development with impacts across many sectors and ecosystems. Economically the detrimental impact of climate change will be widespread and have bearing not only on water security, food security and energy security but also impinge on agriculture, forests, livestock, and fisheries, the sectors vital for Pakistan's economy.

Climate change also carries risks for social dimension particularly by adversely affecting health. In addition, the extreme natural events such as floods and droughts or sea level rise due to climate change may displace people, reduce or wipe out their income, cause unemployment or jeopardize hundreds of jobs, may result in inflation of food prices and increase the number of people at risk of food insecurity and hunger. It could also trigger migration and spark civil unrest. In environmental terms, climate change is likely to affect the ecology and habitats, quantity and quality of land, soil, water and biotic resources. Other adverse environmental impact include rise in sea level and ocean temperature and salinity as well as increase of weeds and pests, which in turn may enhance environmental changes.

The effective response to disaster risk reduction due to climate change, by people and communities, in various part of the country will depend on a combination of physical, human, economic and social factors. For example coastal areas and communities of small farmers will be at greater risk. The rural houses constructed from mud and thatch will be at much greater risk compared to better quality houses in towns and cities. The poor and downtrodden will suffer more due to rise in cost of living and because of reduced food security, enhanced health expenditures and upsurge in energy prices. It is therefore extremely important for policy makers to take these risk factors into account while taking measures to combat climate change and adapting approaches to disaster risk reduction.

The approaches to disaster risk reduction due to climate change in Pakistan finds expression in a number of national policies including the Climate Change policy of Pakistan, Framework for Economic Growth (2011), National Energy Conservation Policy as well as the CDM National Operational Strategy. The National Climate Change Policy advocates climate resilient development to ensure that the measures to combat climate change are mainstreamed in the economic and social development plans. A comprehensive DRR Governance System has also been established and made responsible for adapting approaches both for preparedness and management in respect of all major disasters including climate related ones.

Mitigation and adaptation are two key aspects of response approaches for risk reduction related to climate change in the country. Regarding mitigation, the country is only a small GHG emitter but its emissions are bound to increase considerably as it strives to develop. The mitigation approaches in order to arrive at the low carbon development scenarios have been estimated to cost an additional investment ranging from $8 to $17 billion by 2050. In terms of adaptation, a number of approaches to reduce climate change risks are being promoted or envisaged related to water resources, agriculture and livestock, coastal areas and the Indus Deltaic Region in Pakistan, and for enhancing forests and other vulnerable ecosystems. A preliminary finding, however, shows that costs related to adaptation approaches for risk reduction will be too high, ranging from US$ 7 to US$ 14 billion per year. Developing countries like Pakistan do not have the resources to meet such huge costs and need the assistance of developed countries, which made commitments under the Bali Action Plan to help developing countries adapt to climate change.

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Chapter 12
GLOF Risk and Reduction Approaches in Pakistan

Gohar Rehman

Abstract The Hindu Kush, Karakoram and Himalayan ranges in Pakistan offer the most rugged and the hostile natural environment for the human colonies and settlements. This is mostly because of the ever fluctuating and proactive environmental and geo-morphological natural processes in these mountainous areas and partly because of the slow developmental activities due to the economic problems of the country. The unchecked increase in population is one of the major factors which are bringing the human populations closer to these natural processes and turning them into hazards. Glacial Lake Outburst Flood (GLOF) is also one of the most common natural phenomenon in the Karakoram Himalayas of Pakistan. There are 2,600 glacial lakes in the upper catchments of major rivers of Pakistan and all the major lakes are pro-glacial in nature. These glacial lakes are the potential threats to all the ongoing developmental projects towards the near downstream area of the lakes, including various hydroelectric power projects, bridges, roads and the low lying population clusters. Five events of GLOFs were reported alone in 2008 from the Gojal village of Hunza valley causing considerable damage to the infrastructure of these areas. Although there were small-scale successful efforts of draining out few lakes in the Ghulkin Glacier by the local community but there is no comprehensive mitigation program available in Pakistan to reduce the risk posed by the GLOF hazard. The GLOF event may not always directly affect the human settlements but in some cases may cause secondary hazards just as it happened in case of Pingal Lake of Gupis Tehsil. This chapter presents the overall situation of GLOFs in Pakistan and the present safety system placed in the areas with GLOF risk. This chapter also includes discussion about the mitigation options to reduce the risk of this hazard in Pakistan. A comprehensive methodology is recommended in this chapter for the risk assessment of any remote glacial lake using the integrated approach of bringing the field data, numerical relations and the GIS and remote sensing together. The way-forward is proposed in-terms of how to handle this hazard in future to have the safer communities from the GLOF hazard in Pakistan.

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*, Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_12

Keywords GLOF • Glacial lakes of Pakistan • Melting glaciers • Mitigation of GLOFs • Risk reduction • Disaster management • Global warming

12.1 Introduction

The great mountain ranges of Hindu Kush, Karakoram and Himalayas (HKH) cuddle each other in the northern Pakistan creating the uplifts as high as K2 and Nanga Parbat. These ranges offer the most rugged and the hostile natural environment for the human colonies and settlements. These mountain ranges are the host to many of the major alpine glaciers covering an estimated area of almost 1,800 km^2. These glaciers are the feeding source to more than 2,600 glacial lakes in northern Pakistan having surface areas ranging between a small pond of 0.0008 km^2 to a huge lake of 6 km^2. These lakes are either formed within the glaciers which are dammed by glacial ice or may form from the melt water dammed by a terminal moraine of a receding glacier.

Many of the glacial lakes are formed at the margins of glaciers along the lateral moraines. The lateral moraines create a linear high which mostly runs parallel to the direction of the glacial drift. This creates a linear depression between the lateral moraine and the outcropping rocks forming a glacial lake. In the Himalayas, Karakoram and Hindukush, the global warming is believed to be the source of heat which amplifies the phenomena of glacial melting, lake formation and outburst. Different terms are used for sudden release of high water discharge from glaciers such as a Debacle, Jokulhlaup, an Aluvion or a Glacial Lake Outburst Flood. Jokulhlaup is an outburst which may be associated with volcanic activity, a debacle is an outburst from a proglacial lake, an aluvion is a catastrophic flood of liquid mud irrespective of its cause which is generally transporting large boulders and a GLOF is a catastrophic discharge of water under pressure from a glacier but it is used broadly in HKH for any type of a sudden water discharge associated with glacial activity. The debris in moraines are normally very loosely bound and therefore prone to get washed away easily. Because of this loose packing, there is always a fair amount of chance for the weak natural dam to give way to water and cause flash floods downstream. This phenomenon is known as glacial lake outburst floods or GLOFs (Mool et al. 2001).

The random unprecedented outbursts of these lakes are responsible for creating many destructive hazardous situations in the towns and villages settled towards the downstream end of these lakes. The frequency of GLOFs in HKH has recognizably increased over the last few decades which is linked to the effects of the global warming (Roohi et al. 2008). The effect of the global warming is more pronounced in the HKH as compared to the global statistics. Many of the temperature induced geomorphic changes have rapidly occurred over the last 20 years during which Pakistan faced catastrophic events like mega floods of July 2010, formation of Atabad Lake and many GLOF events in different valleys of northern Pakistan (Table 12.1 and Fig. 12.1).

Table 12.1 History of GLOFs in HKH representing some of the major events in the past

Year	Date/season	Location	Information	Sources
1644		Broghil Valley		Hamid Mir (2013)
1844		Ishkoman	Glacier lake outburst	Drew (1875)
1860 or 1861		Karamber	Glacier lake outburst	Hayward (1871)
1865	June/July	Karamber, Sokhter Rabot	Lake at Karamber Glacier	Drew (1875)
1870		Karamber	Ice dam, no outburst	Hewitt (1982)
1884	–	Khurdopin	Considerable damage to lands at Altit and Ganesh	Todd (1930) and Charles (1985)
1891–1892		Ishkoman	Ice dam, no outburst	Hewitt (1982)
1893	6/7 July	Karamber	Water rose up to 23 ft above high flood level at Gilgit	Todd (1930)
1893	July	Khurdopin	Damage to lands at Altit	Conway (1894) and Mason (1929)
1895		Karamber	Glacial flood	Kreutzmann (1994)
1901	–	Shimshal	Breaking of a dam, bridge at Ganesh destroyed	Todd (1930)
1904	–	Shimshal	Damage to terraces at Shimshal after emptying of 2-year old lake (1902)	Todd (1930)
1905	17/18 June	Karamber	Glacier dam broke at midnight. Twenty feet above high flood level. Considerable damage to villages along the river banks above Gilgit	Todd (1930)
1905		Sokther Rabot		Kreutzmann (1994)
1905		Warghut		Tilman (1951)
1905	Second August	Khurdopin	Destruction of Chalt Bridge and Gilgit-Chalt Road	Todd (1930) and Neve (1913)
1906	11/12 August	Shimshal	Damage to bridges at Askurdas, Tashot and Chamogh	Singh (1917), Mason (1929), and Todd (1930)
1907	Summer	Khurdopin/ Malungutti	Slow drainage in 11 days	Todd (1930): 175

(continued)

Table 12.1 (continued)

Year	Date/season	Location	Information	Sources
1909		Khurdopin	Damage of seven houses at Shamets and to Hunza-Nager bridge at Ganesh	Longstaff (1951)
1911–1913		Saklei Shuyinj	Ice dam; subglacial drainage	Stein (1928)
1916		Karamber	Ice dam	Hewitt (1982)
1922	–	Shimshal	Loss of farms	Visser (1938)
1923	–	Shimshal	–	Kreutzmann (1994)
1927	June	Khurdopin	Damages to bridges and farms at Shimshal	Mason (1929) and Morris (1928)
1929		Chong Khumdan	Ice dam	Gunn (1930) and Mason et al. (1930)
1941	–	Shimshal	–	Charles (1985)
1944	–	Shimshal	Damage to terraces at Pasu	Saunders (1983)
1955		Karamber	Ice dam	Hewitt (1982)
1957	–	Shimshal	None	Charles (1985)
1959	21 August	Shimshal	Damage to bridge between Nagar and Baltit	Finsterwalder (1960) and Pillewizer (1960)
1960–1964	–	Shimshal	Loss of farms and terraces at Shimshal in consecutive years	Clark (1960) and Charles (1985)
1972		Chateboi	Small lake	Iturrizaga (2005)
1976	–	Shimshal	None	Charles (1985)
1977–1978		Darkot	Landslide/ debris flow	Raschid (1995) and Whiteman (1985)
1978	–	Shimshal	Damage to terrace at Pasu	Goudie et al. (1984)
1980	July 27	Khalti		Archer (2001)
1980	28 June	Khurdopin/ Yukshin	None	Charles (1985), Local information (Iturrizaga 2001)
1984	August 4	Gulogh		Archer (2001)
1990		Warghut	Lake	Iturrizaga (2005)
1993		Karamber	Ice dam	Hewitt (1998)
1993		Chateboi	Very small lake	Hewitt (1998)
1995	July 25	Sosat		Archer (2001)
2000	11 June	Khurdopin Yukshin	None	Mock (2000) and Iturrizaga (2001)
2003		Yarkhun Lasht		

(continued)

Table 12.1 (continued)

Year	Date/season	Location	Information	Sources
2004		Chateboi	Very small lake	Iturrizaga (2004)
2005		Brep		
2007		Sonoghor Valley		
2010		Bindo Gol		Rasul et al. (2011)
2011		Boni		
2011	July 30	Talis, Mashabrum	120 houses were damaged along with crop lands	
2013	July 31	Reshun Valley	Flash flood	Hamid Mir (2013)

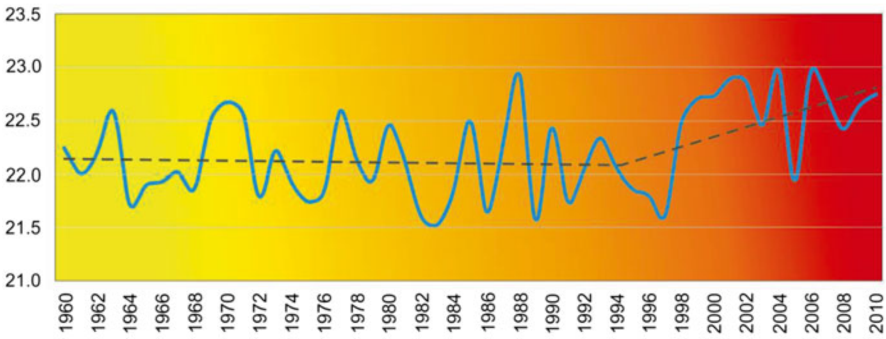

Fig. 12.1 Line graph showing the fluctuating temperature record of the northern mountains of Pakistan. The data is recorded at the elevations of 1,500–2,900 m above masl 1961–2010. The *broken line* represent the mean temperatures which shows steep rise in the mean temperature from 1996 to 2010 (After Rasul et al. 2011)

12.2 History of GLOFs in Pakistan

Karamber valley has the oldest record of producing GLOF events which have been frequently affecting the Ishkoman valley, Punial valley and in some cases the Gilgit city. GLOF event of June 1905 is recorded to be the most powerful event of all having the source from the Karamber valley glaciers. The 1929 event from Chong Khumdan glacier generated such a powerful wave that its effects were recorded in Tarbela Dam and even Attock which is almost 1,500 km away from the source glacier (Mason et al. 1930) (Table 12.1). Although Glof events in HKH are very frequent throughout the past two or three centuries but the available record indicates that there were two decades i.e. 1900–1910 and 2000–2010 in which the Glof events were relatively more frequent (Fig. 12.1, Table 12.1). This indicates the periodicity of the temperature change in this region with each rise follows the other after 100 years (Table 12.1).

12.3 Glacial Lakes of Pakistan

HKH in Pakistan are home to almost all types of glacial lakes which include subglacial, supraglacial and proglacial moraine dammed lakes. There are almost 2,600 glacial lakes present in the HKH and this number keeps on changing through time. The number was reported as 2,500 by ICIMOD in 2005 and in 2010 it was again reported by ICIMOD as 2,420. These lakes represent all three types of glacial lakes and are widespread all over the glacier filled valleys (Figs. 12.2, 12.3, and 12.4). The mode of formation and position of all three types of lakes are different. The subglacial lakes are formed at the bottom of the drifting glaciers where they get most of the heat from frictional drag of the glacial ice and debris with the rock surface

Fig. 12.2 Images showing the changing behavior of the supraglacial lakes through time on Kaberi Glacier, Ganchi, Baltistan. (**a**) Image from 5th June 2011 shows the drained out Lake 1 and expansion in the surface area of Lake 2, (**b**) Image from 14th May 2011 shows that the Lake 1 is in place and Lake 2 is frozen, (**c**) Image from 5th May 2004 shows reduces size of Lake 1, and Lake 2 shows displaced position, reduced size and different shape as compared to image (**a**) and (**b**) (Source: Google Earth)

Fig. 12.3 An ice dammed supraglacial lake in Baltoro Glacier near Skardo

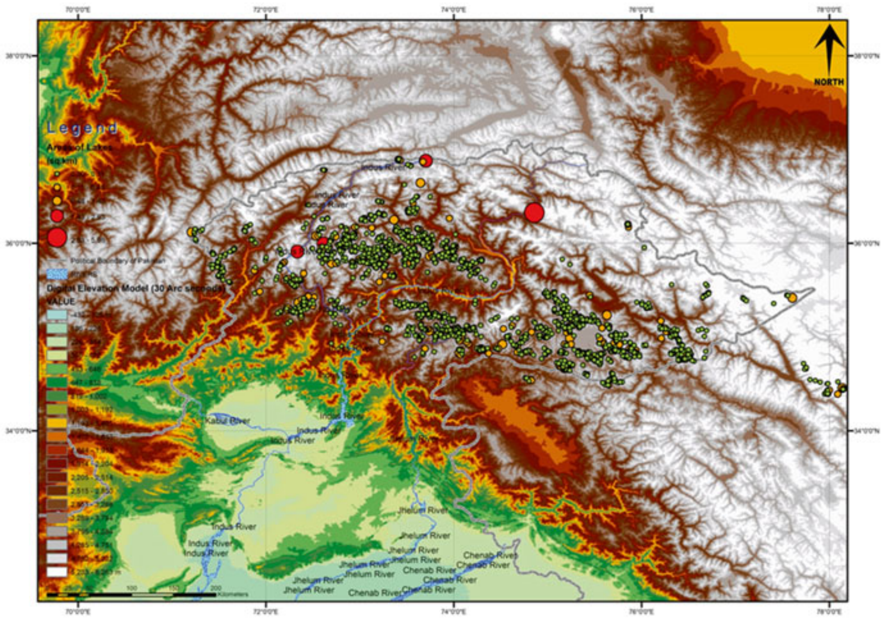

Fig. 12.4 Map of northern Pakistan showing the location of glacial lakes on a Digital Elevation Model

and some of the heat is contributed by the radiations from radioactive minerals present in the rocks. Subglacial lakes are concealed under the glacial ice and are not visible on the surface which makes them very dangerous and undetectable. The use of Interferometric Synthetic Aperture Radar (InSAR) technology enables the detection of the subglacial lakes both in ice sheets and alpine glaciers (Capps et al. 2010). The supraglacial lakes are formed on the surface of a glacier in the depressions and are dammed by glacial ice. These are usually smaller in size but may reach a kilometer in diameter. These lakes are very unstable and keep changing their positions and shapes through time and are very short lived in most of the cases. The proglacial lakes are the lakes which form between the terminus of a receding glacier and the terminal moraine. The stability of moraine dammed lakes is always debatable because of its dependency on multiple sets of physical perimeters which may vary from one situation to another.

Very little work has been done on the subglacial lakes in Pakistan and most of the events from subglacial lakes remain controversial about their origin because of little information about them. The flash flood of 31st July, 2013 hit Reshun village of Chitral and stunned the community with its sudden outrush. The event of such high magnitude was unexpected because the area was previously known for its flash floods from torrential rains which used to produce a discharge of comparatively low magnitude. In the catchment area of the Reshun village, there are two huge alpine glaciers having few supraglacial lakes. But at the terminus of both these glaciers, the signs of water outflows near the lower part are very clear. It is also know from the local settlers that the summer temperatures in Reshun and adjacent village zait are much higher as compared to the other villages of Mastuj Tehsil. Zait village has been given the name of Zait Punjab by locals because the crops in these villages become ready for reaping virtually at the same time as that of Punjab which is the southern warmer province of Pakistan. This high temperature can easily melt the glaciers and the likelihood of the July 2013 flash flood in Reshun can be attributed to the GLOF event. This event can be more precisely related to the subglacial lake because the supraglacial lakes present on the surface of the glaciers do not show any evidence of outflow or surface channeling which in case of an event as recent as 2013 must have been very clear. Therefore this event relates more to the subglacial lake. In the same way there must be many potentially dangerous subglacial lakes which are hidden or unexplored and may create a disaster situation in future.

The supraglacial lakes are very abundant in the HKH and exhibit a highly variable behavior. The life span of these lakes is usually very short and their sizes and shapes also keep changing with changing temperatures (Figs. 12.2 and 12.3). Supraglacial lakes are usually small in size but may reach up to a kilometer in diameter. The supraglacial lake of a size of about 300 m diameter or more can produce a crevasse in the underlying glacier which may drain the water from surface to the bottom of the glacier (Krawczynski et al. 2007). Water from supraglacial lake has a much higher temperature as it absorbs heat from the sun and it speeds up the process of glacial melting as it moves inside the glacier. It can also add water to the subglacial lakes if present by penetrating through the crevasses and can trigger a subglacial lake outburst flood.

Shimshal valley is long known for its GLOFs because seven glaciers open directly into it. These glaciers have a number of supraglacial lakes particularly at the terminal end of Molunguti Glacier which is the closest to the Shimshal Village. Alongside the supraglacial lakes, the presence of subglacial lakes and their role behind few of the GLOF events in Shimshal Valley can never be underestimated because the supraglacial lakes of considerably big size to produce a high discharge are not present on any of these seven glaciers.

Most of the glacial lakes in northern Pakistan with larger surface extent usually greater than 0.2 km^2 are the proglacial lakes dammed by a glacial moraine (Table 12.2). The well-known Karamber Lake of Chitral, Khukush Lake of Gupis, Sadpara Lake of Kashmir, Ghurashi Lake of Ghandus Baltistan and Uttar Lake of Ishkoman are one of the few well-known proglacial lakes of Pakistan. Karamber Lake of Chitral has a long history of GLOFs hitting the Ishkoman Valley from time to time (Tables 12.1 and 12.2). The most devastating of all those events was in 1905 which affected the low lying areas of Ishkoman, Gahkuch and Punial and its effect

Table 12.2 List of top 90 lakes of northern Pakistan having surface area more than 0.2 km^2

S. No.	Longitude (X)	Latitude (Y)	Perimeter (km)	Lake surface area (km^2)
1	74° 51′ 27.8027″ E	36° 19′ 36.9865″ N	24.947	5.988
2	73° 42′ 14.5427″ E	36° 52′ 45.2722″ N	7.757	2.632
3	72° 36′ 46.1088″ E	35° 59′ 41.0773″ N	11.953	2.081
4	72° 20′ 3.4497″ E	35° 54′ 42.5625″ N	5.422	1.639
5	72° 32′ 9.5905″ E	36° 04′ 41.2978″ N	5.99	1.428
6	75° 14′ 10.1707″ E	34° 59′ 27.6366″ N	4.346	1.325
7	75° 37′ 51.7861″ E	35° 14′ 2.8180″ N	5.195	1.262
8	73° 38′ 46.0772″ E	36° 38′ 38.4259″ N	5.122	1.069
9	72° 41′ 55.7781″ E	35° 47′ 8.3009″ N	4.281	1.04
10	72° 35′ 39.4975″ E	35° 56′ 39.1854″ N	6.499	1.031
11	71° 12′ 27.8800″ E	36° 07′ 7.2585″ N	6.457	0.982
12	78° 08′ 10.1165″ E	34° 27′ 24.1542″ N	4.612	0.977
13	73° 55′ 43.5060″ E	35° 04′ 54.1965″ N	7.579	0.966
14	74° 03′ 42.7155″ E	34° 49′ 44.5781″ N	4.155	0.949
15	73° 44′ 43.7931″ E	35° 51′ 52.6722″ N	4.518	0.857
16	75° 10′ 45.5859″ E	34° 39′ 58.0156″ N	3.739	0.756
17	77° 36′ 16.2352″ E	35° 24′ 59.4747″ N	6.493	0.739
18	72° 20′ 45.2676″ E	35° 22′ 2.2940″ N	3.6	0.736
19	74° 17′ 29.9823″ E	34° 52′ 14.0904″ N	3.611	0.714
20	73° 21′ 53.1697″ E	35° 56′ 42.5499″ N	3.763	0.69
21	73° 44′ 16.9805″ E	35° 03′ 53.8333″ N	5.107	0.671
22	75° 08′ 12.9212″ E	34° 41′ 48.2694″ N	4.334	0.661
23	73° 21′ 46.4858″ E	36° 14′ 56.9590″ N	4.236	0.555
24	72° 13′ 59.8831″ E	35° 18′ 0.3219″ N	3.456	0.552
25	74° 31′ 12.3277″ E	34° 55′ 14.8350″ N	2.991	0.546

(continued)

Table 12.2 (continued)

S. No.	Longitude (X)	Latitude (Y)	Perimeter (km)	Lake surface area (km^2)
26	74° 48′ 31.4142″ E	34° 50′ 41.9049″ N	3.254	0.4853
27	72° 25′ 58.2553″ E	35° 25′ 7.9761″ N	3.313	0.4713
28	73° 41′ 39.0705″ E	34° 52′ 36.4430″ N	2.915	0.4642
29	72° 55′ 14.6665″ E	35° 47′ 55.5322″ N	3.09	0.4524
30	72° 11′ 39.3292″ E	35° 47′ 57.9914″ N	4.231	0.444
31	72° 30′ 50.2240″ E	35° 25′ 21.2357″ N	2.956	0.4429
32	74° 04′ 14.7356″ E	34° 48′ 37.8391′ N	2.595	0.4259
33	73° 45′ 46.2875″ E	35° 52′ 57.0748″ N	3.106	0.4206
34	73° 17′ 26.3537″ E	35° 56′ 44.4698″ N	3.337	0.3803
35	73° 17′ 29.9020″ E	35° 05′ 16.6615″ N	3.447	0.3662
36	74° 49′ 39.2386″ E	35° 03′ 8.9303″ N	4.235	0.3611
37	73° 54′ 38.6492″ E	35° 58′ 18.8337″ N	2.829	0.3468
38	74° 49′ 7.8194″ E	34° 32′ 52.1141″ N	2.97	0.3383
39	71° 52′ 30.7018″ E	35° 42′ 32.2256″ N	2.422	0.3234
40	74° 49′ 38.6970″ E	34° 32′ 12.1177″ N	2.43	0.317
41	73° 12′ 30.3433″ E	35° 35′ 15.6071″ N	2.462	0.3164
42	73° 34′ 34.8382″ E	35° 52′ 48.0442″ N	2.255	0.3119
43	74° 06′ 1.2128″ E	34° 57′ 44.0677″ N	2.514	0.2998
44	73° 38′ 44.8442″ E	36° 04′ 48.1126″ N	2.221	0.2959
45	76° 12′ 18.8499″ E	35° 10′ 15.1753″ N	2.397	0.2956
46	76° 12′ 39.5192″ E	34° 59′ 12.3303″ N	3.328	0.2905
47	73° 46′ 29.4817″ E	35° 51′ 20.6034″ N	2.705	0.2882
48	74° 05′ 24.9422″ E	35° 01′ 4.2524″ N	2.401	0.287
49	73° 15′ 18.9573″ E	35° 44′ 18.1467″ N	2.434	0.2836
50	72° 17′ 48.3056″ E	35° 38′ 9.0615″ N	2.991	0.2738
51	72° 33′ 10.6335″ E	36° 04′ 52.5739″ N	3.021	0.2733
52	72° 24′ 4.5776″ E	35° 40′ 44.2180″ N	2.867	0.2689
53	75° 45′ 45.0146″ E	34° 56′ 47.9766″ N	2.186	0.2685
54	73° 12′ 39.7203″ E	35° 49′ 30.1043″ N	2.361	0.2649
55	75° 22′ 56.3293″ E	34° 49′ 27.4406″ N	2.312	0.264
56	74° 45′ 39.9697″ E	34° 50′ 21.2607″ N	2.06	0.2628
57	72° 44′ 43.2318″ E	36° 04′ 5.1224″ N	2.182	0.2616
58	73° 20′ 38.2639″ E	35° 40′ 30.8383″ N	2.137	0.2612
59	75° 35′ 31.2434″ E	34° 56′ 47.5218″ N	2.597	0.2559
60	75° 51′ 36.0463″ E	36° 10′ 19.9443″ N	3.029	0.2538
61	74° 40′ 48.1215″ E	34° 54′ 29.2449″ N	1.97	0.2529
62	77° 58′ 56.9612″ E	34° 23′ 52.4359″ N	2.23	0.2526
63	73° 09′ 15.8088″ E	35° 54′ 21.2641″ N	2.496	0.2525
64	73° 07′ 37.5110″ E	36° 09′ 44.2845″ N	2.52	0.2488
65	73° 25′ 41.9334″ E	36° 53′ 6.9213″ N	2.457	0.2476
66	74° 57′ 40.3422″ E	35° 04′ 55.2123″ N	2.925	0.2453
67	73° 33′ 27.0812′ E	36° 00′ 37.8599″ N	2.823	0.2415

(continued)

Table 12.2 (continued)

S. No.	Longitude (X)	Latitude (Y)	Perimeter (km)	Lake surface area (km^2)
68	73° 30′ 17.2898″ E	36° 07′ 43.1244″ N	2.396	0.2349
69	73° 02′ 50.1402″ E	36° 15′ 48.1805″ N	1.962	0.2315
70	72° 38′ 33.1878″ E	35° 50′ 0.6290″ N	2.427	0.2289
71	73° 15′ 54.8696″ E	35° 39′ 10.0406″ N	1.952	0.2259
72	73° 34′ 17.3577″ E	35° 46′ 56.2589″ N	1.911	0.2258
73	73° 25′ 22.0199″ E	36° 06′ 59.4582″ N	2.278	0.2219
74	74° 04′ 36.8841″ E	34° 51′ 27.9103″ N	2.392	0.2215
75	75° 08′ 25.5389″ E	34° 41′ 0.6887″ N	1.961	0.2214
76	73° 21′ 25.7425″ E	35° 39′ 6.8250″ N	1.996	0.2205
77	73° 27′ 51.5795″ E	36° 06′ 29.4580″ N	2.194	0.22
78	76° 14′ 1.1306″ E	35° 05′ 47.0582″ N	2.377	0.2197
79	74° 31′ 47.2812″ E	35° 05′ 11.8095″ N	2.194	0.2179
80	78° 08′ 37.3451″ E	34° 26′ 47.4229″ N	2.284	0.2162
81	75° 19′ 15.8695″ E	35° 07′ 56.5345″ N	1.993	0.2137
82	75° 35′ 55.7988″ E	34° 55′ 23.6909″ N	2.556	0.2136
83	73° 03′ 49.6266″ E	35° 55′ 12.5453″ N	2.33	0.2131
84	73° 52′ 36.9921″ E	35° 51′ 6.8458″ N	2.067	0.2083
85	73° 23′ 49.2638″ E	35° 57′ 44.0700″ N	2.167	0.2052
86	72° 22′ 37.8336″ E	35° 23′ 58.1615″ N	2.288	0.2044
87	75° 52′ 13.3722″ E	34° 52′ 40.0135″ N	2.275	0.204
88	75° 26′ 45.5339″ E	35° 26′ 47.9868″ N	2.277	0.2025
89	74° 09′ 20.1309″ E	34° 55′ 34.1912″ N	2.035	0.2019
90	75° 11′ 36.2276″ E	35° 15′ 48.3998″ N	2.189	0.2009

was even felt in the low lying areas of Gilgit city. There are a number of proglacial lakes which have a potential of an outburst in future because the stability of the dam alone is not the only issue for holding the volume of water back. There are many other physical factors which can alter the stability of the dam including few factors which strengthen the dam while the others decrease the dam stability.

12.4 Triggering Factors

There are multiple triggering factors behind any GLOF event including the seismic activity, volcanic activity, landsliding, rockfall etc., which are represented in the flow chart below (Fig. 12.5).

In supraglacial lakes the dam situation is mostly controlled by temperature therefore many ice jammed lakes flow out during summer season in the time of glacial retreat. In proglacial lakes the dam situation varies considerably as it is a

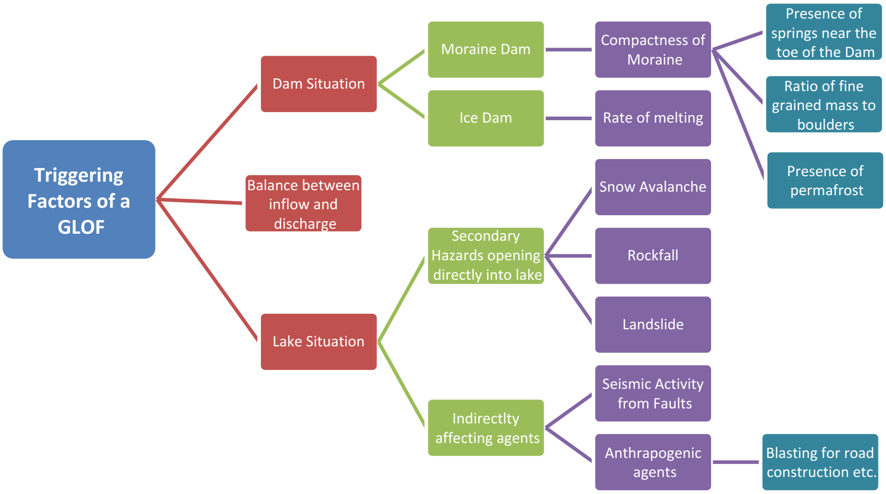

Fig. 12.5 Flow chart showing different triggering factors of a GLOF event

moraine dammed lake which may be strong enough to withstand the high pressure or in other case may just easily get washed away by a small shift of balance in rate of inflow and discharge. The compactness of the moraine dam is very important factor which ensures least percolation of water through the dam and thus keeps its stable for a longer period of time. On the other hand if the moraine dam consists of loosely bound sediments with a lot of boulder, the water will easily move through the empty spaces in the dam and will wash away the finer mass leaving behind a heap of unstable boulders which will ultimately collapse. The presence of permafrost also decreases the stability of dam because the increasing temperature can melt the permafrost in later stages which will create plenty of voids in the dam and will ultimately lead to its failure. Secondary hazards like rockfall, snow avalanche, debris flow or a landslide if fall or open directly into the lake produce a powerful wave which puts pressure on the dam and may trigger its outburst. They not only create a wave but also add a large amount of material in the lake which elevates the water level and increases pressure on the dam. Seismic activity is also one of the major triggering phenomena where ground shaking in case of an earthquake may lead to generation of a wave or may cause the subsidence or liquefaction in case of a saturated moraine dam.

12.5 Hazard Potential of GLOFs in Pakistan

All the previous events included in Table 12.1 and many others which are not included have been hitting different areas of northern Pakistan throughout the history and have caused severe damages to the human life and the infrastructure.

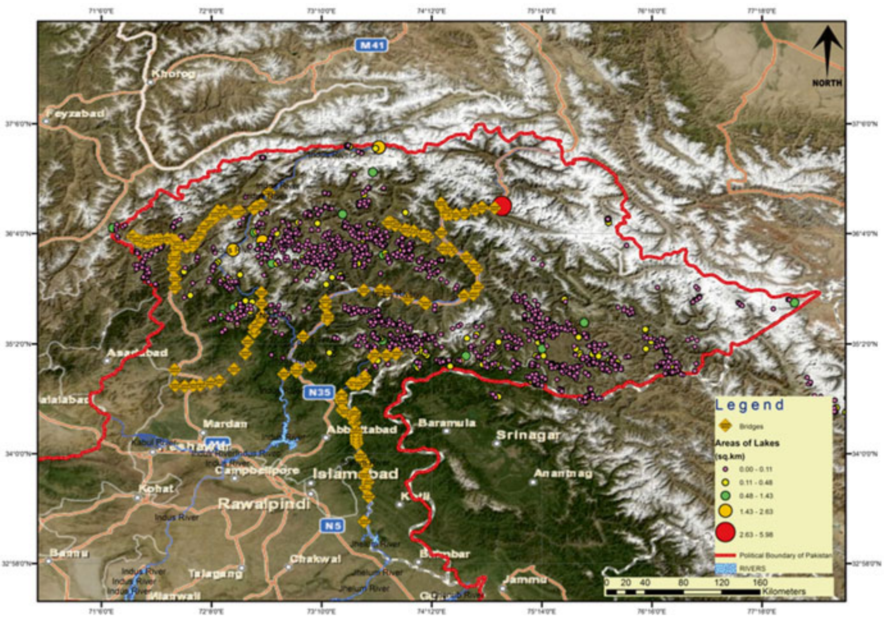

Fig. 12.6 Map showing roads and bridges of the northern Pakistan which are vulnerable to the probable GLOF events in future. Roads are displayed as *light brown bold lines* and N35 is the KKH

Glacial lakes of HKH in Pakistan are the potential threats to all the ongoing developmental projects in the near downstream area of the lakes, including various hydroelectric power projects, bridges, roads and the low lying population clusters. Five events of GLOFs were reported alone in 2008 from the Gojal Village of Hunza Valley causing considerable damage to the infrastructure of these areas. Booni Gole Glacier located near Chitral in Hindukush mountain range generated outburst flood in July 2010 triggered by anomalously high precipitation from the monsoon system which eroded the agricultural lands and also damaged the low lying areas of the valley (Rasul et al. 2011). Although there were small-scale successful efforts of draining out few lakes in the Ghulkin Glacier by the local community but there is no comprehensive mitigation program available in Pakistan to reduce the risk posed by the GLOF hazard.

Futuristically, the Karakoram Highway (KKH) is the only major route connecting Pakistan with the northern areas and the China. The KKH (N35, Fig. 12.6) runs along the Indus River switching between its left and right banks through numerous bridges along its entire length (Fig. 12.6). The transportation is so much dependent on these bridges that in case if any of them goes down will put the traffic on a halt for months until the bridge becomes functional. The wave from a GLOF may be powerful enough to damage the bridges which are not planned to withstand the extraordinary discharge of water. There are multiple small dam projects planned and few are already under construction on the River Indus for hydro-electric power generation, which if not designed to stand firm against the GLOF wave may create even bigger hazard downstream. The probability of the presence of many low lying settled population clusters is higher because there is scarcity of open flat land and people settle their colonies on the debris fan.

In Swat valley the areas of Kalam, Bahrain and Madyan are the vulnerable areas which may get hit by a GLOF event in future because there are many glacial lakes present in their catchment areas. Kalam is at the confluence of five major tributaries of streams directly connected to more than 15 glacial lakes including the Kandol Lake. The same way Bahrain is exposed to more than ten glacial lakes which can hit the town of Bahrain which is settled on the debris fan of the Bahrain River. Shiringal is the other populated area of the Swat valley which is exposed to nine glacial lakes including the couple of lakes in the catchment area of the nearest Barikot Village.

In Chitral few GLOF events are reported from Yarkhun Lasht or Yarkhun Valley including Boni which may be linked with the glacial lakes of Broghil area. The reported flash floods of the Reshun village near Mastooj Tehsil are resulted from the subglacial lake outburst floods which have a source in the direct catchment of the village which is discussed earlier in detail. The Gupis valley of Gilgit Baltistan is 120 km long strip which has a vast catchment area full of glaciers and glacial lakes (Fig. 12.8). The Khukush Lake is the largest of all the lakes and is a threat to the low lying population cluster straddling along the Gupis River (Rehman et al. 2014). Ishkoman Valley is also known for its GLOF events including the events from Karamber Lake and the famous 1905 flood wave which was powerful enough that the affects were felt in Gilgit as well. The cluster lakes of Sat Sar Mala, Lulusar Lake, Dudipatsar Lake, Saifulmaluk Lake and Sirkatha Lake are few of the many glacial lakes in the drainage area of Kunhar River which can be potentially dangerous and may create a hazardous situation in the future for the low lying areas of Jalkhad, Burawai, Batakundi, Domel, Dum Dama, Naran Kaghan and other low lying areas along the Kunhar River. The cluster of Doarian lakes, Chitta Katha Lake and Kel Lake are present in the catchment area of Neelam River Valley which need to be scientifically tested for their stability.

The vast populated town of Skardu is settled right in the mouth of Sadpara Lake which is one of the few lakes in Pakistan which are monitored frequently and are properly dammed. Glaciers of Shimshal Valley, Batura Glacier, Passu Glacier, Gulkin Glacier, Gulmit Glacier, Nagar Valley glaciers, Shisper Glacier, Chalt Nagar Glaciers and few other glaciers of Hunza-Nagar Valley are the potential sources of many subglacial lakes and supraglacial lakes. The most noticeable for GLOF events is the Shimshal valley which has a history of floods from glacial lakes. The glaciers of Hunza-Nagar Valley need to be monitored for their subglacial lakes because many events of GLOF are reported from Shimshal Valley and other parts of Hunza-Nagar Valley but very few are visible on the surface of the glaciers.

The populated town of Jutial in Gilgit lies right in the mouth of a channel having six glacial lakes in its catchment area. Three of these six lakes are of size considerable for causing serious damage to the town of Jutial. These three lakes need to be studied in detail and require proper measures to be taken before they cause any damage.

Similarly the Kargah Nala of Gilgit has two apparently smaller looking lakes but they require to be studied in detail considering the density of population exposed to them.

12.6 Secondary Hazards

A GLOF event in some cases may create a secondary lake by blocking the main river valley. The same example is present in the Gupis Valley where the well-known Pingal Lake has formed when the main river was blocked by the debris from the Glof event in the remote Sosot Lake in 1994 (Rehman et al. 2014). The event transported the boulders with an average radius of 0.7 m from the proglacial remote lake to the Gupis River (Fig. 12.7). The Sosot Lake is 16 km away from the Gupis River connected through a straight north-south trending river valley. The Sosot Lake is at the elevation of 4,485 m from the sea level while the Gupis River is at 2,475 m elevation from sea level which makes the vertical difference of more than 2,000 m

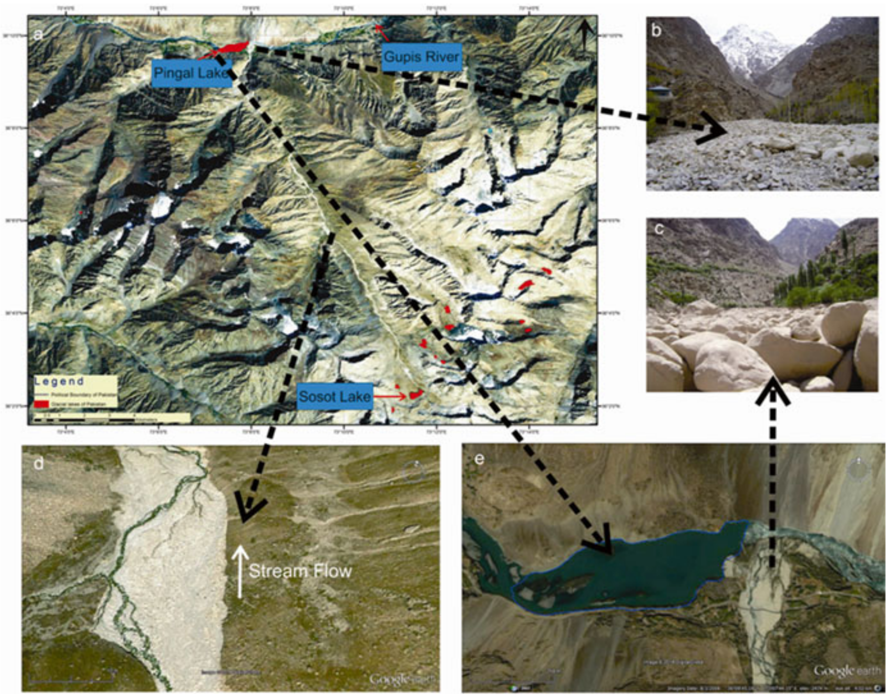

Fig. 12.7 (**a**) Satellite map showing the locations of Sosot and Pingal lakes, (**b & c**) Showing the photograph of the boulder from the Sosot Lake outburst flood, (**d**) showing the zoomed-in satellite view of the GLOF boulders, (**e**) Satellite image showing the Pingal Lake (Source of satellite image (**a**) is the ArcGIS online maps and for (**d & e**) is the Google maps)

in a span of just 16 km. The gradient of 0.125 is steep enough to help the transportation of such a huge amount of load down the stream. The Sosot lake is the morain dammed lake which is charged by the melt water from glaciers it its catchment (Fig. 12.7).

The historical image interpretation suggests that the original surface area of the Sosot Lake before the outburst was 0.15 km^2 which became 0.0756 km^2 after the outburst. The volume of water discharged was enough to transport huge boulder to block the Gupis River. Another lake started forming behind the debris dam because of the continuous inflow of water. The supply of water downstream was ceased for hours and the lake kept forming until its length became 4 km along the Gupis River. This new lake started becoming threat to the downstream areas because its size was increasing at a very high rate. The local villager immediately got activated to open the newly formed dam by their own efforts because their houses, producing lands and other assets were inundated. Since the efforts were local and were without any external support, therefore they ended as a failure but were successful enough to reduce the surface stretch of the lake along Gupis River from 4 km to almost 1 km which is its current position. Although the GLOF event itself did not cause any considerable damage but created a flood situation in the upstream direction and inundated couple of villages. At the same time the increasing volume of newly formed lake increased the pressure on the natural dam and posed a threat to the downstream villages which was neutralized by the efforts of local villagers.

A small glacial lake may drain abruptly into another lake which may not only add volume to the receiving lake but also produces a wave which puts incredible pressure on the dam which may trigger an outburst.

The supraglacial lake may drain into the subglacial lake through crevasses and may increase its volume anomalously. This not only melts the glacier from inside but increases the pressure on the ice which is holding the subglacial lake and may trigger an outburst.

Therefore the GLOFs in some cases may not have a primary hazard potential but can still be disastrous as they may just shift the problem to a new place with even much more amplified intensity.

12.7 Methodology to Deal with GLOF Hazard

GLOFs are very powerful natural phenomena and very few mitigation options are available to stay safe from them. The low predictability of their outburst is also an important factor in increasing their hazard potential. In-order to have a GLOF hazard free community, our effort should involve two approaches where one is the futuristic approach and the other is the on spot dealing approach.

First approach involves detailed scientific study of the glacial lakes therefore it has long term applications. It is an imperative procedure and the most important one of all the mitigation steps and preventive measures. Rather mitigation is planned on the basis of the results from the scientific study. The flood attenuation modeling is the technique used to evaluate the probabilistic perimeters of a flood from an outburst of a lake. The comprehensive methodology has been proposed by Rehman et al. (2014) in which three different equations were used together to calculate three important perimeters. These three perimeters include the peak flow discharge at the mouth of the lake at the time of outburst, attenuation of discharge at different distances from the lake and the velocity of wave at a given location to calculate the cross-section area that the flood wave will require to flow through. In the methodology he proposes Walder et al. (1997) method to calculate the peak flow discharge because it is comparatively more realistic and tested on different lakes throughout the world. He suggests the empirical equation known as Costa (1988) formula to calculate the discharge at any location away from the lake. The third but the most important perimeter is to calculate the velocity of lake which is of critical importance to find out the cross-sectional area that the flood wave will require. The cross-sectional area is the ultimate product which is then adjusted in the field by calculating the cross-sectional area of the river channel at different locations using total stations and other survey instruments (Fig. 12.8). Cross-sectional area required by a flood wave at any particular location is a function of velocity and discharge. The Manning's equation is suitable for calculating the velocity of the flood wave because it considers multiple variables including the roughness of a channel, the sinocity of the river, the gradient of the river and the hydrolic radius which is equal to the cross-sectional area of the current flow divided by the wetted perimeter. Once the velocity is calculated through Manning's equation and discharge through the E. Costa formula, the cross-sectional area can be calculated through dividing the discharge value by velocity ($Q = AV$ or $A = Q/V$). Calculating cross-sectional areas along river channel is also accomplished using the computer based Digital Elevation Models (DEMs). The use of DEM or Digital Terrain Models (DTM) is increasing because the advancements in the satellite technology and inventions of different sensors have enabled us to produce accurate and high resolution DEMs. The Light Detection and Ranging technology (LIDAR) is making wonders in the field of remote sensing which enables different filters including the vegetation filter, infrastructure filter and forest filters etc. Digital Terrain Models (DTM) based on LIDAR technology have a very high ground resolution and vertical accuracy and thus are extremely effective in conducting flood hazards analysis through remote sensing. The new studies in the northern mountains of Pakistan can be accomplished through remote sensing coupled with the field calculations. The use of LIDAR based DTM is highly suggested in-order to achieve as much precision as possible. The selection of the source and resolution of DEM or DTM is very critical in performing flood analysis because the vertical and horizontal ground details of the available elevation data always have problems and usually come with built-in errors. This makes the data less reliable and requires extensive on-ground verification and comparison before bringing it to use. By combining all these numerical and analogue techniques, a model of a flood wave can be developed which maps all the vulnerable locations downstream. This map helps to plan all the future developmental projects keeping in view the particular glacial lakes, their hazards potential and on-ground buffer zone or their hazard potential boundary. It is particularly useful in designing the bridges along

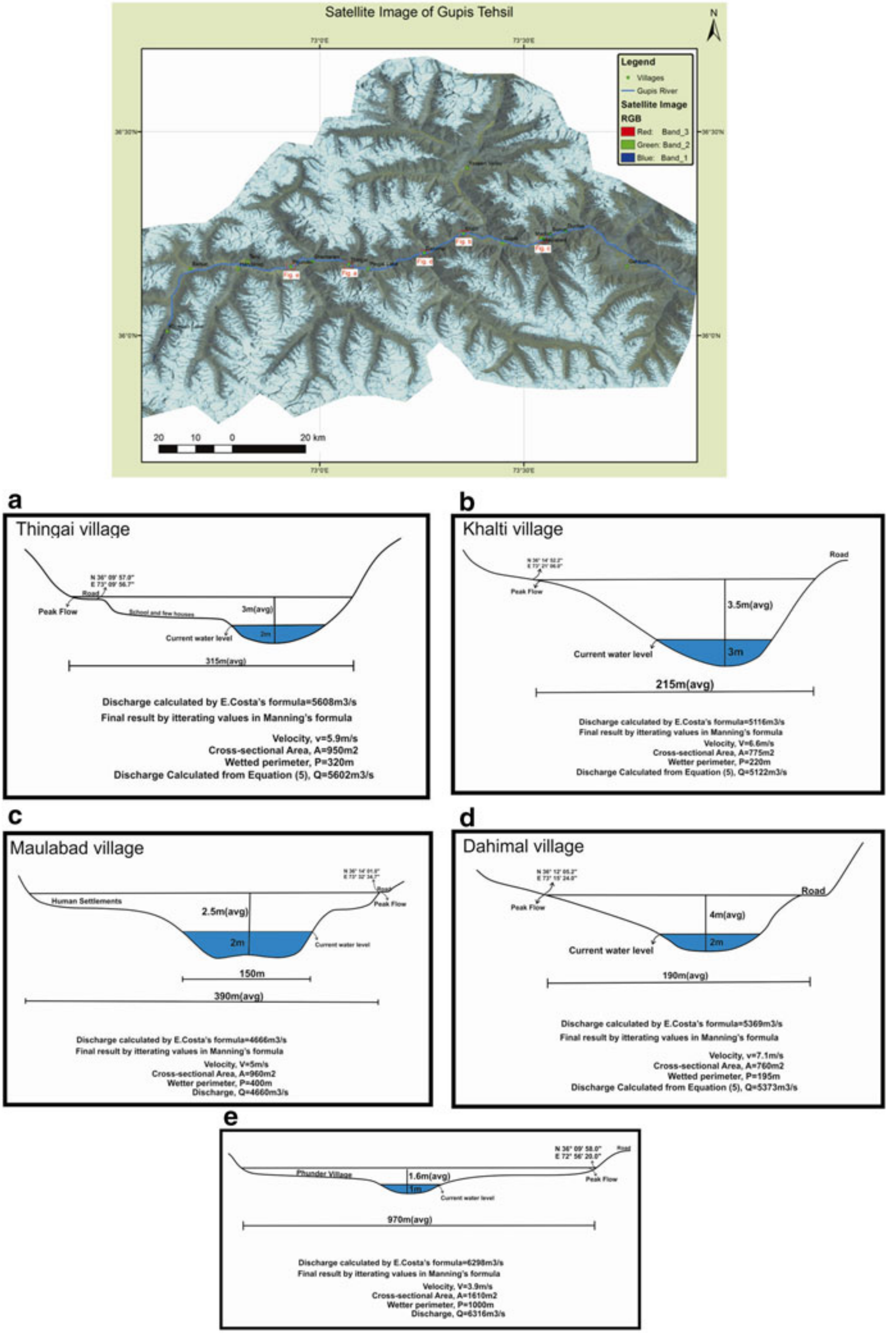

Fig. 12.8 Cross sections measured across the Gupis River at five different locations and satellite image on the top showing geographic location of these cross-sections along the Gupis Valley (**a**) Gupis River profile near Thingai Village with blue shaded area showing the current water flow,

rivers or even roads according to the height of the probable GLOF wave. The flood model is also helpful in rescue operations because the most vulnerable locations are mapped which are then reached straight away in emergency situations. The other advantage of the flood model or flood map is that early warning system can be installed only in the areas which are under the threat and can be evacuated immediately before the flood wave reaches them.

The second approach is the on-spot dealing approach which involves the mitigation of lake at its location. Many lakes in Nepal and other parts of the world have been successfully drained either completely or their level was lowered to a safe position. It is done either by dredging artificial channels in the natural dam or by conducting controlled blasting. This method of reducing GLOF hazards require extraordinary care and professional skill because there have been instances where such efforts ended up in a disaster. The other on spot method involves strengthening the dam by artificial re-enforcements. It is usually done by adding concrete to the moraine dam to fill the empty spaces and strengthen the loosely bound grains.

12.8 Conclusions and Way Forward

A very little effort has been done on dealing with potentially dangerous lakes individually in order to create a probabilistic flood attenuation models for planning the future developmental activities in the areas at risk. The KKH (N35, Fig. 12.6) runs along the Indus River switching between its left and right banks through numerous bridges along its entire length. This route is foreseeable as a major trade route for China and Pakistan when Gawadar Port will become operational and therefore, cannot be left-out neglected in terms of its economic and strategic importance. Looking at the number of glacial lakes along Indus River, the systematic way forward suggestible is to conduct a comprehensive flood modeling along all the stretch of the KKH in Karakoram and Himalayas. There are many on-going small and large hydroelectric power projects in the HKH in which the inflow of water is always of great importance. If the potential GLOF waves are not considered in planning and designs of these projects as a major destabilizing perimeter then an even bigger disaster could happen. Therefore special importance and priority should be given to these remote hazards which may apparently look distant and harmless but may turn out to be a disaster. InSAR technology should be applied to study the areas with GLOFs history for the presence of proglacial lakes and having no apparent glacial lakes e.g. Shimshal Valley.

(**b**) River profile along the Khalti Village and the upper black line represents the peak flow discharge, (**c**) River profile along Maulabad Village showing the peak flow flooding the human settlements incase of Glacial Lake outburst flood, (**d**) River profile along Dahimal Village where peak flow showing the flooded road incase of the probable glacial lake outburst flood, (**e**) River profile near Phunder Village and peak flow line showing whole village as flooded in response to the probable GLOF event

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Part III
Disaster Risk Reduction in Pakistan

Chapter 13
National Strategy, Law and Institutional Framework for Disaster Risk Reduction in Pakistan

Amir Nawaz Khan and Mushtaq Ahmad Jan

Abstract Disasters are on the rise, and we cannot estimate the full range of impact of natural hazards, climate change and climate variability. Water scarcity is a major challenge for some part of our country. Increasing urbanization and pressure on land use will continue to increase our vulnerability and as a result more and more people will be at risk. We need to stop environmental degradation, enhance information exchange and cross border cooperation to ensure disaster risk reduction. However, there is a need of sustainable and coherent institutional mechanism with a vision of long term planning. Governments will still be judged by how they respond to a disaster. Disasters do give us windows of opportunity. We need to use these windows to ensure that people are not put back into the same vulnerable position again and again. There is a need to change the traditional one-dimensional focus on response and to build a stronger understanding of the need to evolve strong and disaster resilient societies. The earthquake 2005 was an eye opener for the government of Pakistan and the whole nation. The establishment of Earthquake Reconstruction and Rehabilitation Authority (ERRA), National Disaster Management Authority (NDMA), Provincial Disaster management Authorities (PDMAs) and FATA Disaster Management Authority (FDMA) reveal the significance of the disaster management. Beside, this development the efforts of the private sector institutions and organizations cannot be ignored. They not only responded to the earthquake, 2005 and flash floods of Peshawar, 2008 but are also engaged in providing services to the Internally Displaced Persons (IDPs) and still providing services to the affected communities of floods 2010 throughout the country. It is clear that a radical change in the approach towards comprehensive disaster management is needed, with far greater attention toward prevention and preparedness rather than relief and rehabilitation. Perhaps we should begin by tackling the matter at the most

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_13

fundamental level in order to ascertain and apportion the moral responsibility for the safety of the marginal population that inhibits risk zones. The present chapter is an attempt to explore the institutional structure for disaster management in Pakistan. The chapter focuses on an overview of disasters in Pakistan, causes of Pakistan's vulnerability to disasters and climate change impacts as well as legal framework for disaster management in Pakistan, Institutional and organizational arrangements and problems in the current system is also discussed in the chapter.

Keywords NDMA • NDMC • DRR • Institutional framework • Legislations

13.1 Introduction

Pakistan, in the global context, is one of the hard hit nations of both the natural calamities and man-made disasters. Being an immediate neighbor of Afghanistan, Pakistan in general and the province of Khyber Pakhtunkhwa in particular, have suffered hugely because of frequent turbulences of foreign origin in Afghanistan and the subsequent influx of millions of refugees and all sorts of terrorism and violence since 1979. On the other hand the increasing risks of disasters, resultant destructions and causalities have greatly affected developmental projects, investment environment and the overall economy of Pakistan (CDPM 2011). Disaster resulting from variety of natural hazards both in the mountains and plains are rendering tremendous loss of lives and other properties. Ecological changes caused by the climate change, fluctuation of glaciers, rapid deforestation, erosion and unprecedented population explosion are among the salient factors that are strongly escalating the risk of numerous disasters such as river and flash floods, landslides, Glacial Lake Outburst Floods (GLOFs), famine and drought etc. One glaring example of such disasters is the earthquake-2005 in which almost one lac people lost their lives and millions were rendered homeless. Similarly one of the most recent examples of such calamities is the Floods-2010. The Floods-2010 have been the worst in Pakistan's documented history. It has been estimated that the Floods-2010 caused a total damage of US$ 9.5 billion, which is one fourth (1/4th) of the country's financial outlay for the year 2010–2011. The damage estimates have revealed that Floods-2010 have surpassed the three major disasters of twenty-first century, which are Indian Ocean Tsunami of 2004, Pakistan's Earthquake of 2005 and Haiti's Earthquake of 2010 (Khan 2012).

Top 10-disasters of Pakistan during the year 1900–2011 are shown in Table 13.1 in terms of people killed, and people affected (Table 13.2) during different disasters in Pakistan. Disaster profile of Pakistan made us understand that Pakistan has a multiple disaster statistics as it is a disaster-prone country of South Asia in which huge loss of property, flora and faunas generally occurs every year in the country. Frequent occurrence of flood causes severe disaster in Pakistan, followed by tropical cyclone, infrequent strong earthquakes and landslide in the country. Government of Pakistan involves various stake holders of country and overseas to deal with disasters on massive scale to mitigate hazards caused due to various types of natural calamities (SAARC 2014).

Table 13.1 Top 10 natural disasters in Pakistan for the period 1900 to 2011 Sorted by number of killed

Disaster	Date	No. killed
Earthquake (seismic activity)	8-Oct-2005	73,338
Earthquake (seismic activity)	31-May-1935	60,000
Storm	15-Dec-1965	10,000
Earthquake (seismic activity)	28-Dec-1974	4,700
Earthquake (seismic activity)	27-Nov-1945	4,000
Flood	1950	2,900
Flood	28-Jul-2010	1,961
Flood	8-Sep-1992	1,334
Flood	2-Mar-1998	1,000
Flood	Jun-1977	84

Source: SAARC (2014)

Table 13.2 Top 10 natural disasters in Pakistan for the period 1900 to 2011 Sorted by numbers of total affected people

Disaster	Date	No total affected
Flood	28-Jul-2010	20,202,327
Flood	9-Feb-2005	7,000,450
Flood	8-Sep-1992	6,655,450
Flood	15-Jul-1992	6,184,418
Flood	2-Aug-1976	5,566,000
Earthquake (seismic activity)	8-Oct-2005	5,128,000
Flood	Aug-1973	4,800,000
Flood	Jul-1978	2,246,000
Drought	Nov-1999	2,200,000
Storm	26-Jun-2007	1,650,000

Source: SAARC (2014)

13.2 Causes of Pakistan's Vulnerability to Disasters

13.2.1 Poor Quality of Construction of Housing (Adobe Houses), Buildings and Infrastructure

Lack of implementation of building codes and land use planning and regulations has seriously affected urban housing and infrastructure in Pakistan. The mushrooming of slums and urban poverty has further aggravated and deteriorated the already unsafe construction practices in the country. Development of infrastructure for health, education, safe drinking water and sanitation has been mostly overlooked due to high construction costs and nature of the terrain and landscape. Often there is no other possibility than to build a house or road in a position known to be vulnerable. In particular people of the mountainous regions lack access to hazard-resistant building technologies and construction materials. Vulnerabilities of mountain communities could be further exacerbated in post-disaster scenario the blockage of roads and other infrastructure and harsh climatic conditions. Consequently the target populations of the area have no access to evacuation and relief activities during the response stage (Government of Pakistan 2007).

13.2.2 Fragile Natural Environment

In Pakistan the natural and environment is very fragile which host a variety of natural and man-made disasters. The rate of soil erosion is quite high in the Northern region. Pakistan has been left with only 4 % forest and vegetative cover, in contrast to the required 25 % percent, thereby experiencing an intense and uninterrupted discharge of water, especially during monsoon seasons. Beside this the increasing snowmelt in the Himalayan glaciers has intensified flood and Landslide risks. Overgrazing of marginal lands in Baluchistan and Tharparkar, coupled with cultivation of water- intensive crops, such as rice and sugar cane, has worsened the drought conditions. A many-fold increase in livestock population in arid zones has led to overexploitation of range-lands without providing them the time to recover. Extensive installation of tube-wells in Balochistan has accelerated extraction of ground water, which is lowering the water tables very fast. Solutions to drought and water shortage problems in arid zones require modifications in agricultural and livestock management practices; e.g. reduction in the size of livestock population to make it compatible with carrying capacity of rangelands and replacement of water-intensive crop varieties with drought resistant crops (Government of Pakistan 2007).

13.2.3 Population Growth and Size

Growth and size of Pakistan's population have become a major dynamic pressure, negatively affecting all aspects of social, economic and environmental life. Population has grown by 350 % since independence in 1947. Pakistan will be the second largest contributor to global population, after China, with a contribution of 133 million till 2025. The Sub Group II on Population Projections for the 10th Five Year Plan 2010–2015 has revised population estimates since 1999–2000 on the basis of various background studies. According to this estimate, Pakistan's population in mid-2011 was estimated at 177.1 million, 2.1 % higher than last year. It was only 32.5 million at the time of independence but we added 144.6 million more people during the last 64 years. Pakistan's population has been growing at a decelerating pace but still Pakistan has one of the highest population growth rates in the world. Population growth has decelerated from 3.06 % in 1981 to 2.07 % in 2011 (Government of Pakistan 2012a, b). Increased population has pushed people to move and live in hazard prone locations, which were traditionally considered as uninhabitable; e.g. flood plains, steep slopes and coastal areas. Population growth in upstream locations has increased the demand for fuel wood, fodder and timber, which leads to uncontrolled forest cutting, and causes intensified erosion and higher peak flows. Population density in hazard prone regions also means greater loss of life and property in case of disasters. If the population growth trends continue at current rates, a far greater number of people would be living in areas prone to earthquakes, floods and droughts in the coming years. In order to arrest the rising trends of vulnerability, Pakistan must confine the growth in its people.

13.2.4 Urbanization, Industrialization and Environmental Degradation

The rapid pace of modernization, urbanization, and industrialization has led to serious environmental concerns in the developing countries like Pakistan. Over the past few decades, the natural resources have depleted remarkably resulting from accelerated pace of economic and social transformation. Economic changes such as large increases in population, agricultural output, industrial production, capital accumulation, and innovative technologies have transformed the country's natural resource base, both as a source of factor inputs and as a byproduct of pollution associated with economic activity. The continuously accelerated and unabated environmental degradation in the country is dangerous for people's health and livelihoods, the survival of species, and ecosystem services that are the foundation for long-term economic development (Alam 2010). Pakistan is in transition from an agricultural and rural to a modern industrial economy. This gradual shift entails rapid urbanization, infrastructure development, environmental degradation, soil erosion and water and air pollution etc. Urban expansion is happening faster due to high rural-urban migration. Pakistan's cities are expanding much faster than the overall population. At independence in 1947, many refugees from India settled in urban centers. Between 1951 and 1981, the urban population quadrupled. The annual urban growth rate during the 1950s and 1960s was more than 5 %. Between 1980 and early 1994, it averaged about 4.6 %. In 1994, 32 % of Pakistanis were living in urban areas. Urban population was estimated at 47.7 million in 2001 using the growth rate of 3.5 %. Estimates suggest that during 1951–1998 when the overall population grew by almost 4 times, the urban population rose by 7 times. The population of urban areas in Pakistan was about 17.8 % of the total population in 1951, which rose to become 33 % in 1998. The preference for development of infrastructure and services in urban centers coupled with opportunities for jobs and higher incomes have acted as pull factors in attracting educated and uneducated rural lots to cities. With urbanization, consumption patterns shoot-upwards drastically. City life demands better services and more natural resources (land, water, forest) to sustain life styles. Growing industrialization also require more water, timber and mineral resources. This leads to accelerated exploitation of natural resources in countryside and upstream, thus degrading the environment; e.g. Cutting of forests, depletion of ground and surface water resources and land clearance for development. Studies indicate that environmental degradation in Pakistan may lead to land erosion and soil degradation, which could enhance landslides in Northern Areas, Kashmir and Muree Hill tracts. The clearing of mangroves along with reduced volumes of water discharge in the ocean in coastal Sindh has led to sea intrusion. The loss of this natural barrier could expose coastal communities and infrastructure to escalated frequency of storms and flooding (Government of Pakistan 2007).

13.2.5 Climate Change and Variability

It has been observed that the global warming is causing damage to Pakistan's environment. Among the impacts felt and seen are biodiversity loss, shifts in weather patterns and changes in fresh water supply. The studies carried out for analyzing the trends in temperature and precipitation in the Northern Areas for the last century, found that at Skardu seasonal and annual temperatures have risen than the last century. A study conducted by Chaudhry et al. (2009) indicated that Pakistan experienced 0.76 °C rise in temperature during last 40 years. However, the increase in temperature in the mountain environment hosting thousands of glaciers was recorded as 1.5 °C during the same time period. Temperature increase might cause an upward shift of almost 400 m in the frost line. It might impact upon the snow and rain patterns and the availability of snow for melt during summer, which is a major source of water in many rivers. Occurrence of precipitation in the form of rainfall upto 4,000 m above mean sea level is common feature in mountainous terrain where it was rare in the past and now snowfall seldom occur at these elevations (Rasul et al. n.d). Observations of the World Glacier Monitoring Service based in Switzerland indicate that mountain glaciers in the Karakorams have been diminishing for the last 30 years. Experts believe the flow of water in rivers increased during the decade of 1990–2000 in comparison to 1975–1990, which means melting of more ice upstream. It has also been observed that some of the Glaciers in Pakistan have retreated significantly in the recent past. Scientists believe this is an indicator of climate change, resulting in more snow melt. Changes in the climate denote that the incidence of flash flooding and extreme flooding can increase during the next few decades. Studies conducted by SDPI also indicate that with a doubling of CO_2, average rainfall in South Asia would increase between 17 and 59 %. This will be associated with a doubling in the frequency of high rainfall events. Variable monsoons, also anticipated, could mean more droughts. Experts also believe that further desiccation of arid areas due to warming would endanger food production in the plains unless a lot of trees are planted there (Government of Pakistan 2007).

13.2.6 Gender Power Imbalances

The constitution of Islamic Republic of Pakistan gives equal rights to both women and men. However, in practice women are rarely equal to their male counterparts. According to the Human Development Report 2007/2008 the Gender Empowerment Measure (GEM) rank of Pakistan among 93 countries registered with UN is 82. The GEM quantitatively measures the empowerment of women on a country basis. This indicator includes the measure of inequality in control over earned economic resources, participation in political decision-making and economic decision-making (JICA 2008). Countries like Pakistan who have experienced large disasters demonstrate that the cost of ignoring gender in disaster response, recovery and preparedness is tremendous. This results in overlooking the damages, needs and priorities of most vulnerable in times of disaster and worsens existing poverty and inequity. Lack of gender sensitive assessments and programming intensify the existing political, social and economic inequality. Women should be empowered as equal stakeholders to act as key resource, before, during and after disasters in reducing loss to lives, household economy and in reducing break-down of social safety-nets.

13.3 Future Disaster Trends in Pakistan

The analysis of hazard risks, vulnerabilities and dynamic pressures reveal a scenario of more people living in and around hazard-prone areas. New types of hazard and disasters are occurring these days at the global level. New settlements would continue to spring up with expanding population in hazard prone areas. This trend may worsen over the years since population of Pakistan is expected to be doubled in another 25–30 years. It is also important to mention that the frequency, severity and intensity of certain hazards is on the rise; e.g. droughts, flooding, soil erosion and landslides, resulting from environmental degradation and climate change. From this scenarios it could be concluded that disasters would be more frequent in future and their social, economic and environmental impacts will grow higher than before. Regions that previously were not prone to certain hazards (e.g. droughts, flooding), may experience them in future (Government of Pakistan 2007).

13.4 Legal and Institutional Structure for Disaster Pakistan

13.4.1 Legal Arrangement

A reactive emergency response approach has remained the predominant way of dealing with disasters in Pakistan till now. The West Pakistan National Calamities (Prevention and Mitigation) Act, 1958 focused on the maintenance and restoration of order in areas affected by certain calamities and for the prevention and control of and relief against such calamities. Till earthquake 2005 the legislation was still response centric (NDMA 2010). The Calamity Act of 1958 was mainly concerned with organizing emergency response. A system of relief commissionrate at provincial level was established. An Emergency Relief Cell (ERC) in the Cabinet Secretariat was responsible for organizing disaster response by the federal government. The awareness of policy makers, media, civil society, NGOs, UN agencies and other stakeholders remained low about disaster risk management and the Country as a whole lacked a systematic approach towards disaster risk management (The Pakistan Forum 2011). Later on this act was repealed The Punjab National Calamities (Prevention and Relief) Act, 1951; The Khairpur National Calamities (Prevention and Relief) Act, 1954; and The West Pakistan National Calamities (Prevention and Relief) Ordinance 1956 (Government of Pakistan 2007). A number of ordinances, acts, rules and regulations regarding Environment were passed and promulgated by the government of Pakistan. Prominent amongst them is the Pakistan Environmental Protection Act, 1997. It has no direct relationship with Disasters but focusing on the sustainability of environment and natural resources, indirectly aiming at the reduction of disaster risks (Government of Pakistan 2007). The Pakistan Environmental Protection Act-1997 provide for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development. This was the first attempt to draft an enabling law to address environmental pollution in the country was made in 1977. Key features of the 1997 Environmental Protection Act are establishment of the Pakistan Environmental Protection Council to coordinate and supervise enforcement of the provisions of this Act; establishment of the Pakistan Environmental Protection Agency; establishment of a National Environmental Coordination Committee; establishment of the Provincial Sustainable Development Funds to provide financial assistance to the projects designed for the protection, conservation, rehabilitation and improvement of the environment; prevention and control of pollution and the sustainable development of resources and for research in any aspect of environment (Government of Pakistan 1997). In 2001 another ordinance with the name of Local Government Ordinance was promulgated. The Local Government Ordinance (LGO) provides new avenues for an effective and context-specific disaster management (Government of Pakistan 2001). The Emergency Services Ordinance, 2002 establishes emergency service to deal with emergencies in an effective manner and encounter threats to public from modern warfare, terrorism and disasters and defines responsibilities at each level (Abadi 2010).

To achieve sustainable social, economic and environmental development in Pakistan through reducing risks and vulnerabilities, particularly those of the poor and the marginalized groups, and by effectively responding to, and recovering from all types of disaster events the government of Pakistan promulgated a comprehensive policy document in 2006 with the name of National Disaster Management Ordinance 2006 (Maleeha 2012). The Ordinance provides for legal and institutional arrangements for disaster management at federal, provincial and district levels. A comprehensive approach has been adapted for the first time in the history of Pakistan for disaster management. The National Disaster Management Ordinance- 2006 was passed by the National Assembly in 2010 and it is now part and parcel of the national policies for disaster management. The mission of the new legislation is to manage complete spectrum of disasters by adopting a disaster risk reduction perspective in development planning at all levels, and through enhancing institutional capacities for disaster preparedness, response and recovery. To cater the need, the National Disaster Management Act-2010 provides arrangements for the creation of intuitional structures for disaster management from national level to community level. The priority area of these legislation are Institutional Arrangements for DRM, Hazard and Vulnerability Assessment, Training, Education and Awareness, Disaster Risk Management Planning, Community and Local Level Programming, Multi hazard Early Warning System, Mainstreaming DRR into Development, Emergency Response System and Capacity Development for Post Disaster Recovery (Government of Pakistan 2010).

This policy document introduces a proactive and anticipatory approach by laying special emphasis on risk assessment, prevention, mitigation and preparedness, with the aim of creating a resilient nation. The document is divided into four chapters: (i) chapter one assesses risk awareness and preparedness in Pakistan, finding that Pakistan's current disaster risk reduction (DRR) capacity is insufficient; (ii) chapter two outlines the National Disaster Management Authority's (NDMA) vision for capacity development in Pakistan, with a focus on vulnerable populations; (iii) chapter three explains NDMA's plan for policy interventions, particularly for development in the areas of risk knowledge, mitigation, and preparedness; (iv) chapter four explains NDMA's implementation framework to mainstream DRR in Pakistan, including plans for financing, monitoring, and educating students on disaster preparedness (UNISDR 2013). The main objectives of the Disaster Management Policies of Pakistan are:

- Creating an integrated national capacity to identify and monitor vulnerability and hazard trends including potential climate change impact.
- Creating Multi-Hazard Early Warning capacity while building upon existing systems and emphasizing the information and warning needs of vulnerable end-users.
- Strengthening an integrated disaster preparedness and response capacity from the local to the national level.
- Promoting development planning that considers and addresses disaster risks alongside environmental and climate change concerns.
- Strengthening the structural and non-structural resilience of key infrastructure and lifelines in Pakistan.
- Strengthening capacity at national and provincial levels to facilitate and provide support to the implementation of DRR policies, plans and programs across sectors and in high-risk areas.
- Strengthening Local Level Risk Reduction capacity focusing upon communities, and supportive linkages with Union Councils, tehsils and districts.
- Ensuring DRR is systematically integrated into recovery and reconstruction programming, "building better, safer and stronger" and informing DRR mainstreaming in general (Government of Pakistan 2013).

13.5 Institutional Structure for Disaster Risk Reduction

The success of the National DRR Policy lies in the effective implementation of operational plans to be prepared and implemented by national and provincial governments in line with broad policy parameters. The need for strong institutional and policy arrangements has been fulfilled with the promulgation of National Disaster Management Act-2010. Under the Act the National Disaster Management Commission (NDMC) has been established under the Chairmanship of the Prime Minister as the highest policy making body in the field of disaster management. As an executive arm of the NDMC, the National Disaster Management Authority (NDMA) has been made operational to coordinate and monitor implementation of National Policies and Strategies on disaster management. The new system envisages a devolved and de-centralized mechanism for disaster management. Accordingly, Provincial Disaster Management Commissions (PDMCs) and Authorities (PDMAs) have been established while similar arrangements have been made in AJ&K and Northern Areas. The District Disaster Management Authorities (DDMAs) have been notified across the country. The DDMAs are going to be the linchpin of the whole system and playing the role of the first line of defense in the event of a disaster (NDMA 2014). Most significantly, the role of National Disaster Management Authority, Provincial Disaster Management Authorities, FATA Disaster Management Authority, Gilgit Baltistan Disaster Management Authority along with district authorities will be the key to implement National DRR Policy for enhancing DRR capacities of line departments and at-risk communities. Figure 13.1 give a picture of Organizational Structure for Disaster Management in Pakistan.

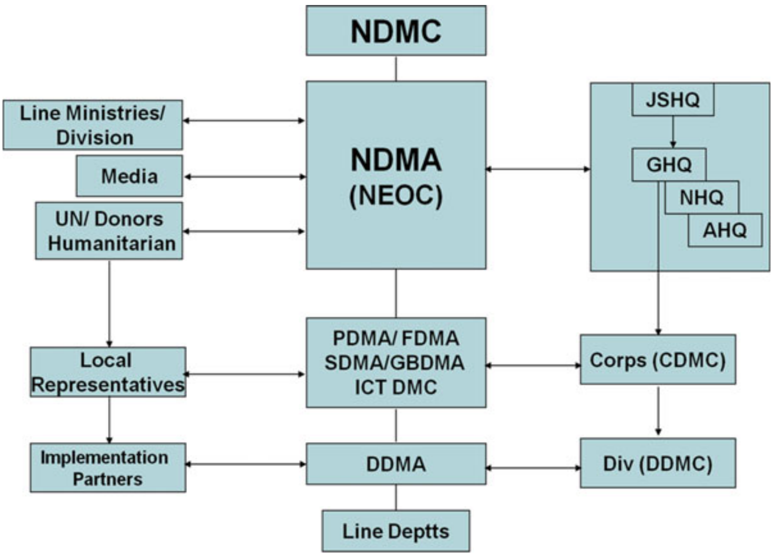

Fig. 13.1 Organizational structure for disaster management in Pakistan (After Abro 2011)

13.5.1 National Disaster Management Commission (NDMC)

The NDMC is the apex body for disaster management in Pakistan. Prime Minister of Pakistan is the *ex-officio* Chairman *of the Commission*. Other members include leaders of the opposition in Senate and National Assembly, Federal Ministers for Defense, Health, Foreign Affairs, Social Welfare & Special Education, Communication, Finance and Interior. Other members includes Governor Khyber Pakhtunkhwa (for FATA), Chief Ministers of 4 Provinces, Prime Minister of AJ&K, Chief Executive of NAs, Chairman JCSC, and representatives of civil society or any other person appointed by the Prime Minister. The Chairman NDMA work as *ex-officio* Secretary of the commission. NDMC has been mandated to develop policies, approve the National Disaster Management Framework and Plan, and approve plans prepared by ministries, divisions and provincial Disaster Management Authorities. Besides it has to ensure that all ministries, division/authorities strictly follow the framework and ensure integrated national response in case of a calamity. NDMC has to arrange for, and oversee provision of funds for the purpose of mitigation measures, preparedness and response (Government of Pakistan 2007).

13.5.2 National Disaster Management Authority (NDMA)

The NDMA is headed by the Chairman of the Authority appointed by the Federal Government (Fig. 13.2). The mandate of NDMA is to act as secretariat to the NDMC, manage complete spectrum of DRM, develop national framework for

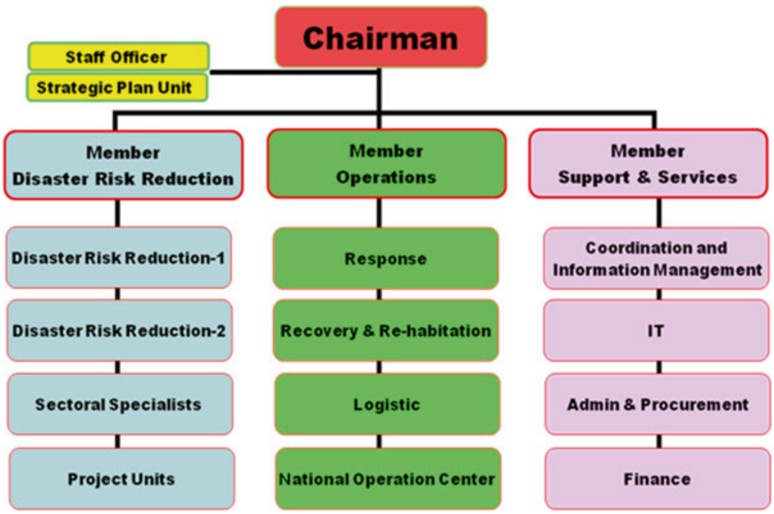

Fig. 13.2 Organogram of National Disaster Management Authority-Pakistan (After Abro 2011)

disaster management, ensure implementation of national disaster management framework, map all hazards in the country and conduct vulnerability analysis on a regular basis. The NDMA has to organize training and awareness raising activities. The NDMA serve as the lead agency in international cooperation for disaster management. The NDMA is coordinating with civil society organization and donor agencies. The NMDA is trying to create the requisite environment in which media should participate in disaster risk management activities (Ibid, 50).

13.5.3 Provincial Disaster Management Commission (PDMC)

Beside National Disaster Management Commission there is a Provincial Disaster Management Commission in each province. The Chief Minister of the Province is working as Chairperson, *ex-officio* of the commission. Other membership includes leader of the opposition in provincial assembly and one member nominated by him. The chief minister have the authority to nominate members from line ministries, civil defense, police, fire services, university faculty, research institutions, commerce, industry and insurance. The major function of PDMC is to formulate the provincial disaster management policy, to prepare provincial plan in accordance with guidelines provided by the national commission, to approve the disaster management plan prepared by the provincial departments and to review the implementation of the plan. Moreover it has to manage the provision of funds for mitigation and preparedness measures, review development plans of provincial departments, ensure that prevention and mitigation measures are integrated into development plans and review the measure that has been taken by provincial departments for mitigation, capacity building, preparedness, and issue necessary guidelines/directions (Ibid, 52).

13.5.4 Provincial Disaster Management Authority

Each provincial government has established a Provincial Disaster Management Authority for the province. The Authority is headed by a Director General. PDMAs act to formulate the Provincial Disaster Management Policy with the approval of the Provincial Commission. Coordinate and monitor the implementation of the national policy, national plan and provincial plan, conduct vulnerability assessment of the province to various disasters and specify prevention/mitigation measures and lay down guidelines for disaster management plans by the provincial departments and district authorities. The PDMA is evaluating preparedness at all Governmental or Non- Governmental levels. It is responding to disasters and also working to enhance preparedness. Besides, PDMA has to promote general education, awareness and community training on disaster management to enhance the capacity of line department and general masses (Ibid, 53).

13.5.5 District Disaster Management Authority (DDMA)

At the district level District Disaster Management Authority is coordinating the activities of disaster preparedness and management. According to National Disaster Management Policy district Nazimis the Chairperson, *ex-officio. In case of absence of Nazim* the District Coordination Officer will lead the DDMA. Other membership includes the District Police Officer, the Executive District Officer Health; and such other district level officers appointed by the district government. Major responsibilities of DDMA includes formulation of district/municipal disaster risk reduction and preparedness plans and to ensure implementation; continuously monitor hazards, risks, and disaster threats and conduct vulnerability of the district or municipality. In the event of emergency the DDMA had to take operational control of the situation to deliver support promptly to the affected communities. Besides the DDMA has to review development plans of government departments and provide guidance on mainstreaming disaster risk reduction measures. Encourage involvement of community groups in disaster risk reduction and response through training, education and awareness programmes (Ibid, 53).

13.5.6 National Institute of Disaster Management (NIDM)

The idea behind the establishment of NIDM is that this institute will work to enhance the capacity of public sector organization on disaster risk management. This institute has been tasked to develop training modules, undertake research and documentation in the field of Disaster Management and organize training programmes. It is the responsibility of the Institute to formulate and implement a comprehensive Human Resource Development Plan, covering all aspects of Disaster Management. It has to provide assistance in national level policy formulation in the field of Disaster Management. The Institute may provide required assistance to the training and research institutes for development of training and research programmes for stakeholders including Government functionaries. Moreover the institute will promote awareness among stakeholders, including College or School Teachers and Students, technical personnel and others associated with multi-hazard mitigation, preparedness and response measures.

13.5.7 National Disaster Response Force

The mandated task of the National Disaster Response Force is a specialist response to a threatening disaster situation or disaster. The force shall be constituted in a prescribed manner and the terms and conditions of service of the members. The general superintendence, direction and control of the NDRF are vested in the NDMA.

13.5.8 National and Provincial Disaster Management Fund

Under the law the Federal Government has constituted a National Disaster Management Fund (NDMF) for meeting the demand of any threatening disaster situation or disaster. According to policy the NDMF shall be kept in one accounts maintained in local or foreign currency, in scheduled banks in Pakistan and shall be operated in accordance with the directions of the NDMA. The NDMA can administer the NDMA towards meeting the expenses for emergency preparedness, response, mitigation, relief and reconstruction. Besides each Provincial Government can also establish Provincial Disaster Management Fund. The fund can be financed through grants made by the Federal Government/Provincial Governments; loans, aid and donations from the national/international agencies.

13.6 Problems in the Current System

Despite creation of a National platform for disaster management the present scenario at national level thrives on gross duplication, poor coordination and communication. Moreover the existing framework does not establish formal linkages with relevant ministries, departments, or directorates. The legal arrangement fails to identify and define relationship between key disaster related institutions. The duplication of functions is another core issue which the law needs to address vigorously e.g. prior to the establishment of NDMA, Federal Emergency Relief Cell was the lead organization for disaster management, yet it is still operational with no distinct role to perform. There exists a long list of responding agencies in case of a disaster including Civil Defense, Fire Fighting, Army, Police Emergency, Pakistan Red Crescent Society (PRCS) etc. But the existing Disaster Management Law fails to establish tangible linkages for a harmonized response strategy. Similar failing is obvious in institutionalizing early warning & information management by addressing to the linkages of NDMA with organizations like Pakistan Meteorological Department and SUPARCO. Other important institutions which are not formally linked with the National Disaster Management System include: Federal Flood Commission, Dams Safety Council, Environment Ministry, NVM (National Volunteer Movement), Geographical Survey of Pakistan etc. (Abadi 2010). There is no sufficient understanding and knowledge of risk factors and risk reduction strategy at all level. Standard procedure for institutionalized identification and assessment of geographical locations which are vulnerable to various disasters is missing. Capacity to conduct vulnerability analysis is very low due to scattered data at provincial and district levels. The concept and approached toward DRR's integration into development is at its initial stage. There is lack of institutional capacity, lack of awareness at decision making level, and lack of accountability consequently increasing Pakistan's vulnerability to disasters. There is no institutional setup for carrying out research on climatic changes, development of flood and drought reduction strategy and capacity building for coping with post-disaster situations. Beside lack of awareness, communication and political will and week early warning system has exposed the country to a number of disasters.

13.7 Recommendation for Sustainable DRR in Pakistan

Knowledge mapping and development of multi hazard profiles and vulnerability and risk assessments along with attached risks for every District is necessary to be conducted. The risk assessment at district level would provide a base on which layer of DRM Plans can be developed corresponding to the ground realities. Though it is understandable that the needs identified from risk assessment at District level cannot be totally catered for by the resources available, however it be carried in a few of the most vulnerable districts to get an idea of the level of needs (Government of Pakistan 2012a). Streamlining Land Records for reducing the disaster threats by addressing the issues of encroachment and damage to the ecology of the region. This entails not only computerizing the land records but also working towards appropriate land use planning and allocation of land, conservation of waterways, clearing of natural drains, and ensuring that all infrastructures are maintained and protected. Government needs to simultaneously work on both midterm and long term strategies to cope with disasters in Pakistan. Some of the midterm arrangements can be; (a) National hazard and vulnerability assessment, (b) Multi-hazard early warning system, (c) Institutional and legal arrangements for risk reduction and response, (d) Promoting disaster risk reduction and preparedness planning, (e) Community and local level risk reduction programming, (f) Training, education and awareness raising, (g) Mainstreaming disaster risk reduction into Development, (h) Mainstreaming DRR into school Curricula, (i) Capacity development for emergency response, (j) Capacity development for post disaster recovery.

13.8 Conclusion

In the light of above facts, it is evident that Pakistan is in dire need of an organized disaster management programme to face the emergency situations and their implications. So far, disorganized and ad hoc methods had been in practice in disaster management system. It is because of this that the country suffered more. Therefore, it is incumbent upon the Government of Pakistan to strengthen its policies of disaster management. In other words, disaster management should be amongst the top priorities of government. NDMA can be strengthened by proper allocation of funds, research, equipment, training and maintenance of transparency. In this regard, effective communication between concerned agencies and with people is a must. Embankment of rivers, disaster proof housing and infrastructure, early warnings, rapid evacuation, nomination of danger zones prior to disaster, establishment of rescue centers and creating public awareness about disasters and safety techniques with their inclusion in curriculum will surely pay dividends. Disasters often come without early warnings, recent floods in Pakistan, however, took a gradual course. But lack of sound disaster management and unpreparedness policies and their implementation has resulted in grave damages to Pakistan in all the previous disasters. Therefore, the onus lies upon the Government of Pakistan to revisit its policies and strengthen institutions to not only tackle such situations but making them to our best use. It is high time that the government as well as every citizen of Pakistan plays its own respective role to bring about a positive change.

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Chapter 14
DRR at the Local Government Level in Pakistan

Atta-Ur-Rahman and Rajib Shaw

Abstract After 2005 Kashmir earthquake, the Government of Pakistan has established national and provincial disaster management authorities and at local level district disaster management authority to handle the disaster risk management system. Under the Hyogo Framework for Actions, a paradigm shift from relief to risk assessment, preparedness and early warning systems is underway, emphasizing community resilience to disasters for hazard mitigation. It is fact that primary responsibility of protecting people and property from hazards rest on the national and local governments. It is the individuals, households and communities that are in the forefront of either escaping from or fighting against disasters. Though the national programs for disaster preparedness and mitigation are essential to save lives and protect livelihoods. This underscores the need for managing disaster risks at the community level. This chapter also discusses the key actors at national, provincial, district and local level and analyses the decentralization of disaster risk management institutions, and the role of local actors. This chapter is divided into ten sections, Sect. 14.2 describes the local government system in Pakistan, Sect. 14.3 elaborate the national disaster management authority and local government system in Pakistan, Sect. 14.4 focuses on the role of Provincial/State/FATA/Gilgit-Baltistan disaster management authorities in the local government, whereas DRR and district disaster management authorities has been discussed in Sect. 14.5, DRR at sub-district/Tehsil/Town level elaborated in Sect. 14.6 and DRR at union council level in Sect. 14.7. Community resilience and local government system analysed in Sect. 14.8, disaster resilience and local government in Sect. 14.9 and challenges and policy options in mainstreaming DRR at local level has been analysed in Sect. 14.10.

Keywords Disaster risk reduction • Local government and DRR • Community resilience • Challenges and policy issues

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_14

14.1 Introduction

Globally, during the past two decades there has been rise in the frequency and intensity of both human-induced and natural disasters (Rahman et al. 2014). The cost and damages by these recent massive disasters have been widespread including the 2004 Indian Ocean Tsunami, the 2005 Kashmir Earthquake, 2011 tsunami in Japan and 2013 Typhoon Haiyan. In 2013, out of ten most damaging natural disasters, exceptionally high frequency of eight is reported from Asia alone (Caulderwood 2014). The Philippines, China and Vietnam were suffered the most from Typhoon Haiyan, whereas India, Nepal and Pakistan were hit by flooding and incurred 7,194 deaths, while an earthquake in Pakistan killed 825 people in September. In 2013, the most economic expensive disasters were that of flooding during May in Central Europe cost $22 billion, on 20th April China earthquake which cost $14 billion, on November 8th Typhoon Haiyan cost $13 billion, on October 4 Typhoon Fitow in China and Japan cost $10 billion, droughts in China cost $10 billion, a series of droughts in Brazil cost $8 billion, July flooding in Alberta, Canada Cost $5.2 billion, August-September floods in north China cost $5 billion, another flood event in southwest China cost $4.5 billion and hurricane Manuel in Mexico cost $4.2 billion (Caulderwood 2014).

This clearly indicates that numerous communities and their infrastructure are at risk to various natural and human induced disasters. It is due to this changing disaster scenario at global, regional and local level, the disaster risk reduction practitioners are also gathering their learning outcomes and modifying the traditional coping mechanism to a more productive pro-active approach. The same was also emphasised in the Hyogo Framework of Action 2005–2015 which insist on shifting focus from post-disaster relief and rehabilitation efforts to pro-active strategy of risk assessment, mitigation, preparedness, early warning, rapid response and early recovery (UNISDR 2005). Several governmental and non-governmental organizations are applying disaster risk reduction approaches to halt or minimize the impacts of increasing disasters. However, there is a long list of developing countries which are hard hit by the impacts of these disasters. Pakistan is one of them with a low human development index. The 2014 Global Climate Risk Index of Germanwatch ranked Pakistan at 8th in 2011 and 3rd in 2012 among 180 nations of the world (Kreft and Eckstein 2013).

Pakistan is one of the disaster prone countries in the world (Shams 2006). Its exposure to wide range of disasters to a greater extent is attributed to its geographical location, geology, physiography, climate and socio-economic characteristics (Khan 2003; Rahman et al. 2014). To the south the 1,046 km border with the Arabian Sea exposes the country with variety of disasters including tsunami, storms, cyclones, earthquake etc. According to Geological Survey of Pakistan, the entire country is exposed to a range of seismic risk. Similarly, flooding is another frequently occurring hazard facing the country due to monsoonal rainfall and heavy melting of snow, ice and glaciers (Rahman and Khan 2013). The country also experienced several episodes of drought and landslides. During 2001–2013, a total of about

80,415 people were died due to the impacts of natural disasters, out of which 74,484 were the victims of earthquakes, 5,722 by the frequent flood disasters and 209 by landslides events in various part of the country (EM-DAT 2014).

Following the massive 2005 Kashmir earthquake, the Government of Pakistan realized the significance of disaster management institutions and as a consequence established National Disaster Management Authority (NDMA) a focal body to deal with mitigation, preparedness, adaptation, early warning, response and recovery process. In the country, to effectively handle different disasters, the National Disaster Management Commission (NDMC), National Disaster Management Framework (NDMF), National Disaster Management Ordinance (NDMO) and National Disaster Management Authority were established as an institutional and legislative reform. Under the disaster management legislation, the provincial governments were insisted to establish disaster management commission and disaster management authority in their respective provinces (GoP 2010). The NDMF and NDMO were the stimulating forces behind the provision of guidelines for the institutionalization of disaster management system at the provincial and district level. This process has paved a way for the decentralization of disaster management institutions at the five tiers of the government hierarchical system i.e. federal, provincial/state/region, district, Tehsil/town and union council.

Presently, at the provincial/state/regional level, there are Disaster Management Authorities (PDMA) namely; Punjab PDMA, Sindh PDMA, Khyber Pakhtunkhwa PDMA, Balochistan PDMA, State PDMA, FATA Disaster Management Authority and Gilgit-Baltistan Disaster Management Authority. The disaster management institutions were further decentralized when district disaster management authorities were established at the district level (GoP 2010). So far several district disaster management authorities have developed district disaster management plans. However, disasters are still largely managed by the provincial/state/regional Disaster Management Authorities and the district disaster management institutions are not fully functional at the district level. Similarly, the 4th tier tehsil/town and 5th tier union council, mainstreaming disaster risk reduction so far not properly addressed in the legislation and local government system. However, for 2014 local government election, almost all the provinces are in the process of bringing reforms in the local government legislation and there are hopes to properly incorporate disaster risk management at the 4th and 5th tiers of the local government system. It is well known fact that assessing community vulnerability at the local level has much fruitful coping results than over the wide geographical areas. It is therefore, need of the hour that disaster management institutions should empower the local community and promote disaster education and preparedness at the gross root level.

Under the Hyogo Framework for Actions, a paradigm shift from relief to risk assessment, preparedness and early warning systems is underway, emphasizing community resilience to disasters for hazard mitigation (Prabhakar et al. 2009). It is fact that primary responsibility of protecting people and property from hazards rest on the national and local governments. It is the individuals, households and communities that are in the forefront of either escaping from or fighting against disasters (Shaw 2012). Though the national programs for disaster preparedness and mitigation are essential to save lives and protect livelihoods. This underscores the need for managing disaster risks at the community level. This chapter also analyses the key actors at national, provincial, district, sub-district, union council and community level. In the chapter an attempt has been made to analyse the decentralization of disaster risk management institutions, and evaluate the role and responsibility of local actors including district disaster management authority, town/tehsil council and local community.

14.2 Local Government System in Pakistan

Local institutions means sub units at the public level to which the government gives some authorities so that, they may be able to solve the local problems with the local resources (Saleem and Ahmed 2012). Local Bodies are a system of Government which provides the facilities to the people in specific areas, but in Pakistan it is still in experimental stage (Chauhdary 2005). The Government of Punjab defined local government in The Punjab Local Government Act 2013 as “a district council or a town/tehsil council or a union council or a Municipal Committee or a Municipal Corporation, or a Metropolitan Corporation” (GoPunjab 2013).

Since the inception of Pakistan 1947, a number of community development initiatives were taken by the government to accelerate the socio-economic growth at local level. These developmental programmes were extended throughout the country. From 1953 to 1959, The Village Agricultural and Industrial Development Program was started with an idea of community development through community based organizations in vogue as partnership between local councils and government department. Such community based organizations were put under the control of government development officers to financially and technically support the developmental work (GoAJK 2014). The real history of Local Government elections inside Pakistan was started from the regime of General Ayub Khan (1959–1969). In 1959, he issued an Ordinance through which non-party Local Government “Basic Democracy (BDs)” elections were held and a Basic Democracy introduced as a local government system in Pakistan (Saleem and Ahmed 2012). The idea behind this system was to bring together both political and community development at local level. In this system, the government administration was organized in five tiers. Union council was the lowest level, comprises of a single village or a group of villages of at least 8,000 populations. The BDs went a long way in developing awareness and local leadership among the rural masses. Zia-ul-Haq, after coming into power, reviewed the Local Government system and established the same system on strong footings, which progressed step by step.

The Local Government Ordinance 2001, also called as Devolution Plan was issued by General Musharraf with an intention to establish the real democracy. District Government, tehsil/Town Councils, Union Councils, Village Councils and Citizen Community Boards were planned by the National Reconstruction Bureau

(Saleem and Ahmed 2012). In the local government system, power is devolved to the district administrations, which is the third tier of government system after federal and provincial set-up. Each district administration is headed by Zila Nazim/District Nazim and executive head of district administration with a key responsibility of implementing government strategy and devising productive initiatives (Anjum 2001). Until 2010, each district administration was headed by a district coordination officer. Tehsil/town council is the fourth tier and tehsil/town nazim is the executive head. Similarly, union council is the smallest unit and fifth tier of local government system and headed by union council Nazim/Chairman (Figs. 14.1 and 14.2). Nazim/Chairmen of all the union councils in a district form the district assemble.

14.3 National Disaster Management Authority and Local Government System in Pakistan

Communities are the core of risk reduction initiatives, as it is directly related with their lives and properties (Shaw 2012). Prior to the state governance system, the community were the disaster risk manager and solution provider and take care of themselves and community. In the present scenario, the community based disaster risk reduction initiative is well rehearsed. The researchers argue that decentralization of disaster risk reduction policies may largely minimize the impacts of disasters. The countries with well-established local government system have experienced comparatively little impacts of unforeseen events. The decentralized local governments have close community roots and remain within the community, respond quick and more effectively than the federal and provincial authorities.

Since disaster risk management is a cross-cutting planning area and requires timely preparedness and response. It is in this regard, at the national level National Disaster Management Authority (NDMA) was established to serve a focal coordinating body and facilitate the implementation of mitigation, preparedness and recovery plans and programs (GoP 2013). It is NDMA which directly communicate with the stakeholders. NDMA is young and still needs to acquire the capacity to act as the main facilitator of DRR in the country and provide overall support and technical guidance to line agencies, FATA/GB/State/Provincial Disaster Management Authorities (F/G/S/PDMAs) and District Disaster Management Authorities (DDMAs).

In Pakistan, the disaster management legislations insists on the decentralization of disaster risk reduction approaches and seek involvement of key stakeholders at district, tehsil, union council and community level in decision making and implementation of disaster planning activities (Figs. 14.1 and 4.2). But so far the effective involvement of local government is not reported due to lack of financial, technical and human capacity in understanding disasters coping mechanism. Whenever a disaster hit certain geographical area, community were the most quick and effective respondents in reducing the impacts of disasters. It is therefore, local community

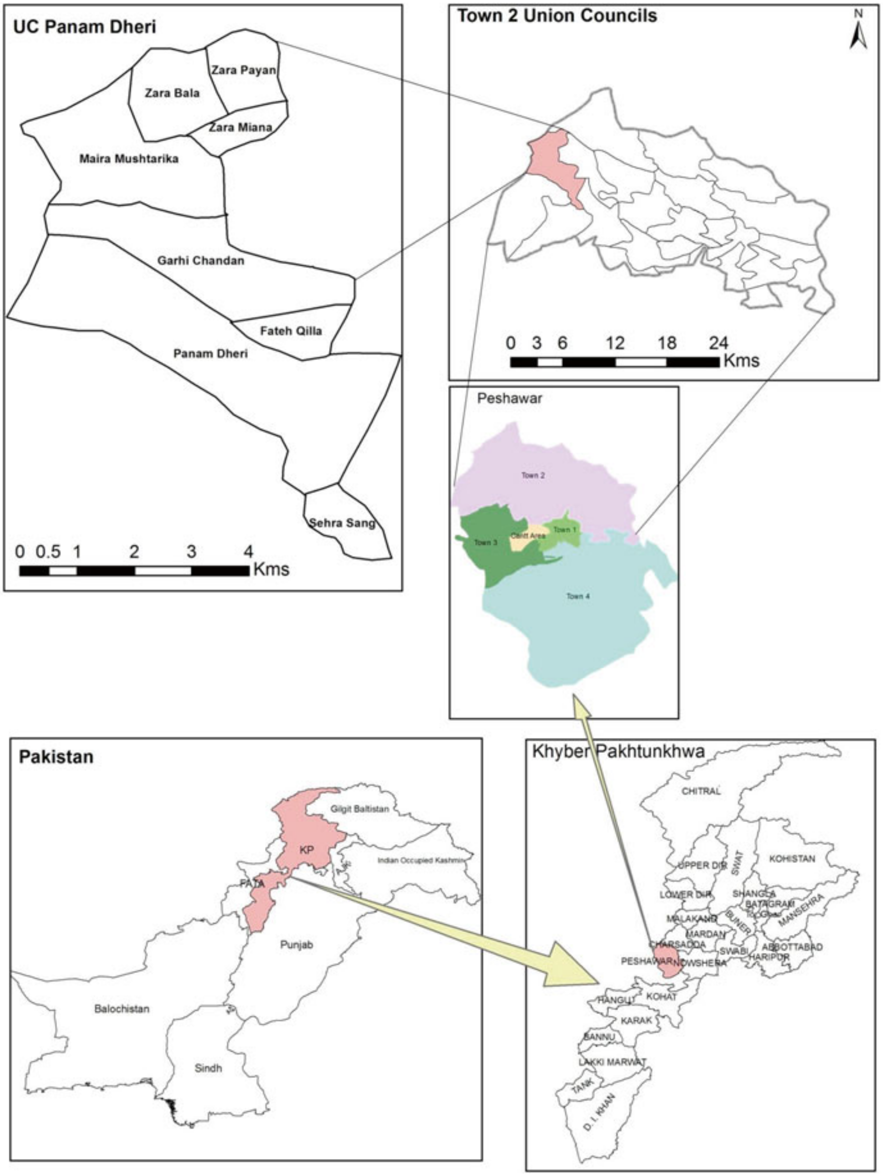

Fig. 14.1 Map showing Pakistan, provinces, districts, town and union council

stakeholders need to be involved in local policy making, mitigation, preparedness and recovery process. Nevertheless, at local level the productive operationalization of disaster risk reduction planning needs to incorporate with due weightage to community decisions in disaster risk management process at the local level.

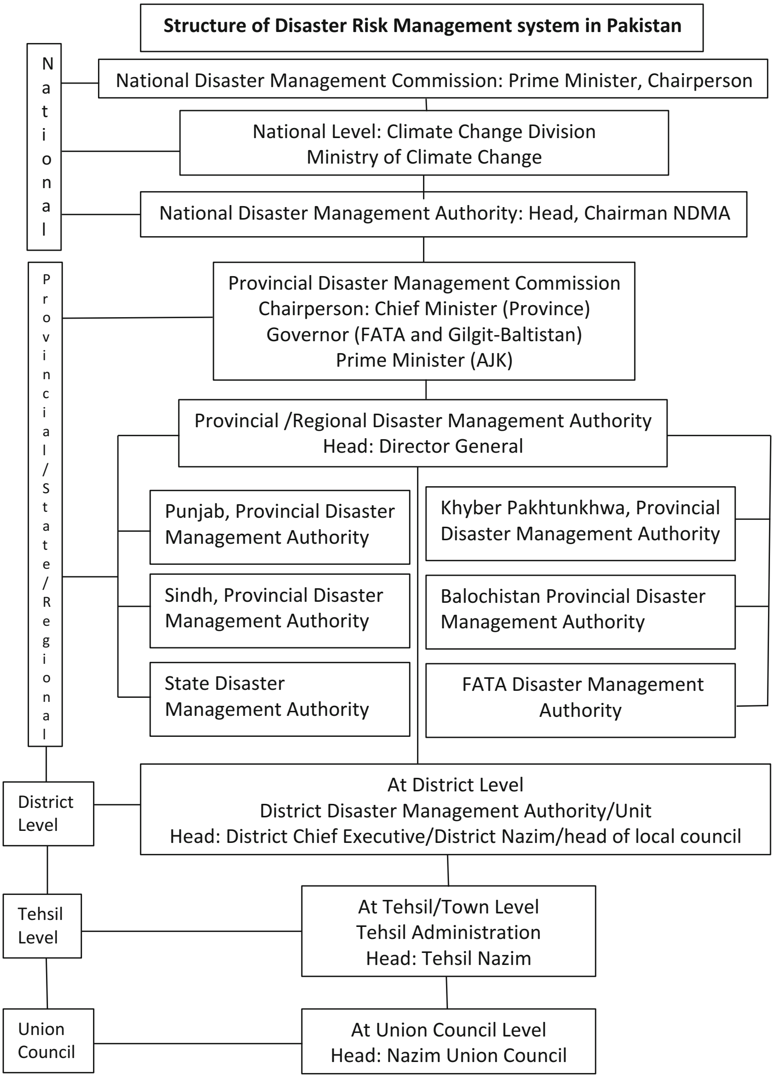

Fig. 14.2 Structure of disaster risk management system and local government system in Pakistan

14.4 Provincial/State/FATA/Gilgit-Baltistan Disaster Management Authorities and Local Government

After massive 2005 Kashmir earthquake, the National Disaster Management Commission was established, which is chaired by the prime minister and a higher policy making body related to disaster planning and management (GoP 2010). In 2006, the federal government promulgated the National Disaster Management

Ordinance with an attempt to regulate and establish consistently Disaster Management Framework at the gross root level including National, Provincial, district and Local level to dealt with the emerging issues related to all disasters and climate change related issues for mitigation, adaptation, preparedness, response and recovery. The ordinance which latter on passed by the parliament called as National Disaster Management Act 2010 also insisted the provincial disaster management commission to tackle the natural and human induced hazards effectively. The National Disaster Management Ordinance 2006 provides a legal status for National Disaster Management Framework and establishment of Provincial Disaster Management Commission and Provincial Disaster Management Authority (GoP 2010). In each province, the commission is the highest decision making body for disaster risk reduction planning and it is chaired by respective chief minister (provincial chief executive). Each province/region was directed to develop provincial/ regional disaster risk management plans following the guidelines of the national disaster management framework and legislations. The PDMA's are equally supported by the provincial related line departments in terms of technical and financial assistance in their respective areas.

Keeping in view this challenging task, so far Punjab Provincial Disaster Management Authority, Sindh Provincial Disaster Management Authority, Khyber Pakhtunkhwa Provincial Disaster Management Authority, Balochistan Provincial Disaster Management Authority, FATA Disaster Management Authority, Gilgit-Baltistan Disaster Management Authority and State Disaster Management Authority were established (GoP 2013). The major thrust of the provincial/regional disaster management authority is still on disaster response and recovery operations. Poor technical, financial and human capacity is a major hurdle in effective disaster risk reduction approaches. There is absolutely lack of coordination between the local community-based actors and regional disaster management authorities.

14.4.1 Punjab, Provincial Disaster Management Authority

Like rest of the country, the province of Punjab is also susceptible to a variety of disasters including flood, earthquake, storms, intense rainfall, drought, heat-waves etc. However, monsoonal flood is a recurrently damaging phenomenon. At is in this regard, the Provincial Disaster Management Authority (PDMA) for the Province of Punjab has been established under Section 15 and Sub-Section (i) of the National Disaster Management Act 2010. Prior to the establishment of PDMA, the provincial relief commissionerate were the only responsible government agency for disaster relief and rehabilitation. Due to lack of financial resources, preparedness planning, absence of institutional set-up and technical capacity, the province received frequent colossal loss (GoPunjab 2012).

In Punjab province, Provincial and District Response Forces have been established under the executive leadership of Rescue 1122 incorporating the voluntary structure of Civil Defence. Under PDMA, Gender and Child Cell is also working to help marginalised and vulnerable segments of disaster victims. The GCC has been prioritized and mainstreamed as an integrated disaster response strategy. In addition to her jurisdiction, the Punjab Provincial Disaster Management authority helps brothers and sisters in other part of the country, in March 2014 the Punjab Provincial Disaster Management Authority extended relief operation for the drought victims in Tharparker Sind. Similarly, in December 2013, a winter package was also sent for the earthquake victims of Balochistan. Prior to this, in September 2013 extensive relief goods were supplied for the Awaran earthquake affected population.

14.4.2 Sindh, Provincial Disaster Management Authority

Sindh Provincial Disaster Management Authority (SPDMA) has been established under the National Disaster Management Ordinance 2006 and Disaster Management Framework. In pursuance to the ordinance Provincial Disaster Management Commission was constituted. Sindh PDMA was assigned a task to devise provincial disaster management policy; Coordinate and monitor the implementation of the National Policy and Plan and prepare Provincial disaster management Plan; undertake risk and vulnerability assessment for prevention and mitigation vulnerable population in the province; prepare guidelines for the preparation of district disaster management plans; Promote disaster awareness and training; provide technical assistance to district disaster management authorities; advice the Provincial Government regarding all financial matters in relation to disaster management (GoS 2014).

14.4.3 Khyber Pakhtunkhwa, Provincial Disaster Management Authority

In view of National Disaster Management Ordinance 2006, the Government of Khyber Pakhtunkhwa has established a Provincial Disaster Management Authority and Provincial Disaster Management Commission in 2008, to build and promote disaster mitigation, preparedness, early warning, response and recovery system in the province. In response to numerous natural and human induced disasters, an autonomous body under the name of Provincial Rehabilitation, Reconstruction and Settlement Authority (PaRRSA) was also established in Khyber Pakhtunkhwa, where all the related line departments are mutually supporting this organization. In 2012, KP-PDMA has inaugurated the Provincial Emergency Operations Centre (PEOC) at Peshawar to ensure smooth flow of information between provinces and affected districts from the bottom-up before, during, and after a disaster. The PEOC contains state-of-the-art communications tools and latest equipment including data storage to support early warning systems and enhance information management capacities in case of a disaster (GoKP 2014). The control room of PEOC will serve as a hub of information collection and dissemination pre, during and post disaster phase. Previously, office of the Provincial Relief Commissioner was responsible for disaster relief, compensation and rehabilitation of victims. With the establishment of PDMA, the functions of the Relief Commissionerate were merged in the Khyber Pakhtunkhwa Provincial Disaster Management Authority. In order to get effective results and facilitate the PDMA at the gross root level, District Disaster Management Units (DDMUs) were established at district level. However, there is a need to decentralize the disaster management system to 4th and 5th tiers of local government system that is tehsil/town and union council level.

14.4.4 Balochistan, Provincial Disaster Management Authority

Balochistan is exposed to wide range of natural and human induced hazards including floods, earthquakes, cyclones, Tsunami, drought, fires, civil unrest, terrorism, refugees, health epidemics and transport accidents (GoB 2014). It puts tremendous repercussions on the sustainable development of Balochistan province. In this regard, Balochistan Provincial Disaster Management Authority (BPDMA) was established to promote disaster risk reduction approaches and to prevent and reduce extent of damages to humans, infrastructure, livestock and other properties. The vision of Balochistan PDMA is to ensure the protection of the people, property, infrastructure, and material resources in order to minimize injury, loss of life and damage to property resulting from the impact of disaster (GoB 2014). The government of Balochistan has also notified that Disaster Risk Reduction will be incorporated in all development planning and programs.

14.4.5 State Disaster Management Authority

State Disaster Management Authority (SDMA) has been established in Azad Jammu and Kashmir. The vision of SDMA is to mainstream disaster risk reduction (DRR) approaches into development planning and built community and institutional capacities for addressing climate change issues, disaster mitigation, preparedness, response and recovery. The major function of SDMA is to streamline institutions, pool resources, build capacity; Prepare strategies for DRR; establish rapid response mechanism to reduce AJ&K's vulnerability (SDMA 2014). In the Azad Jammu & Kashmir, district(s) are key administrative units for effective disaster management planning, preparedness and mitigation. Under the guidelines of disaster risk management framework and to decentralize the disaster risk reduction initiatives, District Disaster Management Authorities (DDMAs) were established in all the districts of Azad Jammu & Kashmir for effective disaster risk reduction at local level.

In 2012, the StateDMA notified Gender and Child Cell (GCC) with an aim to ensure the needs of the most marginalised and vulnerable segments of disaster victims. The GCC has been prioritized and mainstreamed as an integrated disaster response strategy. Presently, the GCC are working in two important key areas of Child Protection during disasters and gender mainstreaming in disaster management and response. The child protection program seeks during disasters to ensure that child protection concerns have been mainstreamed across disaster management and response. In this regard, standard operating procedures (SOPs) have been compiled on child protection during disasters and working to strengthen mechanisms for the implementation of these SOPs (GoAJK 2014). The Gender Mainstreaming initiative aims to ensure that disaster response and rehabilitation is gender sensitive and inclusive of vulnerable groups. The project is three pronged focusing on Strategic Planning, Capacity Building and Gender Disaggregated Management and Information Systems (GoAJK 2014).

The StateDMA has also established State Emergency Operation Centre (SEOC), which is a key functional unit of SDMA and operational 24 h/7-day basis for information management, coordination, warning and alerts. Its major functions include monitor developing threats; Organize field assessments and disseminate incident and loss/damage information; Control and manage State level emergency operations; Coordinate resources for lower level (district and sub-district level) emergency functions; Ensure that the government and the communities are alert and are kept informed of evolving situation (GoAJK 2014).

14.4.6 FATA Disaster Management Authority

In pursuance of Pakistan National Disaster Management Ordinance 2006, Federally Administered Tribal Area (FATA) Disaster Management Authority has been established in 2008, to build disaster management policy and plan, and promote disaster preparedness, mitigation, early warning, response and recovery system. FATA Disaster Management Authority (FDMA) is a federal government organization, which deals with natural or man-induced disasters in federally administered tribal areas of Pakistan. FDMA's mandate is to engage in activities concerning to all four stages of disaster management spectrum (GoP 2014). Early recovery is another mandated task of FDMA, to restore and strengthen the capacity of regional and local institutions and communities to recover from a conflict or a natural disaster. In this regard, during 2011, FDMA has launched the Inter Agency Early Recovery Need Assessment (IAERNA) program throughout the FATA region. This assessment will play a vital role in sustainable FATA disaster management planning and development.

In FATA Disaster Management Authority a Women Desk was established in 2012, which was renamed in 2013 as Gender and Child Cell (GCC). The Gender and Child Cell is effectively working to increase understanding of Child Protection in DRR; enhance institutional capacity to address Child Protection issues in DRM; contribute to policy guideline on mainstreaming Child Protection, and practical guidelines on how to institutionalize gender-sensitive risk assessments, and ensure mainstreaming into communications, training and education; encourage government to take actions to integrate Child Protection perspectives into DRR policies and program for sustainable development; mainstream Child Protection perspectives into all disaster management initiatives and use gender-sensitive indicators to monitor progress of gender mainstreaming; ensure Child Protection mainstreaming in program implementation, monitoring and evaluation (GoP 2014).

So far FDMA in collaboration with international agencies published following key documents on FATA DRR namely; Monsoon Contingency Plan 2013; Khyber Agency Tirah Assessment Report; Plan of Action for Safe School and Educational Buildings in FATA; Gender Standard Operating Procedures For FDMA; GCC SOPs to Integrate Gender into Monitoring and Evaluation; FATA Flood-2010 damage assessment; FATA DRR plan. Recently, FDMA has also signed MoU with various national and international organizations for capacity building of institutions, human resource and financial support. During the past couple of years, FATA is in the forefront of war against terrorism, and FDMA is so far doing well even in this challenging time. Over all FDMA is slow but consistent in achieving the mission and mandated tasks.

14.5 District Disaster Management Authorities and Local Government

In Pakistan, district is the third tier of government administrative unit for effective disaster risk reduction planning and management (see Fig. 14.1). For effective implementation of disaster management plans, all the provincial/regional DMAs have established DDMA's on priority basis. The provincial and regional DMA has also extended the technical and financial assistance to district level authorities. The analysis revealed that so far DDMAs are not fully functional at district level. Similarly, the provincial disaster management authorities should involve the district government in decision making and disaster risk reduction planning and implementation process. Likewise, to increase awareness and sense of ownership amongst the community, the DDMA should actively coordinate and involve the local population and community in disaster related activities.

The major function of DDMAs are to formulate district Disaster Risk Management (DRM) plan; Conduct training for local government officials, public & civil society representatives & communities at risk; Continuously monitor the hazards, risks and disaster threats and coordinate with vulnerable population; Mobilize and coordinate all interventions from other agencies at the time of emergencies; Coordinate and monitor the implementation of district DRM plan; identify buildings and places as evacuation sites or relief centres in case of disaster; mobilize needed financial and other resource for disaster risk management; setup, maintain, review & upgrade district level early warning and communication systems; establish stockpiles of relief and rescue materials ensure preparedness to make such materials available at a short notice; review development plans of government departments and provide guidance on mainstreaming DRR measures in these plans; prepare guidelines for mitigation, preparedness and response as well as for risk reduction; identify alternative means for emergency communications; keep linkages with the PDMA & the related line departments; encourage the involvement of NGOs and community groups in DRR (GoPunjab 2013; GoS 2014; GoB 2014; GoP 2014; GoKP 2014; GoAJK 2014).

The provincial and regional DMAs have already notified District Disaster Management Authorities. In Khyber Pakhtunkhwa, the provincial legislative body has renamed the DDMA by District Disaster Management Unit (DDMU). However, in rest of the country, it is called as district disaster management authority. After 2014 local government election, the DDMAs will start proper functioning and with a hope to properly mainstream disaster risk reduction strategies in their district level policies, development plans, programs and on priority prepare a sound district disaster management plan. It would be more rational if all the districts, prepare long term action plan and to achieve this, there should be short terms incremental plans.

14.6 DRR at Sub-district/Tehsil/Town Level

In Pakistan, tehsil and town council is the fourth tier of the local government system (see Fig. 14.1). Each Town has a Town Municipal Administration (TMA). It consists of a Town Nazim, Town Municipal Officer, and Town Officers with a team of other officers to assist the Town Municipal Administration. Functions of Town Municipal Administration include spatial planning (land use planning and zoning), provision and supervision of municipal services (sanitation, water, solid waste, traffic engineering, street lights, fire fighting, roads and streets, graveyards, maintenance of open spaces and parks) development control (building control and site development) in all four towns. Tehsil/town Nazim is executive elected head at the sub-district level and can work directly with the communities for devising and implementing disaster risk reduction strategies. In the past, it has been observed that tehsil Nazim along with tehsil administrations served the communities in response to any disastrous event and whenever there was demand they also hired the expertise and technical skilled persons from district disaster management authorities. It would be of paramount importance if each tehsil/town should have their own tehsil/town disaster management plan under the guidelines of national, provincial and district management system and incremental action plans for coping against the unforeseen events. Tehsil/town/sub district disaster management authorities should also involve the actors from the union councils and local communities, while planning for disaster risk reduction. Mainly at tehsil/town and union council level disaster education and awareness would be an effective strategy in minimizing the impacts of disasters. Furthermore, community based indigenous knowledge about disaster mitigation, preparedness and response need to be explored and mainstream in the local disaster management plans.

14.7 DRR at Union Council Level

For local governance, union council is the 5th tier of the local government system for developmental planning and implementation (see Fig. 14.1). In Pakistan, local level planning and implementing rural and urban activities rooted since the inception of Pakistan. These are the decentralised forms of local level government units called as union council, headed by community elected representatives to serves the community and play a bridging role between the local level planning with the tehsil/town, district, provincial and national level authorities. As per the Punjab local government Act 2013, a union council is an area consisting of one or more revenue estates or census villages and in case of urban areas, a census block(s) and a revenue estate as notified by the government for the purpose of election (GoPunjab 2013). Every district is divided into union councils excluding cantonments, based on population varying from minimum 15,000 to maximum 25,000 as per the population census of 1998 and as stated in the local government ordinance 2001. Union council is an important community level lowest tier in the local governance system, which to some extent generate their own resources and allocate budget for local development works (Chauhdary 2005).

Disaster risk management is not yet properly mainstreamed as an institution in planning and implementation at the union council level. However, for the sake of local community it would be more fruitful to consult the district and provincial authorities for allocation of financial resources, technical assistance for devising strategies disaster risk reduction activities. After 2014 local government election, the provincial, regional and district disaster management authorities may provide guidelines for internalizing DRR in sub-district, union council and community level. Involving local community and particularly those which are high risk in hazard assessment, mitigation, adaptation, preparedness, early warning, rapid response, rehabilitation and recovery would definitely help in minimizing the impacts of disasters on local population. The local population are living with hazards since their forefathers and have their indigenous knowledge and coping mechanism against the local and regional disasters. In this process, active involvement of most vulnerable social group would be of paramount importance and the availability of least vulnerable group for effective implementation. In such process community will work under the umbrella of union council level local government system and local population will be at the heart of decision making and implementation of disaster risk management activities. This would have direct impact on reducing cost of DRR activities and would benefit people in enhancing their capacities to be more resilient against the disasters at the gross root level.

Keeping in view this logical scenario of planning and development, local level authorities have been instituted. The local government system serves as a major role player in effective accomplishing the community based DRR agenda. In the local level planning system, there are some critical issue which need to be properly endorsed in local government Act including lack of financial resources, skilled man-power and political instability, and issues pertaining to the role and responsibility of executive committees at union council level. The PDMA and DDMA should coordinate and finance the disaster management activities at the union council level. As lack of resources shall remain a major barrier in disaster risk reduction operation. At gross root level, disaster education and awareness will be another effective strategy in minimizing the impacts of disasters at local level. Capacity building of local community has so far been recognized a significant attempt in reducing disaster impacts, because community has always been the rapid respondents to any disaster event.

14.8 Community Resilience and Local Government System

Community Based Disaster Risk Reduction (CBDRR) is one of the emerging and widely recognized approaches, where vulnerable communities are engaged in hazard assessment, analysis, mitigation and monitoring disaster risk by building citizen capacity and minimize vulnerabilities. In this process, community is actively engaged in both decision making and implementation of disaster risk reduction activities. The participation of most vulnerable social groups is of major concern in the CBDRR process, while the support of the least vulnerable groups is necessary for successful implementation of disaster related actions (GoAJK 2014).

Community based disaster risk reduction is an effective framework for implementing disaster resilience strategy at local level (Manyena 2006). At the local level, CBDRR calls on people to work for the disaster risk reduction agenda at the community level. In fact, community has the indigenous knowledge of DRR and the quickest respondents to any unforeseen events. Keeping in view this logical scenario, local level authorities have been instituted. The local government system serves as a major role player in effectively accomplishing the community based DRR agenda. Developing a sense of ownership amongst the community, and also respect their local culture, traditions and political system. It would be very rational to utilize local resources for disaster risk reduction. At the same time, it is of paramount importance that local planning authorities should focus on disaster prevention, preparedness, emergency response and effective recovery strategies within the available local resources.

It is important to mention here that enhancing community capacity is of paramount importance because the community will be able to assess the hazard vulnerability and implement appropriate risk reduction measures. Similarly, in disaster management plan include such actions that should prevent disasters, mitigate hazards and prepare the community to effectively respond to crises and emergencies (Manyena 2006). This process is called as community risk reduction or community risk management or community-based disaster risk reduction or community-based disaster risk management. Community based risk reduction organizations, individuals and nongovernmental organizations (NGOs) working in disaster areas have been lobbying and advocating for community involvement in risk reduction to governments and UN agencies. CBDRM was a hot agenda during the International Decade for Natural Disaster Reduction (IDNDR; 1989–1999), a UN-initiated strategy to reduce disasters worldwide (Manyena 2006). Finally, the urgency of addressing disaster risks at the local level has become one of the main concerns of the World Conference on Disaster Reduction held in Kobe, Japan (UNISDR 2005).

In Pakistan, the intensity and frequency of both natural and human induced disasters are on rise. Climate related disasters are there which further intensify the impacts due to changing climate scenario (IPCC 2007). It is therefore, time to properly mainstream and institutionalize the CBDRR approach in the local government system and to recognize the strength and value of this tested approach at local level planning and implementation. The need for engaging local communities and social groups in disaster risk reduction activities, decision-making, planning, allocation of budget for CBDRR activities, assign responsibilities to implementation staff to extend support to community groups and devise applicable strategies and program to support community action (GoAJK 2014).

The StateDMA has devised a strategy to establish a CBDRR committee on union council basis. As a consequence, so for 56 CBDRR committees have been established in the three earthquake affected districts. This process was fruitfully completed with the collaboration of local and INGOs. Training and awareness campaign was the landmark feature of this program and as a result 2,368 volunteers were also trained as a capacity building strategy against the unforeseen events. These committees were also equipped with stockpiles. Furthermore, as a part of community based DRR strategy "school safety pilot project" was launched in 37 schools covering almost 5,000 students in the 2005 earthquake affected districts of Azad Jammu and Kashmir (GoAJK 2014). The StateDMA has also developed a disaster management module for students and teachers and the same was distributed amongst the threshold population. Most importantly, the StateDMA in collaboration with Malteser International (INGO) has installed Public Earthquake Warning Systems namely SECTY at six different locations of District Muzaffarabad and District Bagh (GoAJK 2014). The siren system will automatically turn-on few seconds prior to any major earthquake and can be heard within the radius of 2.5 km. This indicates the growing consciousness amongst the government tiers, which would help the community and ensure safety of human lives in the catering areas.

14.9 Disaster Resilience and Local Government

The concept of resilience is used both in the sense of process and outcome (Manyena 2006). However, in a more effective way, resilience is the capacity of a system, community to cope with, adapt or bounce back by resisting or modifying its impact and maintain an acceptable level of functioning and structure in the light of a hazard shock (Pelling 2003; UNISDR 2005). Hence, the key resilience characteristics are coping with the impacts of disasters, recovery from disasters and "bouncing back"; and adaptation to cope better with future risks (World Disaster Report 2004). It is determined by the degree to which the social system has the potential of organising itself to enhance the capacity of learning from the past disasters for effective mitigation (UNISDR 2005). There are a number of key success factors for building disaster resilient communities: building on the knowledge, capacities and priorities of people; mainstreaming gender issues in disaster risk reduction; public awareness of disasters; community based disaster reduction and creation of partnership and collaboration (World Disaster Report 2004).

Since independence 1947, institutionalization for local government system has been one of the top priorities agenda of the government of Pakistan. During the past 67 years several times, reforms in the local government system was operationalized. Such reforms were related to political, financial, jurisdiction, constituency boundaries and autonomy of local government authorities. Decentralisation of authorities from federal government to gross root local government is one of the principal requirement towards building disaster resilient communities (Manyena 2006). Legally constituted local government units have administrative, political and financial autonomy in implementing policy, development plans and programs and it is therefore, local planning authorities need to be in sound position to empower the local actors for sustainable development and implementation of disaster risk reduction approaches in true spirit at the local level.

Building disaster resilient communities, the local level planning authorities should have full autonomy in decision making, involving local level key actors in the planning and implementation process. Decentralization of administration autonomy to local authorities for enhancing community resilience against the unforeseen events has not yet formally decided. Some issues related to mitigation, preparedness, early warning, response, rehabilitation will be both financially and administratively in reach of the local authorities. However, most of the challenging issues pertaining to mitigation, warning and reconstruction will be more technical and costly for the local government actors to cope with using local skills and resources. Indeed the provincial and district disaster management authorities have technical arms and may extend their services to their respective union councils. In Pakistan, the effectiveness of sustainable disaster risk reduction in the local government system largely depends on the national government policy, legislation, financial support and framework. Local government system can only function effectively in disaster risk reduction efforts and building community resilience when local populations equitably and functionally involved and technically and financially resourced (Lewis 1999). Piecemeal or rather ad hoc decentralisation in fact provides a fertile ground for increasing rather than reducing disaster impacts.

14.10 Challenges, Potentials, Way Forward and Policy Options

The government of Pakistan established NDMA, F/G/S/PDMAs and DDMAs as key organizations in disaster management at national, provincial and local levels respectively. However, the disaster management organization at the national level has not been established with clear roles and responsibilities among the federal ministries. Moreover, linkages between NDMA and F/G/S/PDMAs are quite weak and there is no clear coordination mechanism between NDMA and DDMAs. Since the NDRMF was prepared in 2007, Pakistan has experienced heavy flood damage in 2010 and 2011. The coordination mechanism of disaster management among national, provincial and local levels needs to be strengthened (GoP 2012). Hence, there is need of strengthening disaster management administration at national, regional and local level.

FATA is located at a strategic location along the western border of Pakistan. Since independence 1947, the governance of FATA function under the Article 247 (3) or FCR (Frontier Crime Regulation), which have no room for the local government system like rest of the country. Out of total country population, more than four million are living in FATA. Administratively, FATA is divided into seven agencies and frontier regions. Political Agent (PA) works as executive head of each agency. Recently, one positive development was seen when Political Parties Joint Committee on FATA Reforms was formed. The FATA Committee has made 11 recommendations to government to give FATA citizens the same rights and opportunities as other regions of Pakistan. One of the key recommendation focuses on the introduction of local government system in FATA to be in par with rest of the country (The News 2014). The administrative, political, social and economic reforms in FATA would definitely pave way for initiation of disaster risk reduction efforts and sustainable development at the local government level.

Pakistan is one of the most vulnerable countries to climate related disasters. In 2011, the Germanwatch ranked Pakistan at 8th most vulnerable country and in 2012 at 3rd in Global climate risk index among 180 nations (Kreft and Eckstein 2013), which clearly indicate the increasing trends of climate change exacerbations. It is therefore a paramount significance to accelerate early and cost-effective mitigation and adaptation strategies to climate change risk at the gross root level and mainstream DRR in local government system. The resilience of local community can be enhanced through improving capacity of the local citizens (Prabhakar et al. 2009), government and physical region while dealing with climate vulnerability. It is time to prepare the local communities to effectively adapt, mitigate and bounce back the increasing impacts of climate related disaster.

In Pakistan, capacity building is not a new concept. In the past couple of years, several programs were initiated both by the federal and provincial government for technical and institutional capacity building of their respective organizations. Building community resilience against the unforeseen events, where government is not the sole action player but it is actually a joint venture of different stakeholders including community groups, NGOs, private corporations, donors and government agencies. It is fact that local planning authorities are prerequisite stakeholder in building disaster resilient communities.

Globally, it is accepted fact that being within the community, they are more productive in devising long-term solution to disaster and development issue in their respective jurisdictions (Smoke 2003; Manyena 2006). The local authorities should mainstream the DRR in development plans, project planning activities and monitor its true implementation. However, it would be a challenging task for the local authorities to be an effective actor in transferring element of community based disaster resilience agenda, but there should be someone at the gross root community level to take an initiative right from the scratch.

Efficacy of local government system in mainstreaming disaster risk reduction strategies in development planning is largely dependent on the nature of internal system. In development planning process transparency, participation and accountability are the three key pillars of governance. In the presence of existing weak institutional, economic and human capabilities of local planning authority to deal with the local problems and hazards is a challenging task. The capacity of a local planning authority to develop disaster risk reduction plans and to cope with the unforeseen events depends largely on its overall capacity to plan developmental activities.

Recent research reveals that educating community and mass awareness have played a pivotal role in taking actions and implementing disaster risk reduction initiatives. Experiences, projects, and programs have positive impacts on increasing disaster education, reducing vulnerability and disaster risk management (Shaw et al. 2009). It is education and awareness which equip community members with techniques of risk reduction on self-help basis. While mainstreaming DRR in the local government system, the vulnerable groups including children, women, disables, aged population need to be trained about their role in disaster preparedness and safe evacuation. Similarly, education and training for adult population and how to react and help the vulnerable community and marginalized group in case of a disaster. In addition to this, the community leaders to take special interest in community based risk reduction approaches including awareness, mitigation, warning, evacuation and rehabilitation. Such education needs to be made accessible and affordable for frontline practitioners who operate at community level. Furthermore, more stable and disaster resilient education facilities, such as school buildings provide a shelter in case of disaster need to be made more resilient and reinforce through better engineering and technical knowledge.

In Pakistan, disaster and climate change education is either lacking or very little reflected at various levels, which have overall slight impacts on mass awareness and disaster risk reduction at the community level. After 2005 Kashmir earthquake, the disaster related policies, legislation and institutions has made a paradigm shift from active to proactive approach and where disaster education and awareness has got special attention of disaster managers and decision-makers. Work on the disaster education curricula for school children, undergraduate and university level is in progress under the curriculum wing ministry of education, government of Pakistan. In few specialised institutions including Pakistan Forest Institute, disaster education has been made part and parcel of their curricula. The disaster related authorities have specially realized the desired and significance of disaster education in improving risk assessment and mitigating the local communities from the impacts of disasters.

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Chapter 15
NGOs and Disaster Risk Reduction in Pakistan

Amir Nawaz Khan and Amjad Ali

Abstract In Pakistan, the "non-government organizations" (NGOs) play a vital role in disaster risk reduction. The donor's agencies and International NGOs not only support the National Disaster Management Authority (NDMA), Provincial Disaster Management Authorities (PDMAs) and Federally Administrative Tribal Areas (FATA) Disaster Management Authority (FDMA) to perform their functions effectively but also provides guidelines on policy matter. The local NGOs, community based organizations (CBOs) and volunteers closely work with community and thus enhance their risk reduction and emergency response capacities. The present study analyzed the role and responsibilities of NGOs in advocacy, policy, management and disaster risk reduction (DRR) measures in Pakistan. The study explore that almost whole scenario of DRR is controlled by NGOs. They device the national policy, conduct different level trainings, prepared plans and support DRR measures. The unipolar approached achieve some milestone of legislation, national DRR policy, district plans preparation. However, lack of ownership, ignoring physical and economic aspects of development and contradictory approaches in implementations are some major concerns of their contribution.

Keywords NGOs • DRR • Role of NGOs • DM Act 2010 • NDM Policy 2013

15.1 Introduction

Pakistan is a developing country with a rapidly growing population. The economy is never stable and a number of times halted by natural and/or anthropogenic disasters or political disruption. Under-development can be seen in every sector of economy of the country. This situation leads to poverty and social disruption. Consequently, most of the population lives below the poverty line. Like most of the developing countries, Pakistan never scores satisfactory on Human Development

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_15

Index (HDI). The consecutive governments' developmental policies have top-bottom approaches. As a result, the neglected lower class of population in Pakistan gave rise to the need of alternate organizations addressing the core issues of food, shelter, health, education access to resources and power etc. These bodies and organizations filling the human development needs and gap are commonly known as Non-governmental Organizations (NGOs) – or more recently as Non-Profit Organizations (NPOs). Although, the number of registered NGOs in Pakistan runs in thousands, those that are actually making worthwhile contributions are few hundreds (Anand and Sen 1994, 1995, 1997; Collins 2009).

Disaster management is multi-disciplinary and multi-stakeholder subject which has strong link with development. A comprehensive approach to DRR requires a combination of changes in practices at the local level with changes to national and international policies. Addressing the root cause of poverty and achieving sustainable development leads to enhancing the capacities and reducing the vulnerability to hazards which make a resilient community. This goal of development and resilience community can be achievable through contribution of NGOs in those sectors where Government pays less attention or has least resources. The present study is an attempt to analyses the role of NGOs in DRR in Pakistan. The NGOs play a vital role at national level in policy guidelines, its making and implementation. Similarly, it is the NGOs which implement and experiment the international policies of DRR in Pakistan. In Pakistan, the NGOs supported the disaster management legislation, setup, administration and community based DRR. This influencing role of NGOs in DRR of Pakistan has some contradictory lesson learns. The implementation of two different international DRR policies; supporting the establishment of two similar DRR administrations and their legislation; more focus on community based disaster risk reduction (CBDRR); promoting visibility rather than sustainability in DRR projects are some important outcomes of the contributions of NGOs in DRR of Pakistan.

15.2 Global Regime of DRR and Pakistan

On 22nd December 1989, the United Nations (UN) General Assembly (GA) passed a resolution (44/236) which designated the 1990s as the International Decade for Natural Disaster Reduction (IDNDR 1990–1999). Its basic objective was to decrease the loss of life, property destruction and social and economic disruption caused by natural disasters, such as earthquakes, tsunamis, floods, landslides, volcanic eruptions, droughts, locust infestations, and other disasters of natural origin. IDNDR followed strictly techno-centric and scientific approach in beginning. The Yokohama conference on May 23–27, 1994 put socio-economic aspects as component of effective disaster prevention into perspective which is known as Yokohama Strategy. It was recognized that social factors, such as cultural tradition, religious values, economic standing, and trust in political accountability are essential in the determination of societal vulnerability. It was accomplished with local, regional and international program of actions. It emphasised on exchange of information and policies implementation to reduce the impacts of disasters.

The IDNDR was replaced and continued by the International Strategy for Disaster Reduction (ISDR). The ISDR aims to pursue the initiatives and cooperation agreed on during the IDNDR, and developing new mechanisms as well as pushing for further commitments from policy-makers. The overriding goal is to reduce human, social, economic and environmental losses due to natural hazards, technological and environmental disasters. The building of disaster resilient communities is a main objective. Most of the NGOs in Pakistan targeted the last objective of "resilient communities" in their projects. Second world conference of UN on Disaster Reduction was held on January 22, 2005 in Japan. This conference brought together government officials, non-governmental experts and other specialists from around the world to discuss the growing trend of people affected by natural disasters. The Conference adopted plans to put in place an International Early Warning Program (IEWP), which was first proposed at the Second International Conference on Early Warning in 2003 in Bonn, Germany. This conference was followed by Hyogo Framework for Action 2005–2015 in which main emphasis was given on building the resilience of nations and communities to disasters and integrates disaster risk reduction into policies, plans and programmes of sustainable development and poverty reduction (GFDRR 2011; Aleem 2013).

Resolution of the GA calling upon adoption by governments of the Hyogo Framework and recognizes the Global Platform as a successor mechanism to the Inter-Agency Task Force for Disaster Reduction. National practitioners and stakeholders repeatedly expressed desire to have a mechanism through which they can exchange their experiences in DRR and access information on how other countries addressed particular challenges in the implementation of the Hyogo Framework. The Global Platform has been set up to serve this need, and is expected to become main global forum for all parties involved in DRR, namely governments, United Nations agencies, international financial institutions, regional bodies, civil society, the private sector, and the scientific and academic communities. The Global Platform provides advocacy for effective action to reduce disaster risks, expands the political space devoted to the issue, and contributes to the achievement of the Millennium Development Goals particularly in respect to poverty reduction and environmental sustainability (Magrabi 2011; UNISDR 2004, 2014).

The International Strategy for Disaster Reduction has been given full support and implementation by United Nations system and international financial institutions. They also cooperate to advance integrated approaches to building disaster resilient nations and communities. Recognizing the local element in moving the DRR agenda forward, a Global Network of Civil Society Organizations for DRR was initiated with the close support from UNISDR and the Special Unit for South-South Cooperation of the United Nations Development Programme. The Global Network of "Community Practitioners' Platform for Resilience" was officially launched in Geneva during the first session of the Global Platform for DRR in June 2007. The main goal of the Community Practitioners' Platform for Resilience is to convene community leaders and innovators to advocate for policies and programs that advance pro-poor, climate resilient development. The group represents a unique opportunity for communities vulnerable to disaster and climate change to play a key role in agenda-setting and DRR implementation. The UN, World Bank Partnership Framework for Crisis and Post-Crisis Situations, and the tripartite European Commission, UN, World Bank Joint Statement on Post-Crisis Assessment and Recovery Planning, affirm the highest level of commitment to work together in supporting disaster affected countries through GFDRR.

The major source of inspiration and funding for DRR in Pakistan is Hyogo-Framework of Action (2005–2015). Most of the Government and NGOs are committed to work under the umbrella of HFA. All of their activities are focused to achieve the one or more targets of HFA. The Millennium Development Goals (MDGs) are used as cross cutting theme in HFA. The United Nations General Assembly Resolution 66/199, requested the development of a post-2015 framework for DRR. A first outline is developed in Global Platform in 2013, and a draft should be finalized towards the end of 2014 to be ready for consideration and adoption at the World Conference on Disaster Reduction in 2015. Pakistan has made statement to the United Nations 66th General Assembly thematic debate on DRR in 2012; Global Platform for DRR (2013); and Preparatory Committee (PrepCom 1) of the Third UN World Conference on DRR (2014) (GOP 2012; Aleem 2013; Bokhari 2014).

Pakistan is covered by UNISDR's Asia and Pacific office. Every year, Pakistan share the progress on HFA Pakistan which shows also the activities carried out by NGOs. These reports included IDNDR assessment report (1998); National progress report on the implementation of the HFA (2009–2011); and HFA (2011–2013). UNISDR has identified some milestone for DRR of a country. From the list of these milestone, Pakistan has achieved most of them with help and support of NGOs, for examples National Disaster Management Act 2010; National DRR Policy 2013; and Poverty Reduction Strategy Paper – PRSP (2004) etc. Pakistan is one of the piloting countries of the UN reform process, some 19 UN agencies are engaged in designing joint UN programs in five thematic areas with the ultimate objective of "delivering as one" so as to better support human development for the people in Pakistan especially with regard to the Millennium Development Goals (MDGs). Disaster Risk Management (DRM) has been selected as one of the thematic areas to be addressed through a joint programme, reflecting the importance this subject has gained in Pakistan as well as the active interest UN agencies are taking in DRM. The One UN DRM Joint Programme Component is based upon the work of the United Nation's Thematic Working Group (TWG) in DRM which was initiated in March 2007. Prepared through collective deliberations within the UN system and consultations with Government of Pakistan, this framework also contributes to the implementation of the HFA, which was adopted at the World Conference on Disaster Reduction, Kobe, Japan, 2005. It was by participating UN agencies; FAO, ILO, IOM, UNAIDS, UNDP, UNESCO, UNFPA, UN-HABITAT, UNHCR, UNICEF, UNIFEM, WFP and WHO, started from January 1, 2009 which was ended on December 31, 2010 with estimated budget of USD 66,359,770. The "One Programme" captures up-to 80 % of all UN support provided to Pakistan throughout the period 2008–2010. On the basis of extensive consultations, the Government of Pakistan and the United

Nations Country Team (UNCT) identified six key Strategic Priority Areas (SPAs) and extended the programme for the period 2013–2017 (GOP 2012; UNICEF 2013; German Technical Cooperation Agency (GTZ) 2009).

15.3 NGOs Fundings in Pakistan

Even though the work done by the NGOs is for development and social uplift of local communities, there is almost no support provided by the federal or local governments. Almost all of the funding is by international donor agencies. The funds are transferred using by donors only through banking or other legal channels. A third party audit is also conducted on the use of those funds by NGOs in Pakistan. Although there is relaxation in tax procedures for NGOs, contrary to popular belief, NGOs are not fully exempt from income tax in Pakistan. Grants are generally provided on project basis. Donors publish advertisements calling for Proposals. In response to that NGOs submit Project proposals, their profiles, financial feasibility studies and many other requirements. NGOs/NPOs are shortlisted and selected based on their past performances, available infrastructure and professional competencies of staff and board members (Asian Disaster Preparedness Center [ADPC] 2008; Khan 1993a, b; Verayanti 2011).

15.4 The Role of NGOs in DRR Advocacy, Policy and Management

After Earthquake – 2005, the NGOs particularly the INGOs play a key role in structuring the Earthquake Reconstruction and Rehabilitation Authority (ERRA). The UNDP along with other partner UN sister agencies and INGOs conduct training of high official and provide full support for establishment of ERRA. On legislation part, the Ordinance – 2006 was draft and promulgated by Government of Pakistan to support all these activities. In 2008 from UN One DRM programme, National Disaster Management Authority (NDMA) was established. Disaster Management Act – 2010 was promulgated with help of UNDP. The JICCA and UNDP further support the DRR policy and District Disaster Management Plans form UN One DRM programme platform. The National Working Group on Mainstreaming DRR continues to coordinate and facilitate the mainstreaming of DRR for sustainable DRR integration and development in policies, planning and programming in all line ministries and related professional bodies (GOP 2010a, 2013).

Several multilateral and bilateral donors and agencies are involved in DRM in Pakistan. In accordance with their mandates the World Bank and the Asian Development Bank have provided loans for the rehabilitation/reconstruction of the earthquake areas. The Banks are also taking an active interest to work with the government of Pakistan to mainstream DRM into development. The World Bank has set aside USD four million to provide support to NDMA to assist in conducting risk assessment at federal level and the strengthening of emergency response capacities. Donors and agencies such as the European Commission's Humanitarian Aid Department (DIPECHO), SRSA, DFID, GTZ, SDC, JICA, OFDA/USAID and others provide support to the strengthening of DRM capacities at provincial and local levels. Projects supported include: the strengthening of emergency response services, urban search and rescue in major cities, strengthening the PDMA in Khyber Pakhtunkhwa and community based disaster risk management. It is essential to coordinate and fine-tune plans and activities with these actors and establish linkages for optimization of resource allocation and use (UNICEF 2013; GOP 2007a, b).

The SRFF provides rapid technical and financial assistance for sustainable disaster recovery in low-income countries, mostly, but not necessarily only, in the form of Preliminary Damages and Need Assessment (PDNAs). The main objective of a PDNA is to provide the strategic underpinnings for medium to long-term reconstruction and recovery planning, prioritization, and programming in the event of a natural disaster. This normally includes: quantification and validation of the impact on the economy, households, and individuals; development of sector level recovery and reconstruction strategies for public and private infrastructure, services, and livelihoods; and quantification and prioritization of corresponding sectorial and overall recovery and reconstruction and DRR needs. A PDNA is a government led exercise with integrated support from the UN, the Economic Commission, the World Bank and other national and international actors (GOP 2005, 2010b, c).

National DRR Policy, outlining Pakistan's objectives, priorities and directions for reducing risks from upcoming challenges of disaster management, has been formulated in consultation with all stakeholders. The policy promotes DRR friendly development planning while focusing on climate change adaptation measures, disaster risk insurance, community based disaster risk management approaches. More than 90 % staff and administration of NDMA, PDMAs and FDMA are supported by INGOs. In number of districts, DRR projects and District Disaster Management Authority (DDMA) are supported by NGOs. In fact there is no financial or administrative support from Government in any DDMA (GOP 2007b, 2010b).

15.5 The Role of NGOs in DRR

Philanthropy has been a major part of the Pakistani culture since the beginning. Historically, traditional businessmen have been contributing to community development projects. General public also has a giving nature and been assisting the poor under both humanitarian as well as religious inspirations. The formal NGO sector however developed in the past couple of decades. Since the 1980s the Non-profit NGO sector has witnessed considerable activity and growth in Pakistan. There has been a paradigm shift in our approach to disaster management during the last one decade. The shift is from a relief centric approach to a multi-dimensional endeavour involving diverse scientific, engineering financial and social processes to adopt a multi-disciplinary and multi-sectorial approach. The role of NGOs in this context therefore assumes added significance. The High Powered Committee (HPC) on Disaster Management carried out a nation-wide consultation process with over 600 NGOs to address the lack of a well-coordinated network between the government systems and the NGO sector and also among the NGOs themselves. HPC recommended a nationwide network of NGOs for coordinated action encompassing all aspects of disaster management (UNISDR 2010; Verayanti 2011).

The Disaster Management Act has given legislative back-up to this endeavour by entrusting the State Executive Committees and District Authorities with the responsibility to advice, assist and coordinate the activities of NGOs engaged in disaster management. The District Authorities are mandated to encourage the involvement of NGOs and voluntary social welfare institutions working at grass root level in the Based on morale and ideological questions to this tune have haunted the aid community for a long history of disastrous events in Pakistan. Institutional arrangements for disaster response are the heart of disaster management systems. There is no dearth of personnel, both civilian and military, experienced in handling situations arising out of natural disasters. However, there certainly is a pressing need for improvement and strengthening of existing institutional arrangements and systems in this regard to make the initial response to a disaster more effective and professional. Most of the resources and expertise needed already exist with the Government. Although government of Pakistan does not provide guidelines or directly monitor NGO activities, it is mandatory to register the NGO with the government. Registration is generally under 'Societies Registration Act of 1860' OR Voluntary social welfare agencies ordinance 1961. The guidelines for NGO operations and activities are generally provided by the Donors/Funding agencies. Quality control audits are also performed by the donors. The work of NGOs are focused on community based participation and social development (GOI 2010; Khan 2010; UNISDR 2004).

15.6 The Role of NGOs in Floods – 2010 and Earthquake – 2005

The recent catastrophic floods in Pakistan affected 20 million people and caused multi-billion dollar damages to public and private assets across the country. Similarly, the Earthquake – 2005, caused huge lost and damages of life and property. The Damages Need Assessment (DNA) survey and/or reports were conducted with help of World Bank, Asian Development Bank and Government of Pakistan. These disasters tested GFDRR's rapid response capacities but also created the opportunity to use its partnership platform to assist disaster-affected countries and their populations with timely and increasingly coordinated support. This assistance combines best practices in recovery and reconstruction that integrate and mainstream all aspects of longer term DRR toward sustainable development. It consolidates all assessment information into one report that can be readily used by the government and the donors for raising funds and implementing coordinated recovery efforts. The DNA is now firmly established and is being used as the key and most visible activity by GFDRR for supporting resilient disaster recovery and leveraging longer term DRR (Atta-ur-Rahman and Khan 2011, 2013; GOP 2007a, b).

UN agencies played a key role in providing support and expertise to emergency response/early recovery after the 2005 earthquake, not only within their specific agency mandates and key areas of expertise but also by piloting the cluster approach, one of the key elements of the Humanitarian Reform process. Through the cluster approach UN Agencies demonstrated their core competencies for an effective response management. The UN System's involvement in the earthquake relief and recovery program has led to significant enhancement of the system's own capacities on disaster issues. UN Agencies have also initiated capacity building projects (as part of the recovery process) in the earthquake-stricken areas that have strengthened preparedness and to some degree also prevention and mitigation capacities. Some UN Agencies have engaged in more comprehensive capacity building projects in the area of DRM, particularly UNDP in support of the NDMA and WHO in support of the Ministry of Health. This experience of UN System can be used to support the government's efforts in enhancing capacities for emergency response and post-disaster recovery (GOP 2005, 2007b; Khan 2010).

In areas affected by Floods 2010 and 2011, special emphasis have been laid on incorporating the element of DRR into all rehabilitation and reconstruction projects, both implemented by the government and donor & humanitarian. The NDMA in collaboration with the UN and humanitarian community made sure that the DRR working group/cluster activated to look into mainstreaming DRR into all projects and activities as a cross cutting theme delivers its stated objectives. These measures led to safer reconstruction practices, promote a culture of safety and enhanced resilience of communities against future disasters. The Earthquake Reconstruction and Rehabilitation Authority (ERRA) have been assigned by the Government of Pakistan to implement the reconstruction programmes in the areas affected by Earthquake 2005. ERRA has integrated the principles of DRR into recovery and rehabilitation projects. The ERRA's programmes have been particularly successful in promoting earthquake safer construction in housing, education, health and land development sectors. As the post disaster reconstruction programmes in the earthquake affected areas of KPK and AJ&K are nearing completion, the local capacities on account of emergency preparedness, response and recovery to deal with future disasters have also been increased manifolds. Due to the implementation of a range of DRR initiatives in these affected areas a culture of resilience to disasters has already taken its roots which can be reflected in safer constructions, community awareness about disasters and other DRR initiatives being taken by the local governments and community based organizations. However, the sustenance of such initiatives is dependent upon consistent support by the local Government through allocation of dedicated resources and capacity building of local authorities in the field of DRR (GOP 2007a, b, 2010c; Atta-ur-Rahman and Khan 2011; Khan 2010; Khan and Ali 2014; NDMA 2013).

15.7 Discussion

Development and Financial Institutions become more aware of the costs which a passive non proactive strategy eventually causes poverty. Various incidents at different jurisdictions showed the gaps between legislation, policies, knowledge at the community level, communication, and early warning system in Pakistan. Many of these challenges link Pakistan to its immediate neighbours and the international community at large. The impact has been particularly severe on the poor, women, children, the elderly, crisis-affected populations, persons with disabilities, refugees and temporarily relocated persons. Damage to habitat, loss of livelihoods, trauma of displacement and disillusionment has added to these pressures. Pakistan is also among the World's Top 10 in terms of vulnerability to the impacts of climate change, and the cost of adaptation is estimated at $10.7 billion per year for the next 40–50 years. The 80 million children and young persons under the age of 18 need investment for their education, security and health. Women need to be engaged with issues of their local communities and to be empowered to participate in decision-making processes at all levels. As a pre-requisite for engagement, women also need to equally access and benefit from quality social services. Attitudinal change among men to social and cultural practices at family, community, provincial and national levels is needed.

The UN system has not worked on disaster risk management issues in the country previously; various agencies have an impressive range of core competencies on different aspects of disaster risk management issues. In fact, the idea of UN delivering as One truly represents a unique opportunity to deal with disaster risk issues in an integrated and cohesive manner. The awareness created by recent disasters has created an opportunity to strengthen a "system" of disaster risk management in the country as there is wide appreciation for the need to build capacity not only at the national level but also at the provincial, district and grassroots levels. The One UN Joint Program was a pilot project in which Pakistan was a test case regarding the initiation of a new methodology of working on UN projects in countries that need aid. According to project documents, the One UN methodology was instituted to circumvent replication of efforts by the UN on the development projects. Under this new methodology, all the departments of the United Nations are supposed to work with mutual cooperation and understanding. According to project documents of the One UN Joint Program, the new management design changes are supposed to bring together many operational sectors: Agriculture, Rural Development and Poverty Reduction Health & Population, Education, Environment, Disaster Risk Management, Human Rights, Gender Equality, Civil Society Engagement, and Refugees. The One UN Joint Program was considered one of the utmost projects in the history of Pakistan, but unfortunately the tall claims made in the project documents of the attributes and accomplishments of the One UN Program are very distant from the reality on the ground, especially amongst the most vulnerable poor communities of Pakistan.

Key improvements have been recorded in health and education despite a litany of crises that has affected the country in the past 6 years. Pakistan's HDI ranking, which had increased by 18 places during 2005–2009, slid back 20 positions in 2010 to end at 145th out of 187 countries measured. Pakistan has seen an improvement in IMR, MMR, U5MR rates but still falls short of 2015 targets and is marked both by urban-rural differences and stark regional disparities. A government-led analysis of MDG targets in 2010 concluded that Pakistan is off-track on 4 targets and lagging behind on 19 others, while it is ahead on 6 and on track on 3, of the 32 targets reported on. For inclusive and equitable human development to take place, the State must be able to deliver essential services and create an enabling environment in which people can take charge of their own lives. This requires the State to be able to develop and implement policy effectively. Obstacles to delivery of services and the creation of an enabling environment include political instability, personal insecurity, weak rule of law, and corruption. The tendency to seek preference through influential contacts is both a cause and effect of weakening the State's governance role, and lies at the heart of differential access to services. Thus, the mass media must play a key role in the democratic governance process (Anand and Sen 1994, 1995, 1997; Collins 2009).

Increase in equity-focused expenditure on education and health is crucial to ensure inclusive development in Pakistan. While net primary enrolment rates (NER) have increased across the board and gender disparities have marginally reduced, almost seven million children of primary-age are out-of-school, a disproportionate share of whom are girls. The nutritional status of the population appears to have stagnated, with women receiving less nutrition than men in the same household. Malnutrition contributes to almost 35 % of all under-5 deaths in the country. The 2010 floods provided the occasion to bring this problem to the limelight, including the fact that Global Acute Malnutrition (GAM) rates in Sindh and Baluchistan are well above the emergency threshold (15 %). In addition, polio remains a serious concern. Pakistan accounted for the highest number of cases in 2011. Overall, incidence has increased by nearly 15 % in 2011 despite focused government and UN initiatives. Eradication efforts are hampered by lack of access and awareness.

The major findings based on past work experience during disasters of INGOs and NGOs in Pakistan can be summarized as:

(i) Dual legislation and establishment of dual institutions for DRR creates a lot of confusion and misuse of resources.
(ii) The experimentation of UN shelter and early recovery policy for Floods – 2010 were against their charters as the shelter policy only targeted specific people not general one. Similarly, the early recovery total ignores the humanitarian response to vulnerable population.
(iii) Local governments have not taken control in the coordination of emergency response phase.
(iv) Lack of coordination resulted in many overlapping action programs. Bureaucracy makes NGOs are reluctant to coordinate with local governments and affected local government functions on coordination.

(v) The lack of regulations, standards operational procedure on disaster management has led the parties concerned to act in accordance with their respective institutions procedures.
(vi) The scope of the disaster stricken areas, transportation and communication access, weakness of data collection system have made disaster victims did not receive adequate assistance, and on the other hand aids/program were accumulate in some areas.
(vii) Intervention of cash for work model to community self-reliance was not local need based. As needs of victims are still determined by outsiders and resulted in community dependence on third parties. The number of foreign NGOs working in the disaster-affected areas that offer high salaries has caused the loss of many cadres and personnel of NGOs in West Sumatra.
(viii) Government intimidation, in the case of resettlement without considering the rights and needs in terms of sustainability of their livelihood in the new location gave rise to further suffering for the victims of the disaster. Capacity
(ix) The limitation on resources and skills for rescue made minimum efforts from communities and NGOs in Earthquake and Floods affected areas.
(x) The lack of documentation in emergency response causes incomprehensive analysis of issues and recommendations.
(xi) The differentiation of management standards and program accountability between partners and donors, so that in coordination often causes miss communication.
(xii) Community participation of the affected communities still feels that they are in the weak position and need assistance from outsiders. As a result, the lack of community participation drew some conflict of interest and created some problems on aid distribution.
(xiii) There was no monitoring in early recovery process carried out by independent parties cause a lot of problems in Earthquake and Floods affected areas.
(xiv) The violence issues, particularly which affected to the vulnerable groups have not yet become a common problem for aid agencies. Similarly, aid agencies have not paid full attention to special needs of vulnerable groups.

15.8 Conclusion

Pakistan has taken positive strides in recent years to alleviate core development challenges. Nevertheless, the stresses of an economy under pressure, poverty, gender inequality, inequities and the demands of sustainable development remain, and have been exacerbated by both natural disasters and crises. The recurring large-scale floods, earthquakes, droughts, and landslides are all external shocks which have impacted on the people, their livelihoods as well as on national infrastructure. The floods of 2010 affected more than 18 million people and caused an estimated \$10 billion in damages. They were followed by heavy monsoon rains in September 2011, which affected some 9.7 million people in Sindh and Baluchistan. Natural disasters have disproportionately affected the excluded and the vulnerable. Pakistan suffered heavy cost of the struggle against extremism and terrorism. Loss of life alone is estimated at 35,000 civilians and 3500 security personnel. In addition, direct and indirect costs rose from $2.669 billion in 2001/2002 to $13.6 billion in 2009/2010, with projections for 2010/2011 being as high as $17.8 billion. Most of these achievements were supported by UN donor agencies, INGOs and NGOs. Particularly in social development sector, NGOs play a key role of initiators, modifiers and implementations. DRR is emerging sector of development which gains importance after mega disasters in the country.

The UN sister agencies, World Bank, UNISDR, GFDRR and other INGOs are major supporter, implementers and financers of almost all activities of DRR in the country. These NGOs finance the international training and workshops of minsters and sectaries for policy making; practitioners and management groups for disaster management; local training and workshops for mid-career practitioners, management group and community leaders for DRR. All of community based DRR activities are supported by NGOs. The interesting part of this magnificent contribution is overlapping, lack of coordination and even sometimes exceeding from their mandates. Although there are many gaps in their intervention and a lot of room is available for improvement. However, it pertinent to mention that today the whole scenario of DRR in Pakistan is only possible because of the support and contribution of the NGOs.

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Chapter 16
Urban Risk and Reduction Approaches in Pakistan

Atta-Ur-Rahman and Rajib Shaw

Abstract In the history, numerous cities were affected by natural and man-made disasters. After fall of disasters, heavy amount of budget have been spent on the response and recovery, to reinstate the disruption of urban economic activities. The investment on urban risk reduction is much more effective than picking up the pieces afterwards. It is cities, which empower the societies and hub of industrial and commercial services. Urban resilience is largely a function of resilience and resourceful citizens. The strong and committed involvement of citizen at the grassroots level may yield a resilient city. There are many factors that affect urban resilience and no two cities are alike in their inherent capacity. Therefore, building cities more resilient to both external and internal negative factors may lead to more productive economic returns. In Pakistan, 36 % of the total population is living in urban areas, out of which one-fifth is resided in Karachi alone and two-third in both Karachi and Lahore. Out of total urban centres, eight have more than one million population and 68 have over 100,000 inhabitants. In Pakistan, large cities are at risk to various hazards and they have been threatened seriously, while others are at the verge. The mega cities including Karachi, Lahore, Rawalpindi, Islamabad and Peshawar have already come a across serious episodes of urban flooding during the past one decade. In addition to this, heavy downpour, heat waves, drought, storm surges, flash flooding are some of the key effects of climate change exacerbations on urban areas. Cities are as vulnerable as they are powerful that's why the urban authorities should take concrete steps for preparedness and emergency management plans as an urban risk reduction strategy in a systematic way and enable a city to tolerate a disaster with minimal loss of life and resultant damages. This chapter stimulate new arena for thinking and devising innovative approaches for sustainable urban development in the country.

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_16

Keywords Urban risk • Cities resilience • Urban disasters • Urban risk reduction approaches

16.1 Introduction

Globally, the urban population is growing at a faster pace and it is estimated that by the year 2030, two out of three people will be living in urban areas (Sharma et al. 2011). Urban areas are the centre of economic activities, industries, commercial infrastructure, services and amenities (Shaw et al. 2009). The mega cities have been the hub of trade, industry, commerce, regional and international connectivity. Similarly, urban areas are also the core of educational, cultural and innovations. Such positive socio-economic implications have accelerated the economic growth, open avenues for social mobility and created educated class who are more aware and globally connected.

The extreme hydro-meteorological phenomenon has been strongly influenced by the human induced actions including deforestation, overgrazing, urban development, dam construction, acid rain, heavy urban runoff, release of flood water and high carbon emissions are some of the intensifying climate change factors. Globally, in the year 2012, almost 98 % of all internally displaced population were due to the impact of climate change and related extreme hydro-meteorological phenomenon (IDMC 2013). The population vulnerability to hazards and exposure to climate change adverse consequences have been multiplied as urban centres grew. The problem was further intensified with the rapid increase in urban population especially in the less developed countries. The booming population put tremendous pressure on the land and water resources. As a result the urban peripheral land was brought under the built-up environment and this was once a food basket land. As the urban economic activities widening, the underlying urban risk factors is also multiplying. The expanding urban growth increases the people exposure to multiple hazards and this problem is worse in the poor countries.

Like rest of the world, in Pakistan, cities are considered as the hub of economic activities and act as engines for national economic growth and prosperity. Historically, cities in Pakistan have played a pivotal role in socio-economic development. In the country, rapid pace of urbanization has been started in 1980s. In the present scenario, the urban areas contribute over 70 % to the country GDP (Shams 2006). In the year 2010, about 36 % of the total country population were resided in cities and half of which were in slums, squatters and blighted areas. In Pakistan, slums are not uniform but usually a settlement having dilapidated housing condition in a crowded area within or in the urban periphery (UNHABITAT 2010a). In some part of the country, it is also known as *katchi abadies*. In 1990, 51 % of the total urban population were resided in slum areas, which have shown a little improvement

(47 %) in 2007 (UNHABITAT 2010a). However, in terms of number, the slum dwellers increased from 17.602 million in 1990 to 27.508 million in 2007 (UNHABITAT 2010b). In wake of achieving millennium development goals related to slums, the urban authorities have extended their services in reducing dilapidating condition but still significant efforts need to be maintained and expanded.

Province-wise analysis indicates that there is wide variation in level of urbanization. According to population census organization 1998, Sindh was most urbanized province with 49 % of their population living in urban areas, whereas Khyber Pakhtunkhwa is the least with 17 % of the total population is living in urban areas (Khan and Rahman 2000). However, the urban population of Baluchistan and Islamabad has been increasing at rapid rate of 5.1 % and 5.8 %, respectively (Arif and Hamid 2009). Similarly, about 60 % of the total Sindh urban population is living in Karachi alone. In addition to this, 75 % of the total Sindh population is living in Karachi, Hyderabad and Sukkur. In Punjab, 22 % of the urban population is living in Lahore alone, the country second largest city and 50 % of the province urban population is living in 5 major cities (Khan 2003). In Khyber Pakhtunkhwa, one-third of its urban population is living in Peshawar alone.

In Pakistan, almost every city has serious episodes of repeatedly impacts of natural or man-made disasters in one way or the other. Few cities have been massively damaged whereas others are at the verge. The major cities namely Karachi, Lahore, Faisalabad, Rawalpindi, Islamabad and Peshawar have already come across serious incidences of urban flooding during the past one decade. Intensive heat wave is another notable disaster face by the urban centres. In addition to this, torrential rainfall, drought, extreme temperature, storm surges, flash and urban flooding are some of the key exacerbations of climate change. Cities are as vulnerable as they are powerful that's why the urban authorities should devise effective strategies for institutional framework and improving urban resilience and climate change adaptation in a systematic way (Surjan et al. 2011).

In Pakistan, numerous urban hazards pose considerable challenges to sustainable development. In urban areas, every year hundreds of children, women and men are seriously affected by the impacts of geo-physical and hydro-meteorological disasters. Such disasters put barriers in people's access to basic services of water, health, sanitation and most importantly education. The urban development authorities need to incorporate DRR approaches and ensure that economic growth shall consistently contribute without any setback. These urban centres are constantly contributing to the increasing environmental challenges. For instance, the urban areas account for 78 % carbon emission from the human activities (Parvin et al. 2013). This indicates that urbanization and urban risks have positive co-relation. Despite of high urban risks and vulnerability to various disasters, this aspect have largely been either ignored or underestimated in urban planning process. It is therefore, HFA priority 1 and 4 augmenting for inclusion of disaster risk reduction in urban planning process.

16.2 Growth and Development of Urban Areas

In Pakistan, the urban population is increasing at a rapid pace since its inception. Figure 16.1 reveals that in 1951, 18 % of the country population were resided in urban areas, which further increased to 23 % in 1961, 25 % in 1972, 29 % in 1981, 33 % in 1998 (Arif and Hamid 2009) and 36 % was estimated in 2013. According to population census 1998, out of total 133 million populations, 43 million were resided in cities (Khalid 2003). As far as mega urban centers are concerned, almost one-fourth of the country urban population is living in Karachi alone. Similarly, one-third of the country urban population is living in two primate cities i.e. Karachi (9.3 million) and Lahore (5.2 million). It has been estimated by world Gazetteers online in 2010, eight cities have more than one million population namely Karachi, Lahore, Faisalabad, Rawalpindi, Multan, Hyderabad, Gujranwala and Peshawar. Figure 16.2 indicates comparative growth of top ten cities during 1998–2010. Almost all cities have same pattern of urban growth but Quetta (capital city of Baluchistan province) has recorded exceptionally high growth rate during 1998–2010 (Fig. 16.3).

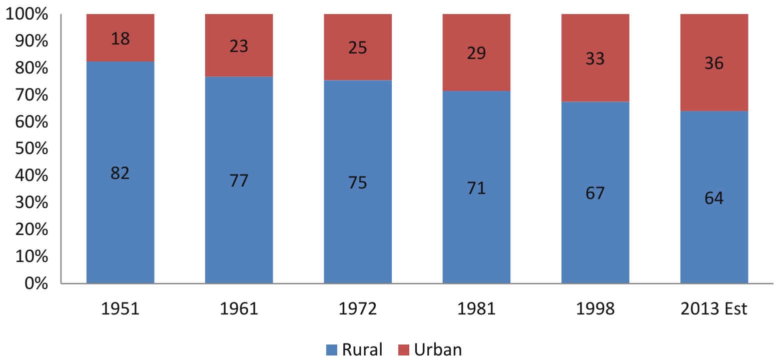

Fig. 16.1 Pakistan, rural versus urban population growth, 1951–2013

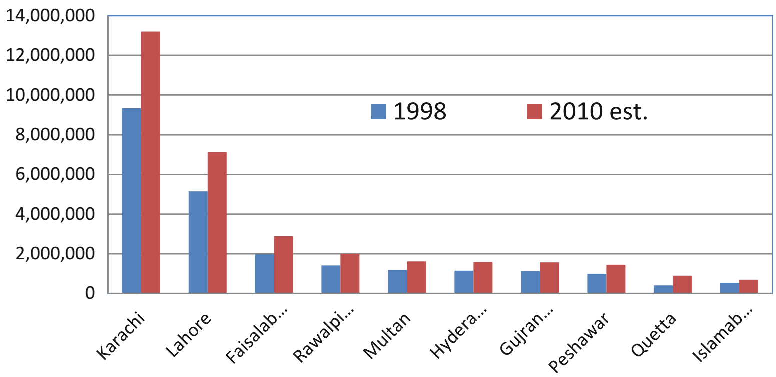

Fig. 16.2 Comparative urban growth during 1998–2010 among top 10 cities of Pakistan

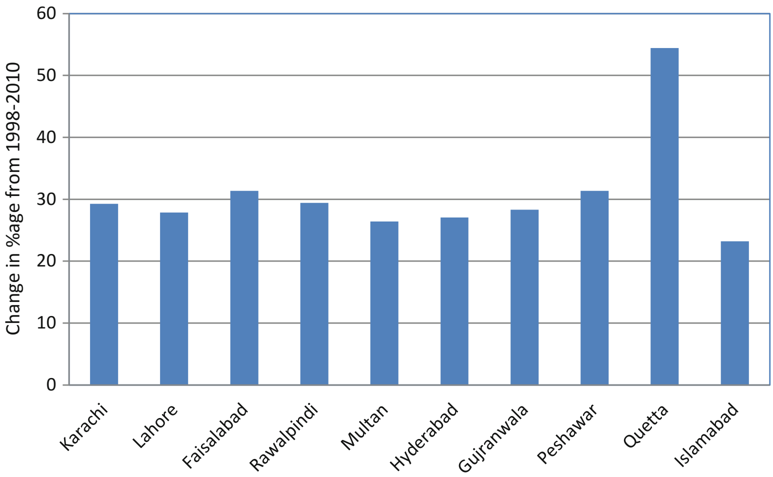

Fig. 16.3 Change in %age in city population from 1998 to 2010

The urban population of Pakistan is growing at a faster rate than the national average (Khan and Rahman 2000). In Pakistan, the urban population was 32 % in 1998, which increased to 36 % in 2010 and expected to further increase to 40 % in 2020 (UN 2010) and projected 50 % by the year 2030 (Arif and Hamid 2009). Nevertheless, in ESCAP region in terms of level of urbanization, Pakistan has been placed amongst the countries with moderate urbanization with highest share of population living in urban areas (UN 2010). In Pakistan, Sindh is most urbanized one with almost 49 % of the total provincial population is living in urban areas. It has been estimated that more than 75 % of Sindh's total urban dwellers are in Karachi, Hyderabad and Sukkur (Khan and Rahman 2000).

In Pakistan, Karachi is an economic hub and dominates the country urban population and economic share. Karachi is also a port city and former capital city of Pakistan. It is a deltaic city and growing at a faster rate. Multiple economic activities and other connections are not only the sole privilege of major cities in the country, but some medium size urban centres also play important role in international trade through specialized products (Khalid 2003). For instance, Sialkot is the best example of producing sports and surgical goods, whereas Faisalabad is specialized in textile products (Khan 2003).

16.3 Disasters and Urban Resilience

In the present scenario of developing world, the urban population is growing at a faster rate and Pakistan has no exception to this changing pattern. In Pakistan, the dominant driving forces behind the overwhelming growth are natural increase, area annexation and migration from rural to urban areas. Because the urban areas have both pull and push factors, and it is push factors that dominates the scene such as commercial hub, manufacturing, health, education and also generate new ideas for future planning that's why it pull population from hinterland.

In the history, numerous cities were affected by natural and man-made disasters and thousands of inhabitants buried under debris. The urban disasters have unprecedented impacts on the city budget. After fall of disasters, heavy amount of budget is spent on the response and recovery. Eventually, these processes also lead to disruption of urban economic activities. Cities are there to empower the societies, because cities are the hub of industrial and commercial centre. Therefore, building cities more resilient to both external and internal negative factors may lead to more productive contributions.

The resilience is referred to planning and policies applied to counter the disaster risk or to mitigate the effect of a disaster (Coaffee and Hare 2008). In literature, urban resilience deals with the potential capacity against the hazards (Campanella 2006). Building urban resilience is a type of planning activity that attempts of protecting against the unforeseen events. Such planning are recently been enacted to develop mitigation strategies for a wide range of challenges that threatened cities including earthquake, flooding, anticipated impacts of climate changes and terrorism has been referred to as urban resilience (Coaffee and Hare 2008). In this regard, urban resilience deals with the design alteration (structural, architectural, land use regulation and enforcement), planning and management measures that seeks to mitigate socio-economic and physical vulnerabilities.

The concept of urban resilience means that the institutional, physical, economic and social capacity of a city to effectively sustain or recover from the impacts of disaster (Campanella 2006). The urban resilience is largely a function of resilience and citizen coping capacity (Shaw and Sharma 2011). The commitment and active involvement of urban dwellers at the grassroots level may lead to more resilient city and can yield a resilient city and social fabrics. The city resilience is the function of multifarious factors and no two urban centres are alike in their capacity. Some factors have historical roots and cannot be easily changed. For instance in a recovery process, a city with a diverse and productive economic setup, the administration will reconstruct the city more quickly as compared to city with a weak social, political and economic set-up.

It is because of these facts, particular stress have been made to build cities more resilient against the extreme unforeseen events and to incorporate proactive management strategies while developing urban plans (World Bank 2011). Beside this, the problems further worsen by the commuters which increase the day-time population of all the major urban centres. This in turns multiplies the challenging task for the urban authorities in extending urban services to the booming population. In addition to this, effective urban planning can also enhance the city resilience. Disaster preparedness and emergency plans may also increase the city tolerance and withstand to a disaster with a low damages to lives and other properties (Campanella 2006). This clearly indicates that investment on DRR efforts may reduce urban vulnerability. It is important to note that mitigation prior to occurrence of a disaster is much more effective than picking up the pieces afterwards (Godschalk 2005).

16.4 Cities and Underlying Risk Factors

Globally, the intensity and recurrence of disasters are increasing day-by-day and it is worsening by the impacts of climate change. During the past three decades, the extent of damages from extreme events have been escalating from \$50 billion average annual loss in 1980s to ≈\$200 billion in the past decade. These unforeseen events hit both developing and developed world alike but developing nations pose high vulnerability and intensification due to explosive population growth rate, increasing urbanization, environmental pollution and climate change.

Urban areas are the core of innovations and creativity. Being globally and regionally connected, urban areas have become ever more vulnerable to the impact of disasters, climate change exacerbations, and global financial, food and energy shocks. Pakistan faces a high risk of frequent disasters and climate change consequences as a result of economic underdevelopment, weak governance, rapid urbanisation and environmental degradation. Repeated disasters have multiplied the human vulnerability, where more than one-third of the country population is living. It is true that cities extensively contribute to overall economic development, but at the same time urban areas faces interrelated challenges, which need to be properly endorsed for its sustainability.

In Pakistan, almost all the cities have been reportedly facing the impacts of disasters in one way or the other. Some cities have been threatened seriously while others are at the verge. The mega cities including Karachi, Lahore, Rawalpindi, Islamabad and Peshawar have already come across serious episodes of urban flooding during the past one decade. Intensive heat wave is another notable disaster face by the urban centres. In addition to this, heavy downpour, drought, storm surges, flash flooding are some of the key effects of climate change scenario. Cities are as vulnerable as they are powerful that's why the urban authorities should formulate effective institutional framework for urban resilience and climate change adaptation in a systematic way.

16.4.1 Unprecedented Pace and Growth of Urbanization

In Pakistan, the unprecedented pace and growth of urbanization is the foremost underlying risk factor. The population is multiplying day-by-day, which pose serious challenges particularly during emergency response large number of vehicles beyond the carrying capacity of roads, traffic congestions along the transport corridors, high population density and poverty. Presently, more population is residing in locations, which are exposed to various hazards in the urban and peripheries. Most of them are poorer section of the society and excessively holding high vulnerability to various hazards of earthquake, landslide and floods etc. (Rahman et al. 2014). They are mostly living on low cost land, which are not formally designated for residential purposes.

16.4.2 Increasing Frequency and Intensity of Extreme Weather Events

Pakistan is exposed to variety of hydro-meteorological disasters particularly floods, extreme temperature, torrential rainfall, rain induced landslides and storms. Generally, the urban settlements in the north and western mountains are susceptible to flash floods and Indus plain to river flood and cities to both river and urban floods, whereas coastal areas to tsunami and sea surges. The haphazard and unprecedented increase in urban population has further exacerbated the risk to climate related disasters. In the past one decade, the increasing trend of flash floods in *nallah* Lai and resultant damages to lives and other properties in Islamabad and Rawalpindi can be quoted as a setting example.

In the past couple of decades, in the country there has been a gradual increase in the frequency and intensity of extreme weather related phenomenon. It is attributed to the climate change aggravation and is likely to further accelerate the occurrence and severity in the hydro-meteorological hazards. In big cities, the increasing frequency and resultant damages is usually attributed to climate change and other environmental drivers and ignores the human induced risk factors. The people living in high risk areas generally blame the heavy and prolonged rainfall as the major factor behind the massive damages. However, little attention has been given to stop illegal construction, avoid poor developmental planning, regulate flow of drainage system, and remove encroachments and strict enforcement of regulations.

16.4.3 Cities and Climate Change Consequences

In Pakistan, over 50 % of the country urban population is living in flood prone areas, and low lying coastal zones (UNHABITAT 2010a, b), and therefore urban dwellers are at high risk to the impacts of climate change particularly to extreme hydro-meteorological phenomenon. The latest literature reveals that the intensity and frequency of climate related disasters have increased and expected to further escalate in future (Rahman and Khan 2013). The disaster and climate change affect both poor and rich but it is poor section of the society who suffer more because of multiple underlying risk factors. This requires government attention that in addition to economic growth, sustainability and poverty reduction, mainstream disaster and climate change issues in urban policies, plans and strategies.

16.4.4 Urban Floods

In Pakistan, flooding is a frequently occurring extreme event. Almost every city is at risk and in effect vulnerable to urban flooding. With the increasing development and impermeable surfaces the likelihood of urban flooding becomes higher and higher. Sometime, the problems of urban flooding were intensified by heavy and prolong rainfall. Approximately, 64 million people living in urban areas are threatened by urban flooding every year. The risk of urban flooding is likely to further increase with the climate change exacerbations. Karachi is a coastal city of Pakistan and exposed to both coastal and urban floods, whereas all the rest of major inland cities are exposed to urban floods. In almost all the cities, poor flood mitigation strategy, encroachment onto the active channel and solid waste disposal in the drainage system are some of key triggering factors of urban floods. Poor watershed management and loss of vegetation in the catchment area are the other contributing factors of erosion in the headwater region and siltation in the drainage system.

16.4.5 Encroachment onto the Flood Prone Area

In Pakistan, the rapidly increasing urban population escalating the urban challenges and put enormous pressure on urban land resources and other amenities. Ironically, in almost all the cities, the urban sprawl is at the cost of farmland conversion to built-up environment. Similarly, continuously encroachment onto the flood prone areas narrow down the channels and in turn reduces the channel carrying capacity is another contributing factor to massive damages by the urban floods.

16.4.6 Drought

Droughts is a silent disaster and put significant adverse impacts on food supplies to urban areas, because cities largely depends on country-land for fresh fruit, vegetables and food items. During 1998–2004, Pakistan was in grip of severe drought condition, which not only retarded the economic growth but also led to food shortages, price hiking especially in medium and small sized cities. This is one of the hazards which likely to further intensify with the changing climate scenarios. Therefore mainstreaming DRR in policies, planning and programs need to be made a priority issues.

16.4.7 Urbanisation and Sub-standard Housing

In Pakistani cities, large numbers of citizen are living in substandard and dilapidated houses. These houses have low resilience even against the small scale hazards. All the major cities right from Karachi to Lahore, Islamabad, Rawalpindi, Peshawar, Quetta etc. have already developed building bye-laws, but it is hardly implemented in the entire cover. The consistent mass movement towards the urban centres usually find poor condition of houses in unplanned neighbourhoods and put millions of poor people at risk. And it is poor people, hit the hardest. Similarly, illegal and unplanned development has been carried out along the flood prone channels, active seismic and landslide areas. These neighbourhoods lack basic urban services.

Under the ministry of housing and works, the role of national housing authority is to develop low cost housing in the country. Pakistan Housing Authority Foundation is a Public Company and also consistently striving to eliminate shelterlessness and reduce the housing shortfall in Pakistan. It provides low cost housing units to low and middle income groups on ownership basis. In the country, there is a shortage of housing units and the gap is widening day-by-day. Currently, an estimated shortage is 7.5 million housing units. House building finance corporation (HBFC) providing finances/ loans for house construction and so far half a million population benefited from the scheme.

16.4.8 Cities and Internally Displaced Population

In Pakistan, the massive disasters of 2005 Kashmir earthquake, super flood 2010, 2011 and 2012 had internally displaced millions of populations. Urban areas near the disaster affected locality were the destination points for most of the displaced populations (UNHCR 2006). It is therefore, with the increasing intensity and frequency of hydro-meteorological disasters and climate variability is likely to further increase hosting of displaced population in future.

16.4.9 Poverty and Inequality

Poverty and inequity are the root cause of underlying risk factors. As a whole, Pakistan has achieved substantial reductions in absolute poverty. During the past decade, sustained economic growth created employment opportunities which helped in reducing poverty. In the past two decades, the poverty dropped from 65 % in 1990 to 23 % in 2004 and this remarkable achievement is relative to other countries in the ESCAP region (UN 2010). Increased foreign remittances, greater employment opportunities, capital investment in the construction sector and business were some of the contributing factors in declining the share of poor population (UNHABITAT 2010a, b).

16.4.10 Urban Environmental Risks and Lack of Infrastructure

The increasing rate of economic development in the urban areas has led to a new challenge of urban environmental risk. The cost of environmental risk has strong co-relation with rapid industrial developments and population. These risks have been multiplied in those cities where the available urban infrastructure and services either lacking or beyond its carrying capacity. As a consequence, the cities facing simultaneous environmental risks and associated urban infrastructural services due to overwhelming increase in the urban population, industrialization, intensive utilization of resources and waste generation. Land, water and air pollution are other key environmental risk to the urban citizens. The urban authorities should develop a sustain plans that cities serves as a source of opportunity.

16.4.11 Urban Water Supply

Access to clean drinking water is one of the millennium development goals (MDGs) and everybody right. It is government responsibility to provide drinking water to their entire population. In this regard, Pakistan is close to universal coverage specially the urban water supply services. It has been estimated by the UNHABITAT 2010 that during the years 1990–2008 the water supply coverage largely improved (UNHABITAT 2010b).

16.4.12 Solid Waste Collection and Disposal

In Pakistan, the nature and amount of solid waste largely differ from city to city. In all the cities, mix solid waste is produced which create difficulty and minimize the opportunity of reuse and recycling. Despite of consistent efforts by the urban authorities to improve services, the proper solid waste collection and disposal is still a serious problem. Toxic waste generated by industries and hospitals are now-a-days another challenging task for the urban planners. Mostly solid waste is dumped in open spaces or burn openly. Technical and financial constraints have been regarded as the major constraint in the solid waste management. Environmental protection policy and legislation are in place but lack of implementation and unawareness are major issues. Few cities have specially focused on the proper collection of solid waste and its subsequent disposal.

16.4.13 Growing Cities and Growing Risks

It is estimated that in the next decade half of the country population will be living in cities and towns. The major share of urban population will reside in major cities. This is due to limited financial and institutional capacities to manage both historical rooted and emerging risks and its exacerbations. With the growing cities population it has been explored that if disaster and climate change is not properly mainstreamed in the urban policies and plans; the urban risks will further grow and would have more serious implications on the urban dwellers particularly the poor section of the society who is often without the benefit of safety nets (WEF 2014). Urban authorities should take the responsibility of enhancing city resilience through risk assessment, risk reduction, preparedness, emergency response and early recovery.

16.5 Why to Build City Resilience Against the Unforeseen?

In Pakistan, the urban population is growing at a faster rate and it is cities where population density is multiplying day-by-day. The natural increase and rural-urban migration are the two dominant factors for this increasing growth rate. Similarly, in these urban centres, the day-time population surpasses the night because of large number of commuters. As cities have pull factors to attract population from the outskirts and the urban areas are the hub of manufacturing, commerce, political, health, and education and most important is the birth place of annotative ideas for future planning and strategies formulations. Rural-urban migration is one of the major contributors in increasing the urban population in all cities of Pakistan. The migrants search low cost housing in the urban periphery either in the low-lying areas, river bank, vulnerable slopes, marshy land, industrial hubs, already city slum and blighted areas, where substandard dilapidated houses, lack of urban services and infrastructure have put the dwellers at risk. Such uncontrolled hap-hazard urbanization further intensifies the extreme unforeseen events and urban risks particularly in the mega cities of Pakistan. It is therefore, cities have the potentials to bring radical changes in the country reactive approaches and switch over to proactive one (World Bank 2011).

The urban disasters have unprecedented impacts on the city budget (IPCC 2011). After fall of disasters, heavy amount of budget is spent on the response and recovery (Carmin et al. 2012). These processes also lead to disruption of urban economic activities. In post disaster phase, clearing of roads, streets, rehabilitation and reconstruction of urban services incur heavy financial resources. This clearly indicates that disasters and effects of climate change put tremendous pressure on the city budget and in effect reduces potential of early recovery of damages. Furthermore, all these mega and intermediate cities are growing faster and faster and there is no clear cut sign of slowing. Eventually, industrialized cities will further contribute to the global warming, which will intensify the impact of climate change. According to World Bank report 2011, cities are the first respondents to climate change impacts (World Bank 2011).

The urban disaster risk reduction is the direct responsibility of urban authorities. The high officials of the urban authorities are especially accountable for their decisions to city dwellers. Since the establishment of each urban authority, they have the potentials, skill manpower, incremental plans, master plans, structure plans and local plans for sustainable city development. The urban authorities are more nimble in taking decision and subsequent implementation than the provincial and national elected members and officials with immediate and impactful results. Therefore, the city high officials must have missionary zeal to meet the unforeseen challenges. As cities are our future and it is estimated that in the next decade more than two-third of the country population will be living in urban areas. This calls for urban innovative plans and urban risk reduction and climate change adaptation.

16.6 Impacts of Urban Disasters

The process of urbanization provides significant social and economic gains, but at the same time it substantially accelerates the risks of ecological disruptions, environmental pollution, extreme events and climate change. The concentration of population along the coastal belts, where changing climate has further threatened the problem of urban flooding, sea level rise, storms, tsunamis etc. It has been estimated that in 2050, the existing number of city dwellers exposed to various disasters will double particularly to urban floods, cyclones, tsunamis and earthquake (WEF 2014). In Pakistan, almost all the cities have reported that they are facing the impacts of disasters in one way or other. Some cities have been threatened seriously while others are at the verge. The mega cities including Karachi, Lahore, Rawalpindi, Islamabad, Peshawar etc. have already come across serious incidents of urban flooding during the past decades. Intensive heat wave is another notable disaster faced these urban areas. In addition to this, heavy downpour, drought, storm surges, flash flooding are some of the key effects of climate change scenario. It requires attention of decision makers and administration to streamline the climate change in policy formulation. Cities are as vulnerable as they are powerful (World Bank 2011).

16.6.1 Loss of Economic Revenue

Cities serve as a Centre of social and economic revenue. With the impacts of urban disasters, the city economic set-up badly suffers. This process directly affects the supply chain and in turn price hike occurs and especially in the cost of daily use items takes place. Similarly, the government revenue generation system also adversely affected.

16.6.2 Loss of Eco-cultural Systems

In the episodes of urban disasters, the ecological and cultural system is affected by the impact of unforeseen extreme events. In cities, there is a gradual loss of natural scenic system due to sea level rise, heavy downpour, heat waves, urban flooding, blockage of drainage system, acid rains, low water quality, solid waste, decrease in green space, depletion of ground water, fluctuation in precipitation pattern, gradual increase in average temperature and storm surges. The conservation of natural ecological system and preservation of rich archaeological monuments need special attention of urban authorities to prepare mitigation plan.

16.6.3 Seismicity and Urban Risk in Pakistan

For effective addressing disaster risk reduction for an urban set-up, it is particularly significant to get knowledge about the urban scenario, trend of urbanization and risk profile (Sharma et al 2011). Seismically, the entire country is exposed to earthquake ranging from minor to severe seismic risk (MOHW 2007). Pakistan lies in the seismically active zone. Historically, the region has experienced several earthquakes of various magnitudes (Rossetto and Peiris 2009) and a high magnitude earthquake is expected in the future (Bilham and Wallace 2005; Raghukanth 2008). Sharma et al. (2011) argue that a high magnitude earthquake with almost a million fatalities could occur in the Himalayan region, where major cities are the high risk nodes. According to Pakistan meteorology department, two-third of the country is located on fault lines that can be triggered any time (The Nation 2008).

Constructing high rise buildings and ignoring the building bye-laws may further increase the vulnerability and can maximize the exposure to massive life and property damages. Pakistan is divided into 19 zones. Based on the past 400 years inventory of earthquakes Fig. 16.4 is depicted which discerns the seismic hazard zones (MOHW 2007; GSP 2013). The cities of Muzaffarabad, Bagh, Quetta, Chaman, Mastung, Kalat, Nushki and Gwadar are located in severe seismic hazard zone. Similarly, Islamabad, Sialkot, Rawalakot, Abbottabad, Mansehra, Pattan, Chitral, Gilgit, Gopis, Thatta, Turbat, Khuzdar, Jacobabad, Dera Bugti and Kohlu are sited in moderate to severe seismic zones. However, the major urban centres including Karachi, Lahore, Rawalpindi, Gujranwala, Gujarat, Jhelum, Gujar Khan, Hyderabad, Larkana, Khairpur, Sukkur, Dera Ismail Khan, Peshawar Mardan, Bannu, and Saidu Sharif are located in moderate to minor seismic hazard zone. The haphazard urban growth has further increased the vulnerability to various disasters and it has been predicted that if proper care is not taken in regulating and retrofitting urban structures, it would have serious fatal implications.

In the past 100 year span, the territory of Pakistan has experienced numerous devastating earthquakes of various magnitudes and intensity. However, the 1935 Quetta earthquake, 1945 Makran coast earthquake which also generated tsunami and the latest 2005 Kashmir earthquake and 2013 Awaran earthquake have been marked as the most devastating. Nevertheless, the 2005 Kashmir earthquake has increased the Government and community awareness in minimizing the people vulnerability and to think about the proactive approach and policy change regarding the concentration of population in the cities and building low resilience structures (NORSAR and PMD 2006). Globally, it has been realized that poor structures are the major reasons behind the high number of victims.

16.7 Urban Risk Reduction Approaches

In Pakistan, there is paradigm shift in disaster risk reduction approaches particularly after 2005 Kashmir earthquake and super flood 2010. As a result the disaster coping mechanism was changed from long standing reactive approach to proactive one.

Fig 16.4 Pakistan, seismic hazard zones (Modified after MOHW 2007)

The proactive approach specifically focuses on the hazard identification, enhancing resilience, capacity development, mitigation, preparedness, early warning, emergency response and early recovery system. The same was also addressed in HFA declaration (2005–2015) and there is continuous introduction of new approaches and coping mechanism in the field of urban risk reduction. The government of Pakistan has already taken certain initiatives to address the urban risk reduction issues such as strengthening legislation and institution; risk assessment and mitigation; preparedness, early warning and emergency response mechanism; disaster and climate change education and reduction of underlying risk factors. However, in urban areas the key risk reduction approaches includes land use planning, prohibiting specific urban functions in incompatible areas, protecting critical structures, emission control, pollution reduction, environmental protection, enforcing building bye-laws, early warning, emergency response, extension of relief etc. These proactive disaster risk reduction approaches are more effective and innovative in tackling urban hazards. Climate induced urban disasters is a latest issue and the urban planning authorities have not so far properly understood and mainstreamed in the urban planning process.

In Pakistan, almost one-third of the urban population is concentrated in Karachi, Lahore and Faisalabad but it is also concentrated in medium and small cities. Therefore, decision-makers must also pay attention to medium and smaller urban centres, enabling them to enhance their role in national and local development. The city Governments are trying to mitigate multifarious challenges and make the city more resilient to hazards of storm surges, cyclones, tsunamis, urban floods, heavy downpour, fire, unhygienic condition, quality water supply, solid waste disposal and drainage system. Such kind of problems is reported from almost all the cities of Pakistan.

Addressing disaster risk reduction into plans, policies, legislation and building bye-law may save lives and property. It is fact that prevention is less costly than disaster response and recovery, and building disaster resilience can minimize loss of damages. The urban authorities are hard press due to lack of technical and financial capabilities to cope with such challenges and also provide basic urban services to their dwellers. This gap clearly indicates that urban growth rate is faster than the catering capabilities of urban authorities. It is time that city Government should formulate effective institutional framework for urban resilience and climate change adaptation in a systematic way.

16.7.1 Issuance of Timely Warnings

In Pakistan, effective and early warning system is either lacking or reported from only few major cities. It is therefore, the urban authorities must develop a system for disseminating early warning and evacuation notices for minimizing the adverse impacts of extreme events.

16.7.2 Disaster Risk Reduction Legislations

In the year 2007, the Government of Pakistan has institutionalized the Disaster management system through Disaster Management Act and National Disaster Management Authority (NDMA). This was followed by Disaster Management Framework, Disaster Management Policy, National Disaster Management Plan (NDMP) 2012 and climate change policy, to focus on disaster risk reduction and how to mitigate the effects of disasters. This legislations and recommendations of NDMP need to be properly implemented throughout the country.

16.7.3 Emergency Response System

The establishment of emergency response system in all cities and town may help in reducing the impacts of disasters. The national disaster management Act 2010 has specifically addressed the significance of emergency response system. Likewise, in

March 2010 the NDMA has also developed national disaster response plan to effectively respond to disasters. Inadequate response capacity and ignorance of disaster related implementing agencies have brought to notice the dire need of a specialized response system. Such a mechanism is particularly worthwhile for carrying out search & rescue, and evacuation operation in both urban and rural set-up. This requires enhancing city emergency response mechanism and capacity building at all level. However, preference and priority need to be given for building emergency response system such as emergency operation centres, Civil Defence and urban search and rescue teams in all urban centres, as it is densely populated and centre of business, commercial, services.

16.7.4 Urban Flood Proofing

In Pakistan, few cities have developed urban flood mitigation plans but still need to be done on the part of urban authorities. Urban flood proofing management through guided head spurs, marginal embankments, levees, prohibiting encroachment onto the flood channel, cleaning drainage lines, flood forecasting and early warning and flood defence system also need to be endorsed in urban planning.

16.7.5 Enforcement of Building Code and Regulations

The building codes and regulations provide procedures, guidelines and recommendations for structural design in various condition and selection of material. Building bye-laws are mainly developed to specify the minimum acceptable level of safety for structures. These are enforced with aim to protect public health, safety and welfare pertaining to occupancy of buildings and structures. The National Engineering Services Pakistan (NESPAK) has developed Building Code for Pakistan in 1986, which was not enforced but the architects and structural engineers in Pakistan have been taking into considerations, while designing structures. Karachi, Lahore, Islamabad, Peshawar and Quetta urban authorities have their own building bye-laws and they are trying to enforce it in true spirit.

Keeping in view this challenging scenario, the ministry of housing and works, government of Pakistan has recently assigned the task to NESPAK (national engineering services Pakistan) for preparing building codes of Pakistan in 2007 with intention that the codes should protect public safety and ensure that there is no unnecessary increase in the cost of technology and material (MOHW 2007). Effective implementation of Building Code of Pakistan can lead to substantial enhancement in the safety of buildings and structures.

Country-wise enforcement of building codes and regulations particularly in the urban areas is need of the hour. Regular updating of building codes according to the latest knowledge and local condition is of prime significance for community safety. It is also important to raise government and community awareness about the disaster resilience buildings and structures. In this context print, electronic media can play a vital role. Similarly, training workshop for masons, builders and community members would further enhance their capacity about the importance and development of structures while applying building codes.

16.7.6 Effective Preparedness, Early Warning and Response

Effective disaster preparedness, early warning system and response mechanism particularly for the rapid on-set events is a key component of urban risk reduction (Parvin et al 2013). Few cities have so far addressed some of these issues but there is need to implement it across the board. Experiences show that community involvement in disaster preparedness, early warning and response have always played effective role in minimizing the impacts of disasters. Capacity building of community can further polish the role and responsibility of individuals and organization. Simulation and drill is also one of the effective strategies of raising awareness and enhancing capacity.

16.7.7 Establishment and Enhancing Stock Repository

As a preparedness strategy, establishment of stock repository will obviously help the urban authorities' hands-on stock for emergency relief and rehabilitation. It is therefore, the urban authorities must establish and strengthen warehouse or stockpiling system for storing food, medicine, relief supplies and rescue equipment.

16.7.8 Extension of Services to Slum Dwellers

In 1990, 51 % of the total urban population were resided in slum areas, which have shown a little improvement (47 %) in 2007 (UNHABITAT 2010a, b). However, in terms of number, the slum dwellers increased from 17.602 million in 1990 to 27.508 million in 2007 (UNHABITAT 2010a, b). In wake of achieving millennium development goals related to slums, the urban authorities have extended their services in reducing dilapidating condition but still significant efforts need to be maintained and expanded.

16.7.9 Emergency Robust Communication System

At strategic locations, every city authority must establish a robust communication system and efficient transport and logistics mechanism to be used during emergency situations.

16.7.10 Emergency Response Plans At All Levels

Develop and implement emergency response plans in relevant ministries and departments at federal, provincial and district levels.

16.7.11 National Disaster Management Fund

Establish a National Disaster Management Fund to enable the federal government to organize emergency response effectively.

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Chapter 17
Disaster and Climate Change Education in Pakistan

Atta-Ur-Rahman and Rajib Shaw

Abstract Pakistan is vulnerable to wide range of hazards and rooting from weather, hydrological, geophysical and human induced disasters. In the past three decades, there has been an increase in the frequency and intensity of hydro-meteorological disasters including floods, extreme temperatures, torrential and prolonged rainfall, drought and storms. In this regard, efforts have been made by the government to endorse disaster and climate change education, and so far variety of initiatives and activities have been planned and some of them implemented. Because, Hyogo Framework for Action (HFA) 2005–2015, priority for action-3 emphasises the role of knowledge and education, and stress on formal and non-formal education and awareness-raising as an important component of disaster risk reduction strategy. Keeping in view this changing scenario, the government of Pakistan has developed the national climate change policy 2012, which clearly pinpointed the need for disaster and climate change education and development of curricula with particular emphasis on disaster and climate change, and its introduction in the country education system. The policy also highlighted to ensure inclusion of climate change education and training as a compulsory subject in the forest education system. In order to enhance the human capacity in the field of disaster and climate change education, the government has also taken the responsibility of sending young scientists and students to reputed institutions abroad for higher studies. In addition to this, it is pertinent to encourage and strengthen the existing disaster and climate change science, in the related institutions and universities through technical and financial support. The national disaster management plan 2012–2022 also highlighted that research need to be carried out on the challenges of disasters and climate change issues. These measures if taken care of in policy, plans and programs will definitely lead to mitigate and minimize the extent of damages in anticipation to the changing climate scenario. This chapter discusses the disaster and climate change education, Pakistan's vulnerability to Disaster and Climate Change, Growth and Development

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_17

of Disaster's Legislations and Institutions, Disaster and Climate Change Education at School, College, University, Professional and Technical Institutions, National Institute for Disaster Management, Religious Institutions, Community Level, and in the State Departments, Civil Services Academies and promotion of Research environment in the country.

Keywords Disaster and climate change • Climate change education • Professional and technical education • School and community level climate change education

17.1 Introduction

Disaster and climate change education (DCCE) is an important component of disaster risk reduction approach. In the past stress always remained on the structural interventions for mitigating the impacts of disasters (Tariq and Van-De-Giesen 2012; Rahman and Khan 2013). However, in the recent past, the introduction of non-structural intervention has played a key role in minimizing the impacts of disasters (Tariq 2013). In this changing scenario, in addition to other multifarious non-structural approaches, the education, training and research has been of the major concern throughout the developed and developing countries. Education plays an essential role in increasing the adaptive capacity of communities and nations by enabling individuals to make informed decisions (UNESCO 2012). Most of the practitioners are agreed that the success of safer and resilient communities can better be achieved through disaster and climate change education (Petal and Izadkhah 2008).

The subject area of disaster education and youth was formally introduced in 2000 during the UN disaster reduction campaign (UN 2000). The basic vision of the United Nations' Decade of Education for Sustainable Development (DESD) was to reorient education and increase people's understanding about the sustainability issues (Shaw et al. 2011a; Nazir et al. 2011). According to the United Nations Educational Scientific and Cultural Organization (UNESCO) it is necessary to create a world where everyone has the opportunity to benefit from education and learns value, behaviour and lifestyle required for a sustainable future and positive societal transformation (UNESCO 2004). In order to cope with the unforeseen challenges, the education institutions ensure to enhance the capacity of teachers and students, so that to better prepare and respond to disasters and climate change exacerbations. The institutions should also ensure that the management personnel has been trained in emergency response, and their safety strategies are in place, regularly updated and tested (UNESCO 2011). Such policies would help the educated citizen to make wise decisions regarding disasters and climate change policies and practices in anticipation to its impacts.

Almost the same thematic area was endorsed in the HFA (2005–2015) and placed in priority-3, which specifically focuses on the use of knowledge, education and innovation to build a culture of safety and resilience at all levels (UNISDR 2005). In the year 2006–2007, UNISDR campaign regarding disaster risk reduction at school was an attempt to mainstream DRR into the government plans and its inclusion in the school curricula. Practitioners and disaster experts working in government sector, NGO's, academia and research institutes have worked hard in operationalizing this thematic area into policy and practice. Likewise, the UNESCO in 2012 has also highlighted that disaster and climate change education requires individuals to be aware of potential climate changes and to know their adverse consequences. With few exceptions, universities and other educational institutions have yet to undertake the necessary innovations and transformations that will be needed to prepare a future workforce on the scale necessary to address the challenges of climate change, and currently there is little infrastructure to develop or support this workforce (Gillenwater 2011).

Historically speaking, the territory of Pakistan has been exposed to numerous hazards of earthquake, flood, landslide, drought, extreme temperatures, desertification, tsunami, cyclone and storms, glacier/Landslide Lake out-burst floods in addition to diverse human induced disasters (Sheikh 2004; Rahman 2010). These hazards are frequently causing damages to life and other properties. As a consequence, Government, NGO's and community have played their role through reactive approaches. In this approach, the attempt was made on relief and recovery aspects of disasters and was measured as a success in minimizing the impacts of disasters. Here it would be rational to acknowledge the notion of Cunny (1983), the renowned disaster expert that 'disaster encourage development' and it was true for Pakistan when Bagh-Balakot fault was ruptured in 2005 and a massive Kashmir earthquake hit the country with almost 100,000 human casualties besides ruining millions of buildings. This was a paradigm shift in the country to rethink and brainstorm over the existing reactive disaster risk management strategies and work for proactive approach and mainstream it into policies, institutions and legislations.

Pakistan is one of the most vulnerable countries facing the risk of climate change, despite its very little contribution to global greenhouse gas emissions. Frequent floods, droughts, sedimentation, extreme temperatures, torrential and prolonged rainfalls, avalanches, GLOFs and cyclones with storm surges are some of the prominent manifestations of climate change phenomenon (GoP 2012; IPCC 2013; Rahman and Khan 2013). The 2014 Global Climate Risk Index of Germanwatch ranked Pakistan at 8th in 2011 and 3rd in 2012 among 180 nations of the world (Kreft and Eckstein 2013). The Government should seriously examine the existing and potential impact of climate change and mainstream it in the national policies and plans. This requires the empirical approach of analysing the future impacts of climate change on various economic and productive sectors. Strengthening disaster and climate change education requires collective wisdom to cope with the emerging challenges through mutual cooperation of individuals, scientific community, NGO's, academia, business, government and civil society.

In Pakistan, under changing climate scenarios, agriculture and water are the key socio-economic sectors, which are under high risk. As Pakistan is an agro-based country and agriculture is the lifeline of the national economy. The agriculture sector contributes approximately 24 % to Gross Domestic Product (GDP) and employs almost 47 % of the country labour force. The recent disasters of drought (1997–2003), the frequent cyclone and storm surges, the flash floods of 2001, 2005, 2008 and the super-floods of 2010, 2011, 2012, 2013 and the heat waves of 2010 are some of the glimpses of serious implications of climate change on Pakistani territory. During massive 2010-flood, besides other damages, agriculture sector also received tremendous losses to standing crops (2.3 million ha) and around 325,000 cattle were also perished. This is actually a life line of the country economy but at the same time it is highly vulnerable to changing climate phenomena.

In Pakistan, the impact of climate change on water resources is anticipated to be more serious. In general, increase in temperature would not only increase water demand, but may also increase rainfall due to high evaporation, which may multiply the intensity of floods. It requires Government attention to further strengthen the research on the exploration of likely impacts of climate changes on fresh water budgets and explore the sustainable coping mechanisms so that to minimise its negative impacts. In anticipation to high country vulnerability and resultant negative impacts of climate change, adaptation and some mitigation strategies have been highlighted in the National Climate Change Policy. The policy specifically focuses on disaster preparedness, capacity building, institutional strengthening; technology transfer; introduction of the climate change issue in education curricula. In order to convey the agenda of disaster and climate change education to every home, community and citizen, 'school' has been marked as one of the driving stream for transmitting DCCE into future labour force. In this regard, the national disaster management authority (NDMA) is working in close collaboration with ministry of education and provincial education departments to take into consideration the challenges of disaster and climate change in the curricula at all level.

In Pakistan, there is a limited attention to address and endorse disaster and climate change in the projects, developmental plans and programs, and the country is hardly prepared to meet the challenges of disaster and climate change as far as human resource and institutional capacities are concerned. However, capacity enhancement and institutional strengthening is a government priority. Nevertheless, the country has been investing limited budget on disaster and climate change education and as a result the country has inadequate disaster and climate change scientists and technologists, which is one of the major hurdles in dealing with disaster and climate change science, preparedness, adaptation, mitigation, response, recovery and policy issues.

17.2 Pakistan's Vulnerability to Disaster and Climate Change

Pakistan is vulnerable to a wide variety of disasters including earthquake, floods, landslide, tsunami, cyclones, drought, Glacier and Landslide LOF, avalanches, heat waves, torrential and prolonged rainfalls. Pakistani territory has a long history of extreme geo-physical events. In the past one decade, the country was jolted with a series of massive earthquakes, whereas in October 2005 Kashmir earthquake occurred, when Bagh-Balakot fault-line was ruptured and incurred almost 100,000 casualties. In the year 2008, the Ziarat earthquake ruined the south-western part of the country with a 215 human casualties. It was followed by consecutive earthquakes of January 2011, 16th April 2013 (Pak-Iran), 24th September 2013 (Awaran) and 28th September 2013 (Awaran). It may be true if we name 2013 as the "earthquake year of Pakistan" as several high magnitude earthquakes occurred in various parts of the country.

Nevertheless, the impact of climate change has further aggravated the intensity and frequency of hydro-meteorological disasters. It is clear from the recent disasters of severe drought period (1998–2003), which paralyzed the social and economic sectors of the country for a long 6 years. During this drought period even some part of the sub-Himalaya received heavy rainfall in 2001, and 620 mm rainfall was recorded at Islamabad in just 10 h, which caused flash flood in Nallah Lai and incurred colossal human and property loss. Similarly, in July 2003, the province of Sindh was severely affected by heavy monsoon rainfall and caused flash and urban floods in major parts of Karachi, Thatta and Badin. This was followed by heavy snowfall during winter 2004–2005 over the northern and north-western mountains of Pakistan, which cut-off several parts from rest of the country. This heavy snow was followed by rapid melting in summer and led to floods in the downstream area. The government was in the process of flood response and recovery, and the coastal Sindh and Baluchistan was hit by Cyclone *Yemyin* in June 2007. It was followed by torrential rainfall in July and August 2007 which has caused disastrous flash floods in various parts of the country. The series of flood events during 2008, super-flood of 2010, 2011, 2012 and the recent heavy rainfall followed by flash flood of 2013 are some of the glaring examples. In 2013, Karachi, FATA, Khyber Pakhtunkhwa, Kashmir and central Punjab were the hard hit flooded areas.

In May 2010, the south-central part of the country was in grip of worst heat wave and according to Pakistan Meteorological Department, 11 met stations of Pakistan have recorded ever highest temperature during the last week of May 2010 (Rahman and Khan 2011). At Mohenjo-Daro, on May 26, 2010 maximum recorded temperature was 53.3 °C, which is the ever highest recorded temperature in the south Asia and is the fourth highest in the world. Contrary to this, during 2013 winter, there was extreme cold wave and over several stations ever minimum temperature was recorded including Murree, Rawalpindi, Islamabad, Kalat, Quetta and Karachi.

In June 1998, the strongest cyclone of category 3 hit Karachi and in May 1999, another cyclone of category 3 hit Keti Bandar near Karachi and killed 6,400 people in Sindh. Similarly, in May 2001, the powerful category 3 cyclone affected the Sindh coast. It was followed by October 2004 cyclone *Onil*, which has caused heavy rain in Karachi. Likewise, in early June 2007, a Cyclone *Gonu* passed near the city of Gwadar with strong winds and heavy rainfall, which has caused damages along the Gwadar coastline. Similarly, in late June 2007, another powerful cyclone *Yemyin* hit the Baluchistan coastal areas. Likewise, in the year 2009, a cyclone *Phyan* generated a strong wind along the coasts of Sindh. In 2010, a powerful cyclone *Phet* hit the Sindh coastal areas. This indicates that almost every year, the coastal part of the country is hit by cyclones. Keeping in view this recurrent disaster, the Pakistan Meteorology Department has established a tropical cyclone warning centre, which issue early warning to the coastal communities. This analytical discussion discern that due to the impacts of climate change the frequency and intensity of cyclones are increasing and will further intensify in future. The government of Pakistan should take strict policy and programs for preparedness, response, adaptation, mitigation and recovery to such disasters and climate change exacerbations.

This unprecedented increase in the frequency of hydro-meteorological extreme events is the direct indication of climate change impacts. The report on Global Climate Risk Index 2014 explored that to what extent the countries have been affected by the impacts of hydro-meteorological extreme events including floods, storms, heat waves etc. and ranked Pakistan 3rd highest affected countries in 2012. The expert group attributed the three consecutive disastrous flood events of 2010, 2011 and 2012 with the changing climate consequences. The UN scientific committee on IPCC found that it is very likely that cold extremes, heat waves and heavy precipitation events will further intensify in future (IPCC 2013). The IPCC also warned that same kind of 2010-flood event may become more frequent and intense in the future over the same region and other parts of the world (GoP 2011). Keeping in view the recent climate change scenario, the Government planning machinery has recently developed a long term Comprehensive Flood Management Plan (2012–2022), where stress has also been made on proactive approach. The country Flood Forecasting & Warning System will further be upgraded and expended by installation of new Weather Radars and expansion of Flood Telemetry Network Stations. All such efforts would help in flood forecasting and early warning system considerably in minimizing future flood losses.

17.3 Growth and Development of Disaster's Legislations and Institutions

Prior to national disaster management authority and legislation 2006, the National Calamities Act of Pakistan 1958 was the only legal document to regulate the relief, rehabilitation and reconstruction efforts. This was only the reactive legal document functioned throughout the country for a long time. Under this regulation, there was an emergency relief cell within the cabinet division. Again it is refereeing just to relief /compensation in either disaster or post-disaster phase. Under the Calamity Act, in each province there was a relief commissioner, who supposed to supervise and coordinate the relief and rehabilitation efforts. Few provinces have also developed Disaster Plan such as NWFP Disaster Plan 1978, where list of hazards are available to which the province is susceptible. Similarly, it has also elaborated the government line departments and their primary and secondary responsibilities during the disaster phase. Similarly, under this legal document, the provincial board of revenue has been made responsible for collecting and maintaining the records of damages and compensation.

Looking to the significance of changing scenario and increasing impacts of disasters, the United Nations general assembly has created international strategy for disaster reduction (UNISDR) in 1999. The secretariat of UNISDR is the focal point in the UN system for the coordination and implementation of the international disaster risk reduction agenda the “Hyogo Framework for Action (HFA) 2005–2015”, which aimed at building resilience of nations and communities against the disasters. It was adopted under the “Hyogo Declaration 2005” and was signed by 168 nations including Pakistan. Its core areas includes ensuring disaster risk reduction (DRR), climate change adaptation, increasing investments for DRR, building disaster-resilient cities, schools and hospitals, and strengthening the international system for DRR. UNISDR’s vision is based on the three strategic goals of the Hyogo Framework for Action: integrating DRR into sustainable development policies and planning, developing and strengthening institutions, mechanisms and capacities to build resilience to hazards.

After the massive Kashmir earthquake 2005 and HFA, the Government of Pakistan was stimulated towards institutionalisation for disaster risk reduction. There was high time for capacity building of disaster related agencies at national, provincial, district, local and community level. As after the earthquake, numerous challenges emerged and encountered the situation. Keeping in view this alarming state, the then president of Pakistan promulgated the National Disaster Management Ordinance (NDMO) in 2006 (GoP 2012). Under this ordinance, National Disaster Management System was introduced. Similarly, the National Disaster Management Commission (NDMC) was established at the national level. The NDMC was assigned the task of preparing guidelines, policies and plan for DRR. Eventually, the National Disaster Management Authority (NDMA) was established in 2007. Likewise, the Pakistan National Disaster Management Ordinance 2006 was approved by the parliament in December 2010 and became the Act called as Pakistan National Disaster Management Act (DMA) 2010. As per DMA, three levels of disaster risk management will work in the country i.e., national, provincial and district levels. The National Disaster Management Authority (NDMA) was established in 2007. The NDMA was held responsible for coordinating, implementing and monitoring body for DRR in the country level. Under the Ordinance (now Act), the National Disaster Risk Management Framework (NDRMF) was prepared by NDMA in 2007 (GoP 2012), which serves an overall guideline for disaster risk management at national, provincial and district levels. In 2012, the Ministry of environment was renamed as Ministry of Climate Change (MoCC) and NDMA is now under the MoCC. In 2009 on the request of Government of Pakistan, the JICA has prepared a national disaster management plan (NDMP 2012–2022) and the same was approved by the Planning Commission of Pakistan. In addition to this, the national climate change policy 2012 was formulated and it was followed by another landmark policy called as national disaster risk reduction policy (NDRRP) 2013.

17.4 Overview of Disaster and Climate Change Education

The aim of disaster and climate change education for all key stakeholders is primarily should convey the understanding of natural and cultural conditions and its interaction in the human use system which stimulate changes and trigger disasters. According to IPCC Fifth Assessment Report (AR5), the global surface temperature within the last century increased by 0.6 °C and under various climate scenarios it is projected to further increase over the next century (IPCC 2013). The adverse impacts of climate change will occur and the developing countries will be the hard hit regions because of low climate sensitivity and low technological and financial capacity to counter the adverse impacts. Moving from urgency-driven risk management to more collaborative efforts to strengthen risk resilience may benefit global society (WEF 2014).

The HFA priority 3 argues on information management and exchange, education and training, and research (Gwee et al. 2011). It also highlights that provision of easily understandable information on disaster risk especially to people living in high risk areas, and enable citizens to take action/s for reducing risk and build resilience. The information need to be tailor with mainstreaming indigenous and traditional knowledge. In the education and training section the HFA stress on the inclusion of DRR education in the school curricula at all level, and share and promote local disaster risk reduction strategies in schools with students, youth, local citizen and teachers (Gwee et al. 2011). HFA further debate that school and community based trainings need to be regularly arranged.

In Pakistan, the national education policy 2009 focuses on various aspects including strengthening education curricula, training, infrastructure safety and preventive strategies (Gwee et al. 2011). The policy further states that a repository of emergency related material including manual, guidelines, minimum standard, and research shall be maintained at all levels. In Pakistan, National Disaster Risk Management Framework was formulated in 2007, to guide the entire system and develop policies, institutions and capacities. In the entire framework, nine priority areas were explored, where DCCE is one of them (NDMA 2009). In the present changing scenario, the promotion of DRR knowledge and awareness is need of the hour. It is pertinent for a national government to mainstream DCCE at various levels. This will automatically pave way for the increasing knowledge and awareness amongst the future decision makers, technical experts, professionals and public representatives. This will in turn, properly reflect and mainstream the emerging issue and phenomenon at policy and institutional level in supplement to public and private forums.

The HFA put special emphasis on the role of knowledge and education, and highlights the formal and non-formal education and awareness-raising as an important component of disaster risk reduction strategy. Section 17.5, priority for action 3 specifically focuses on the use of knowledge, innovation and education to build a culture of safety and resilience at all levels. The core indicator-1 further emphasises that to make available the DRR information at all levels. Keeping in view this core indicator, the NDMA in consultation with the provincial disaster management authority (PDMA) and district disaster management authority /unit (DDMA) should work on the establishment of resource centres for DCCE at district level. This will pave way for building a culture of safety and resilience at all levels.

In Pakistan, the Ministry of Climate Change was established in 2011 with a specific task to focus on the challenges of climate change and make policies and plans for undertaking adaptation measures. In addition to this, the National Disaster Management Authority was placed under the Ministry of Climate Change for creating better linkages in climate change adaptation and disaster risk reduction strategies (NDMA 2013). The Pakistan Environmental Protection Act 1997 provides the legal framework for the protection, conservation, rehabilitation and improvement of the environment (NEP 2005). Similarly, the government has constituted a taskforce to prepare a climate change policy and the same was approved by the national Cabinet in 2012, which provides a framework for addressing the issues that the country faces or will face in the future due to the changing climate.

The territory of Pakistan has witnessed several climate change induced disasters with high intensity in the past one decade. In Pakistan, the climate change poses a major threat to food, water and energy security. In addition to coastal and marine environment, dryland ecosystems, agriculture and livestock, forests and biodiversity are other areas that will be seriously affected. The climate induced melting of glaciers, cyclonic storm surges, tropical diseases epidemics, flash floods, droughts and variable monsoons turn into an inevitable future reality. The super flood of 2010 followed by floods of 2011, 2012 and 2013 are some of the glimpses of this changing scenario. Such frequently occurring events have prompted the Government of Pakistan to mobilise resources and protect the vulnerable population from the approaching climate induced disasters. In this regard, the national climate change policy has endorsed certain guidelines and potential challenges of climate change. Similarly, the climate change adaptation and mitigation efforts are the other key sections of this policy document (NDMA 2013).

In Pakistan, the frequent changes in temperature and rainfall pattern have resulted increase in the heat waves, snowfall, drought, extreme temperature, storm surges, glacier fluctuations, landslides, floods etc. This emerging pattern in climate change has also put rural and urban dwellers and their properties at risk. In this changing climate scenario, the ministry of climate change have recently taken some initiatives in the form of projects to properly address the climate change issues. These projects includes Sustainable Land Management to Combat Desertification; Establishment of a research centre on Global Change Impact Studies Centre; Establishment of Multi-lateral Secretariat; establishment of National Bio-safety Centre; establishment of clean development mechanism cell and National resource conservation strategy resource centre.

The aim of Sustainable Land Management to Combat Desertification project has been to enable environment for mainstreaming Sustainable Land Management (SLM) practices, institutional capacity building, and implementation of nine pilot projects for demonstrating SLM practices in arid and semi-arid regions of all the four provinces of Pakistan. As the unsustainable land management practices in

Pakistan are generating diverse environmental problems such as soil erosion, loss of soil fertility and crop productivity, flood and sedimentation, deforestation and the associated loss of carbon and bio-diversity assets.

Similarly, Global Change Impact Studies Centre (GCISC) was established in the year 2002. The task of this research centre is to serve and provide strategic and policy guidelines for planners and decision-makers in a changing global environment particularly in areas of climate, water, energy, food, agriculture, health, ecology and new technology. In the changing global scenario, Pakistan is also exposed to numerous challenges including the food security and to ensure its provision for the booming population without jeopardising its fragile environment. Presently, the centre's major task is the assessment of the impact of global climate change on the key sectors of water and agriculture, increase awareness about the global changing phenomenon, and to explore suitable adaptation and mitigation strategies (NCCP 2012).

The National Strategy for Disaster Resilience (Council of Australian Governments 2011) focuses on the common characteristics of disaster resilient communities, individuals and organisations. These characteristics are: functioning well while under stress; successful adaptation; self-reliance, and social capacity. It further argue that 'Resilient communities also share the importance of social support systems, such as neighbourhoods, family and kinship networks, social cohesion, mutual interest groups, and mutual self-help groups' (Council of Australian Governments 2011). Using these characteristics and the results of extensive disaster psychological and sociological research, Dufty (2013) scoped potential disaster resilience learning content for learners of all ages and found that disaster resilience learning content should not only cover public safety aspects, but also learning about improving recovery for people, organisations (e.g., businesses) and communities. It found that disaster resilience learning should also include learning about the community itself, including how to reduce vulnerabilities and strengthen resilience by capacity building (Dufty 2013).

17.5 Disaster and Climate Change Education at Various Levels

The process of disaster education can broadly be divided into three stages. Primarily, it is necessary to understand various aspect of disaster mechanism. Causes and consequences of natural and human induced disasters and climate change issues. Secondly, learning how to build disaster resilience and minimize risks and vulnerabilities. In this stage, emphasis on integration of indigenous knowledge of local community while dealing with local hazards and recent innovative risk reduction strategies would be much more effective. Third stage is related to action planning, it is last but not the least stage and focuses on how to act in prevention, preparedness and most importantly during emergency response and recovery.

Disaster and climate change education is a cross cutting field of science and needs to mainstream in both formal and non-formal education sector at all levels and streams. Disaster and climate change education should not be merely teaching the concepts but should also motivate the stakeholders towards the solution of problems using their skills an indigenous knowledge (Petal 2009; Shaw et al. 2011b). The government of Pakistan is committed to integrate DRR education in the school, college and university curriculum. There need to be fine balance between the curricular and extra-curricular activities, and in school and outside school activities.

A well-known quotation for students is "*Tell me and I will forget; show me I may remember; Involve me and I will understand*". One way communication has unsuccessful stories, whereas participatory approach is a tested knowledge dissemination approach. Hence, the disaster and climate change education may have a better link between school, home, community and education. The NDMA in close coordination with the ministry of education is developing a comprehensive strategy to integrate disaster and climate education into curricula (NDMA 2009). In wake of 18th amendment regarding devolution, education is now a provincial matter. However, one of the major functions of Ministry of Education, Trainings & Standards in Higher Education (MESHE) is to develop, coordinate and regulate curricula at all levels.

A methodology called 'curriculum mapping' was used to identify opportunities for disaster resilience learning across the Australian Curriculum. Curriculum mapping is a 'technique for exploring the primary elements of curriculum: what is taught; how instruction occurs; and, when instruction is delivered' (Rubicon Atlas 2013). Curriculum mapping can be used to 'retrofit' existing school teaching programs and education in line with new curriculums. The *National Emergency Management Projects – Educating the Educators* aims to develop disaster resilience within primary and secondary students by improving teacher understanding and confidence in using Disaster Resilience Education (DRE) resources from Australian sources which are explicitly linked to the Australian Curriculum (Dufty 2014).

17.5.1 DCCE at School and College Level

School plays a key role in disseminating disaster and climate change education in the community (Takeuchi et al. 2011; Shaw et al. n.d). Shiwaku (2009) described that the significance of disaster and climate change education is increasing, because children are the most vulnerable group in a society and it is these children who transfer disaster knowledge to community and family. Children who have been taught about the phenomenon of disasters and how to react with disaster situation have been proved and respond effectively during emergencies (Shaw et al. 2011b). The introduction of disaster and climate change education either as compulsory part of the curricula or integrate as extra-curricular activities (informal) have been endorsed in the government policies. As the existing school curricula lack basic concept of DCCE and this need to be incorporated through provincial education policy. It is important that school education should have DRR as an integral part of curricula. While designing school curricula one should focus on the themes and concepts of hazard, vulnerability, risk, disasters and specific emphasis need to be made on the hazards in Pakistan, its causes, impacts, preparedness, mitigation, prevention, response and recovery. The designing of curriculum and development of text material may be placed on priority and it is not that labour-intensive task. This will require the proper government intervention to develop the disaster and climate change curricula in English, Urdu and other regional languages for various educational streams. The insertion of DCCE in the existing curricula either in the form of elective subject or plugin systematically chapters in the relevant subject areas including geography, social studies and science at school level curricula may be introduced at all levels.

The introduction of DCCE as extra-curricular activities would be another option of rapid entry source. This may be in the form of simulations, drills, first aid, fire fighting, search and rescue training, offering fun and engaging ways to introduce important knowledge, skills and competencies for students of all ages. Besides this, dissemination of written materials such as posters, sign boards etc. are some of the important means of sharing knowledge about the disaster and climate change. Similarly, creative disaster related teaching aids and materials in the form of manual and computer games, puzzles, toys for kids, documentary, video clips, disaster stories, comic materials may also help in conveying the disaster and climate change messages.

Such capacity building has to be supported by training, practical exercises and drill and simulations. In addition to this, special type of guidelines and training modules for both teachers and students need to be developed and periodic specialized training programs need to be organised for new trends and inputs in disaster and climate change science. This will in turn equip the future generation with necessary knowledge and awareness about the DCCE. This needs to be supported by periodic teacher training and capacity building.

17.5.2 DCCE at University Level

At higher grade, the disaster and climate change knowledge is predominantly cross-cutting and multi-disciplinary. It encompasses all faculties of knowledge including social sciences, earth and environmental sciences, space and physical sciences. This indicates the inter-disciplinary link between disaster and climate change science with deep roots in natural and social sciences. While focussing on the DCCE at university level, one should kept in mind, the disaster-environment linkages, disaster and hydro-meteorology linkages and synergy of disaster and climate change mitigation and adaptation issues. Since long, numerous institutions offer degree programmes around the globe and have been conducting disaster and climate change related research and training to foster the local and regional demands (Shaw et al. 2011a). It should be noted that disaster and climate change education is not mere a provision of well-verse DRR and CC professionals to the market but it is also a vehicle for integrating DRR knowledge, exploring solution to the emerging disaster and climate change issues and most importantly transmission of DCCE to institutions, policy makers, community and the future generations.

The United Nations University has started an innovative network amongst universities and established UNCECAR (university network for climate and ecosystem change adaptation research) in 2009 by leading universities in the Asia-Pacific region to strengthen the higher education sector to respond effectively to disaster and climate change issues (Shaw et al. 2011a). Education and research are the key focusing area of UNCECAR. The overall mission of UNCECAR is to reduce the overall vulnerability of Asia-Pacific region to disaster and climate change, and enhance the local adaptive capacity through the leadership of higher education sector. The UNCECAR major thrust on higher educational institutions is mainly to provide a human capital and knowledge for safer and climate change resilient societies. Similarly, AUEDM (Asian Universities Network of Environment and Disaster Risk Management) is another forum and initiative in disaster and climate change education. The objective of AUEDM is to share scientific knowledge and experiences, and work for promoting environment, disaster risk management in higher education, and also to seek possibilities of mutual collaboration on field-based action research, and to broaden the scope of education and learning in the environment and disaster management field through collaboration with other stakeholders.

In Pakistan, at university level, some public and private universities have already started and offer specialized courses in disaster management. The University of Peshawar has taken a lead and established the first-ever Centre for Disaster Preparedness and Management in 2008. Since 2008, this centre has trained human resource in the field of disaster preparedness and management. Presently, this specialized centre is offering one year post-graduate diploma, MSc, BS-4 year, MPhil and PhD level programmes. In addition to this, CDPM is a founder member of AUEDM, and it is the country leading institute so far in rendering services of providing human skills to the nation. Similarly, the Military College of Engineering, National University of Sciences and Technology have also initiated degree programs in disaster management (NDMA 2013). The SZABIST University and Preston University Islamabad have also initiated post graduate diploma in disaster management. Some public and private sector universities have also updated their courses and research areas by incorporating disaster management in the existing subjects. At the higher education level, the NDMA in consultation with HEC can play a major role to devise a forum to review, update and monitor the curricula, research and training needs at the graduate, post-graduate and MPhil/MS and PhD level in the professional, technical and general universities. It is the government responsibility to support both technically and financially, and strengthen the institutions and universities who offer degrees programs in disaster and climate change science. This will provide an avenue for the young scientists to undertake research in the field of disaster and climate variability and enhance their skills. This will in turn provide the professional researchers to the market as well as institutions, organizations and line departments.

17.5.2.1 DCCE and Devolution of Education Sector

Disaster and climate change education in its modern form is relatively a new concept in Pakistan. Therefore, lack of awareness, being the major challenge exists in government departments including the ones dealing with education. The lack of awareness coupled with lack of expertise in the relevant government departments impede implementation of national plan and strategy for integrating DCCE in school, college and higher education curricula as predicted in the disaster management Framework. Similarly, a task of mainstreaming DCCE as a subject in the curricula at school, college and university level was reflected prior to 18th Amendment in the Constitution of Pakistan in 2011, in which the education sector was devolved to provinces (NDMA 2013). Since education is a devolved sector and provinces are empowered and responsible to enhance the capacity of young generation in DCCE and introduce it as a compulsory subject in school, college and university system. This process will however be more productive if NDMA in close collaborations with PDMA's work with respective provinces in designing uniform standard curricula for all levels.

17.5.3 DCCE in the Professional and Technical Institutions

In Pakistan, professional and technical education is an important section for mainstreaming DCCE. The key professional and technical areas are engineering, medical, architecture, vocational and technical. There are very few professional level institutions who offer DRR education and training but where available it is split and thought with reference to that particular discipline. These streams to some extent disseminate knowledge pertaining to DRR but the curricula need to be regularly updated by incorporating latest methods and approaches to tackle the emerging issues of disasters and climate change education. The national climate change policy has specifically made stress on the inclusion of climate change as a compulsory subject in the Pakistan forest education system and capacity enhancement of forest workers to adapt and mitigate the challenges of climate change. The development of DRR as a professional discipline needs to be further promoted at national and provincial levels through high-quality academic programs while agreeing on common curricula standards (GoP 2013b). The government should take into consideration and allocate special budget for developing disaster and climate change professionals and scientists, and send them for further studies in reputed international institutions abroad. Everyday emergency responders (search, rescue, evacuation, first aid, ambulance services, police, civil defence, fire brigade /fighting) require enhancement of their training and skills. Similarly, at local level training initiatives need to be taken for builders and masons and to enhance their skills in non-engineered hazard-resistant buildings (GoP 2013a).

17.5.4 National Institute for Disaster Management and DCCE

In Pakistan, the consistent improvement in disaster legislations, institutions, policies and plans clearly indicate that the Government of Pakistan is determined to endorse disaster risk reduction as one of the priority development initiative. In this regard, establishment of NDMA, PDMA's and DDMA was milestone achievements. Parallel to this, there was an increasing demand for the establishment of a high calibre disaster management institute to impart training, awareness, conference, workshop, symposia, seminar and research. Nevertheless, in 2009 under National Disaster Management Ordinance a task was given to NDMA to establish the National Institute of Disaster Management (NIDM). As a result, this mile stone of NIDM was laid down in the year 2009 through the technical support of United Nation Development Programme (UNDP).

National institute for disaster management (NIDM) playing an important role in DCCE and a focal point for training, awareness, research and education (GoP 2013a). So far different training programs have been designed and imparted by the National Institute of Disaster Management (NDMA 2013). The mission of NIDM is to work as a learning centre for the government officials, private sector, media, NGOs and community organizations for developing policy guidelines and enhancing their capacities through training and research. In order to enhance academic and technical scope, credibility and effectiveness of NIDM, options will be explored for its affiliation with research, training and educational institutions at the national, regional and international levels (GoP 2013b). The subsidiary objectives of NIDM includes to develop curriculum on various facets of disaster management; to undertake study, research and other related activities on disaster management; to develop linkages and build partnerships with national and international academic institutions; to develop network of disaster management professionals working in various disciplines in country and abroad; publish newsletters, manuals, research journals and audio-visuals to raise disaster risk awareness among general public and establish and maintain database about disasters in the country (NDMA 2013). However, the vision of NIDM was to build and enhance capacities to respond and prepare for disasters across the country.

17.5.5 DCCE in the Religious Institutions

For enhancing better coverage of DCCE, the stream of religious education (private sector) cannot be ignored. In Pakistan, *Maddaris* (religious) education is another important stream of education, which mostly imparts free education, hostel and food to their students. Such institute have fulltime teaching and examined and chronologically graded and hierarchically structured and promoted to next grade after appearing in the examination. The number of religious institution was only few hundreds during the inception of Pakistan (1947). The figure rose to more than

40,000, where around three million students are studying. In 2014, 17,648 religious institutions were affiliated with "*Wafaqul Madaris Multan*", where 2.2 million were registered students. These religious institutions are governed by their internal system known as '*Wafaq*' who develop and update curricula, take examinations, award degrees, develop text books, teacher training, register and affiliate religious institutions and solve the emerging religious issues. For better coverage it is important that DRR education need to be promoted in private religious institution.

17.6 DCCE at Community Level

Community is considered as the key pillar of disaster and climate change education. The development of disaster resilient community is widely understood that it heavily depends on the success of disaster risk reduction education (Petal 2009). Capacity building of disaster prone community pertaining to preparedness, mitigation, response and recovery of individual and communal resources from the impacts of disasters and climate change is a significant component of disaster risk reduction strategy. In order to enhance the disaster and climate change literacy, it is pertinent that there need be citizen awareness and sensitization to proceed and interact with the environment in view of new behavioural and eco-cultural adaptation and mitigation strategies. It is also important to enhance the community concept about various disasters and climate change phenomenon, its signs, causes, consequences and adaptation (Pruneau et al. 2003). In addition to mitigation strategies, exploring and mobilizing the population in minimizing the impacts of climate change are of key concern. In Pakistan, there is little attention on capacity building of civil society in response to disaster and climate change exacerbations. However, there is consistent stress in policy and planning documents that strengthening of human resource is essential to meet the growing challenges of disaster and climate variability. Furthermore, emphasis should be placed on the community education, awareness and training, which has been one of the fundamental sectors of capacity enhancement. Such kind of education and training requires to be developed specifically focusing on the concept and practical approaches to cope with the challenges of disaster and climate change consequences.

The community based promotion of disaster and climate change education; the community based disaster risk management would be the most effective strategy in building community resilience. As CBDRM approach is a people oriented approach with community members being the main actors (Takeuchi et al. 2011). Contrary to this, imposing new disaster coping mechanism and ignoring the community based traditional knowledge would be less productive. This is one of the prime responsibilities of national, provincial and local disaster management authorities to develop community based disaster management plans with a specific focus on raising public education and organize emergency response training and evacuation drills, periodically. For the purpose of developing capacity building modules and guidelines on disaster and climate change, the National Institute of Disaster Management (NIDM) can play an effective role.

17.7 NDMA and DCCE

The initiation of DRR legislations and establishment of institutions at various levels clearly indicate the committed intentions of government in achieving the goal of mass education, awareness and training. The same has been made as one of the priority area in National Disaster Risk Management Framework. In this regard, the Government has already declared 8th October as the Disaster Awareness Day which is being observed on annual basis. On this day, special awareness events are organised at various levels including simulation exercises, search and rescue drills, and disaster exhibitions (NDMA 2009). Similarly, NDMA has also organised special awareness raising workshops for parliamentarians, provincial legislators, women legislators, media persons and officers of federal ministries, district officials and private sector stakeholders (NDMA 2013). In addition to this, the NDMA is also working on a comprehensive media strategy and hired a leading media and advertising agencies to develop awareness materials for print media, TV channels and radio programs (NDMA 2013).

17.8 DCCE in the State Departments

In Pakistan, there is lack of disaster and climate change education in the related line agencies. The disaster related line agencies and organizations have both financial and capacity building constraints. To keep pace with the rapidly rising impacts of disasters and climate change there is an utmost need of capacity enhancement of key responsible personnel in the related line departments. At the country level since long stress always remained on the structural approaches to prepare and mitigate the impacts of disasters, and little attention has been put on the non-structural approaches including the awareness, training and education. For wider publicity it would be more rational if each related line agency should plan their awareness, education and training programs about the disaster and climate change education. This will have a productive impact on the implementing agency itself and would overcome the awareness challenges.

17.9 DCCE in the Civil Services Academies

There are civil services academies, which impart pre and in-service training to both central and provincial civil servants in Pakistan. The NDMA is working on mainstreaming DCCE into the training modules of various civil services academies of Pakistan. One of the important institutes is the National School of Public Policy (NSPP), where majority of the government servants entering into various sectors are trained both at the entrance level and at mid-career stage. The incorporation of DCCE into the training modules of NSPP is in progress (NDMA 2009). To raise awareness and train the civil servants, the NDMA has undertaken different programmes such as a simulation on disaster response management is conducted for the entrance level officers at the Civil Services Academy (CSA) of Pakistan (NDMA 2009).

17.10 DCCE and Institute of Meteorology and Geophysics

Pakistan Meteorological Department (PMD) offers professional training courses in various branches of Meteorology, Geophysics and allied sciences at the Institute of Meteorology and Geophysics (IMG), Karachi. This Institute was established in 1960, which provides in-service training to the staff of Pakistan Meteorological Department and also offers training to other departments. The courses are of various levels and are designed for the new-comers and for those who have acquired sufficient experience in the field and need higher level training. The syllabi of courses provided at the institute have been prepared at par with the pattern recommended in the Technical publication of World Meteorological Organization (WMO). The courses aim is to provide both theoretical and practical background to fully equip the candidate seeking training (GoP 2012). Adequate emphasis is laid on practical and professional aspects of the subject and is supplemented by on-job training at one of the Meteorological Offices. Another key aspect of IMG is the provision of training of candidates in forecasting and Early Warning system. Acquiring advanced meteorology training enhances the human capacity working in an organization. Highly trained manpower should improve their skills in the field of weather, flood forecasting and the issuance of early warnings of related disasters concerning agrometeorology, meteorology, glacier melting, hydrology, climate change and seismology. After getting professional training the participants are equipped with latest accurate weather forecast techniques and reliable information (GoP 2012).

17.11 DCCE and Pakistan Space & Upper Atmospheric Research Commission (SUPARCO)

SUPARCO is a space agency in Pakistan and imparts training in space related fields to scientists, engineers and officials of relevant line agencies. SUPARCO also assists various universities, colleges and other academic & professional institutions to enhance knowledge through on-going scientific projects and research work. The Institute of Space Technology conduct research and providing training in space related fields including GIS, Remote sensing and Global Positioning system, and its application in disaster planning and management (GOP 2012). The MoCC and NDMA should take special interest in utilizing the knowledge and expertise of technical personnel in SUPARCO and develop linkages and mainstream its expertise into hazard planning and studying changing climate phenomenon.

17.12 DCCE and Research

In Pakistan, research is underway on various aspects of disaster and climate change education and the same is available in hard copies in various institutions. Some of this research has been published in the reputed national and international journals, books and reports. Such research work is covering various aspects of almost all the hazards specifically in the form of case studies. This research material provides outstanding findings and reference materials for policy and planning. However, there is lack of an organization to integrate the research and utilize it for policy planning, decision making and legislation. The government should establish an organization/section within the jurisdiction of NDMA. This section will work as a resource centre for integrating disaster and climate change related research on Pakistan. This will be a useful exercise and would definitely benefit students, researchers, practitioners and line agencies. Furthermore, it would also help in avoiding the repetition and replication of research in the field of disaster and climate change mitigation and adaptation.

The government should take into confidence the leading research institutions where DRR is thought as one of the core research subjects through allocation of substantial resources and provision of research facilities. The Federal and Provincial Governments are also required to ensure adoption of DRR research as an integral part of the institutional competencies in the research and educational institutions under their respective control (NDMA 2013). Another very important sector which needs to be prioritised is the development of linkages between the line agencies, scientific community, practitioners and academia. The dilemma in the country is that the experts in the line agencies don’t work in coordination with the researchers and vice versa. Even some time, the line agencies don’t share their data either due to the non-availability or unconsolidated form or they don’t bother the researchers. The line agency should recognize the significance and worth of research undertaken by the scientific community and academia. We are deadly sure that if joint research strategy is opted it would have far reaching productive implications on the disaster and climate change knowledge, adaptation and mitigation strategies.

At university level, the University of Peshawar, NED University of Engineering and Technology, Karachi, University of Engineering and Technology, Lahore, Karakorum International University, Preston University, Quaid-e-Azam University and UET Peshawar offer research courses in disaster risk management, safer structural engineering, climate change, environment etc. The University of Karachi has developed a risk assessment model for Karachi City (NDMA 2013). The Earthquake Engineering Centre at UET Peshawar is a multidisciplinary research and education Centre, established to mitigate the seismic disaster risk. The centre was upgraded to National Institute of Earthquake Engineering. Similarly, the National Centre of Excellence in Geology, University of Peshawar has established advanced differential GPS stations along the fault lines to monitor the plate movements and predict the future seismicity in the region.

These glimpses clearly indicate the potentials, commitment and dedication of scientific community in the home country. Most of the scientists graduated from the reputed international institutes from abroad. Similarly, the existing institutions are serving at various universities and partially equip with latest technology, knowledge, experts and scientific facilities and have potential to undertake objective research targeting at simulations, modelling to assess vulnerabilities and risk from various hazards. However, it needs special government attention to flourish and encourage them for further strengthening in terms of capacity building, equipment and financial resources. But the disaster related agencies don't recognize their potentials rather they rely and prefer the strategies, plans and research of organizations from abroad as stated by NDMA in the HFA Country Report 2013 that our research institutions lack technology, experts and knowledge.

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Chapter 18
Financing for Disaster Risk Reduction in Pakistan

Mohammad Aslam Khan and Samiullah

Abstract Disaster records in Pakistan during the last few years show severe impact both on the citizens as well as the Government. The losses incurred during the floods of 2010 and 2011 resulted in damages amounting to US$10 billion and US$3.7 billion respectively. Likewise, the earthquake of 2005 caused a loss of US$5.2 billion, which is enormous when compared to the national budget of US$25 billion for the year following the quake. The losses due to the drought of 1998–2001 were also staggering. In 2000–2001 financial year alone, the drought reduced the average economic growth rate from 5 to 2.5 %. The financial pressure generated by these and other disaster events had short-term severe fiscal impact as well as long-term developmental implications, and therefore, need effective remedial measures. These, in turn, demand critical insight into investments in disaster risk reduction and recovery to identify weaknesses therein, so that appropriate fiscal instruments may be put in place. This is particularly important in the wake of expanding population and economy that are exacerbating the disaster risk. This paper analyses the past and present mechanisms to finance disaster management in Pakistan. With the scanty data available in Pakistan, quantifying overall Disaster Risk Reduction (DRR) and recovery investments is a challenging task. Nevertheless, a review of data shows that investments in DRR have been scarce and spending on disaster preparedness has not been given priority in the national development plans. Moreover, for every dollar spent on disaster management, only a tiny fraction was spent on preventing or preparing for them; most of the funds went into relief and rehabilitation. This applies to all kinds of funding including those of the Government, private sector, charities as well as international donors. However, the growing losses from natural hazards demand much greater investment in enhancing resilience, which includes risk assessment, risk reduction, and efficient management of residual risk. A wind of change has started in the country with the creation of institutional

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_18

mechanisms and establishment of a Disaster Management Fund. The study found that there is still a big vacuum, which can be filled only by the development of a comprehensive risk financing strategy with a range of instruments. It further recommends financing through public-private partnerships for the promotion of cost-effective solutions to counter enhanced threats from climate change.

Keywords Disaster risk • Risk financing • Cost of damages • Disaster management fund • Public-private partnership

18.1 Introduction

Disaster records in Pakistan during the last few years show severe impact both on the citizens as well as the Government. This paper after discussing vulnerability to disasters examines the past and present mechanisms to finance disaster management in Pakistan. It is followed by analyzing the shortcomings in the present mechanism in the wake of emerging realities. Finally a range of tools and mechanisms available are discussed for adoption by government and other stakeholders as a part of a comprehensive risk financing strategy. The findings of the chapter are summed up in concluding section of the paper.

18.2 Hazard Vulnerability

Pakistan is vulnerable to disaster risks from a range of hazards including avalanches, cyclones/storms, droughts, earthquakes, floods, fogs, glacial lake outburst floods, heat waves, landslides, and tsunami. High priority hazards in terms of their frequency and scale of impact have been earthquakes, droughts, floods, windstorms and landslides (Table 18.1) that have caused widespread damages and losses in the past.

Occurrence of natural hazards/disasters have threatened sustained economic growth by causing shocks such as the 1998–2001 drought, October 2005 earthquake, and August 2010 floods did (Table 18.1). The losses incurred during the 1998–2001 droughts were staggering. In 2000–2001 financial year alone, the drought reduced economic growth rate to 2.5 % as compared to expected growth rate of over 5 % (Ahmad et al. 2004). The quake caused a loss of about 5 billion US$ (ADB-WB 2005), which is enormous when compared to national budget for 2006–2007, which was about US$25 billion. Cyclone Yemyin in 2007 caused damage amounting to US$674 millions (ADB-WB 2007). The economic damage from 14 flood events between 1947 and 2007 was estimated at US$6 billion. The floods of 2010 wiped off 5.8 % of the national GDP causing a loss of some 10 billion dollars (ADB-WB 2010). The economic damages suffered from the flood of 2011 were estimated at US$3.7 billion (ADB-WB 2011).

Table 18.1 Impacts of natural disasters in Pakistan 1987–2010

S.No	Disaster type	People homeless	People killed	People injured	People affected	Total affected	Total damage $ 000	Rank
1	Flood	8,927,685	11,722	12,62	38,669,447	47,589,394	2,746,030	1
2	Earthquake	2,853,585	142,812	88,096	1,294,429	2,336,110	5,019,255	2
3	Drought	–	223	–	2,269,300	2,269,300	247,000	3
4	Famine	–	–	–	300,000	300,000	–	4
5	Epidemic	–	283	211	16,275	16,486	–	5
6	Windstorm	22,579	11,654	1,183	1,057,000	1,080,780	4,100	6
7	Landslides	3,100	384	114	200	3,414	–	7
8	Extreme temperature	–	1.406	324	250	574	–	8
9	Total	11,806,967	161,464	90190	43,606,901	55,505,058	8,016,385	–
10	Flood 2010	1,744,471	1,984	2,946	20,484,550	20,184,550	10,000,000	–

Source: NDMA (2011)

Table 18.2 Top ten countries of the world affected by disasters 2000–2010

Top countries affected by disasters	Number affected (million people)	Number of disasters	Number of deaths	Ratio disasters to death	Economic costs (US$bln)
China	1,321.6	311	105,849	340	205,654,128
India	602.9	204	60,879	298	25,888,285
Bangladesh	73.2	90	9,696	108	5,884,000
Philippines	52.9	160	10,531	66	2,543,118
Thailand	43.6	57	9,750	171	2,433,613
Pakistan	32.8	74	789,325	1,072	17,134,648
Ethiopia	29.2	48	2,926	61	9,400
Vietnam	21.8	89	3,754	42	5,759,905
United States	20.7	257	4,357	17	353,414,290
South Africa	15.3	42	708	17	866,305
% of total	90	27	25	–	61

Source: OECD DAC

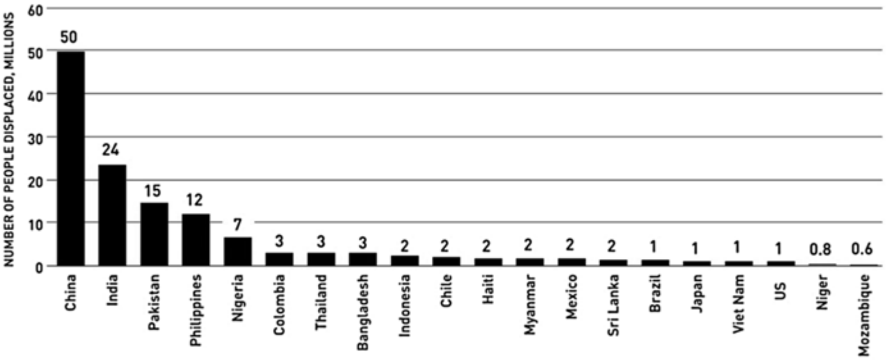

Fig. 18.1 Top 20 countries of the world with the highest disaster induced displacements 2008–2012 (Source: Development initiatives based on Internal Displacement Monitoring Centre (IDMC) data)

When compared with rest of the world, Pakistan was among top ten countries ranking sixth in terms of disasters faced between 2000 and 2010 (Table 18.2) and ranked third in displacement of people due to disasters (Fig. 18.1).

The financial pressure generated by these and other disaster events had short-term severe fiscal impact as well as long-term developmental implications, and therefore, need effective remedial measures. These, in turn, demand critical insight into investments in disaster risk reduction and recovery to identify weaknesses therein, so that appropriate fiscal instruments may be put in place. This is particularly important in the wake of expanding population and economy that are exacerbating the disaster risk.

18.3 Disaster Management Investments: Past Scenario

18.3.1 Past Mechanisms

Historically disaster management in Pakistan followed a reactive post disaster or Post ante rather than a proactive or Ex ante approach. Hence the investments focused on post disaster relief, rescue rehabilitation and reconstruction and gave little importance to disaster risk reduction.

18.3.1.1 Domestic Sources

The Government responded to disaster relief on case-by-case basis through reallocation of funds from other budgetary heads or provided adhoc assistance by creating special funds for a particular disaster. Examples of such funds included Prime Minister Fund for Flood Relief (to which public and organizations could also contribute) as the primary fiscal response to disaster relief at national and provincial levels. Individual government organizations also created relief funds for example Army announced setting-up of its relief fund. Government also used other means to gather funds, which were mandatory rather than voluntary – where sponsors were left little option to deny funding. For instance deductions from salaries for relief fund and flood surcharge on the sale of petroleum. Such ex-post instruments were too small to cover recovery and reconstruction needs and contributed to liquidity shortfalls in the immediate aftermath of disasters. The government's ultimate responsibility to provide post-disaster assistance to not only the poor and vulnerable for reconstruction but also to restore lifeline infrastructure was a huge challenge.

The reactive approach was also apparent in the legal and institutional framework prior to 2005. For example, the West Pakistan National Calamities Act 1958 was the legislation that provided the mechanism for the maintenance and restoration of order and relief in areas affected by disasters. In terms of institutions, an Emergency Relief Cell was created in 1971 in the Cabinet Division for providing an institutional disaster relief support at the federal level. At the provincial level the institution of Relief Commissioners was created to look after the matters at that level. The Federal Emergency Relief Cell in 1974 prepared the first plan proposing organizational structures, responding agencies and procedures for monitoring relief operations; the plan however, did not materialize.

Further, disaster management in the country focused mainly on flood disasters. After each episode of flood, the government investment remained concentrated mainly on rescue, relief and rehabilitation. Nevertheless an important aspect in this regard was that it led to preparation of annual flood fighting plans at all levels of the government – district, provincial as well as federal with a bottom up approach. It also promoted early warnings through various means of communication both indigenous and modern.

18.3.1.2 Humanitarian Assistance

Humanitarian assistance for disasters in the country has come from some domestic but largely international sources. Regarding domestic sources, Development Assistance Committee of the Organization for Economic Co-operation and Development ranked Pakistan the fourth most charitable nation in the world after Sweden, Norway and Luxembourg. Their 2010 report stated that people in Pakistan give 1 % of their Gross National Income (GNI) as charity. This is however, only a small component of the Humanitarian Assistance that the country received from international sources.

The amount of International Humanitarian Assistance received between 1995 and 2008 in response to specific disasters such as flash floods, floods, drought and earthquakes is shown in Fig. 18.2. This assistance reached its peak in 2005, when the country received US$576 million following the flooding and Kashmir earthquake in 2005, and a further US$465 million in 2006 as humanitarian needs in Kashmir continued. In 2008 Pakistan was the 16th largest global recipient of humanitarian aid.

18.3.1.3 Coordination of International Assistance

Office of the Coordinated Humanitarian Assistance (OCHA) coordinates the humanitarian aid from international community to the Government of Pakistan for emergency relief. Such assistance was provided for flood-affected areas in 2010 and 2011 and more recently earthquake affected area in Balochistan. OCHA provide support for emergency preparedness, coordinated assessments, disaster risk reduction as well as capacity building of government functionaries. It also assists in enhancing disaster management and response skills of local humanitarian partner organizations in districts prone to disasters.

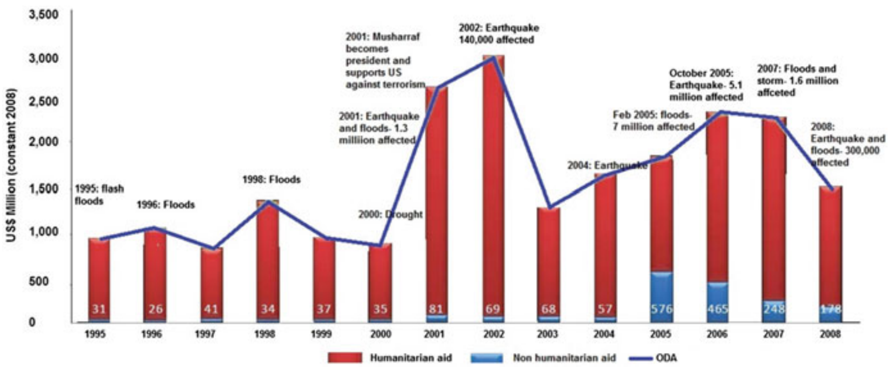

Fig. 18.2 Humanitarian assistance to Pakistan as compared to Non-Humanitarian Aid and ODA 1995–2008 (Source: ORCD DAC (all donors))

Over US$6 billion has been mobilized for humanitarian assistance in Pakistan since 2005. OCHA manages two pooled-funds mechanisms, the Central Emergency Response Fund (CERF) and Pakistan Emergency Response Fund (ERF), which provide assistance for food, water, shelter, health care, nutrition and protection support to people affected by natural disasters and complex emergencies (Table 18.3). Since 2007, Pakistan has received more than U$168 million from the CERF to address urgent humanitarian needs, while the Pakistan ERF has disbursed over $42 million since its inception in 2010.

18.3.2 Weakness and Shortcomings

The weakness of the existing emergency and disaster-response apparatus became too apparent during the devastating earthquake of 2005. It was after the devastation during this earthquake that led to a transformation of national perspective on the disaster issue. The main drawback in the investment mechanisms was that it focused on reactive or ex-post strategies. The data analysis on investments show that there has been very little outlay on disaster risk reduction (DRR) and spending on disaster preparedness has been minimal in the wake of low priority given to it in the country. In June, 2011, the Federal Finance Minister announced that the cost of reconstruction, after the July 2010 floods, would be in the region of US$43 billion. The 2011 floods, 2013 earthquake in Balochistan and 2014 drought in *Thar* have put further strain on national budgets. A major reason for the occurrence of these series of disaster is that most development in the country has taken place with little or no regard to natural hazards, not only exacerbating existing disaster risk but also creating new disaster risks. This amply demonstrates the need for the government and donors to increase investments in disaster risk reduction and enhancing resilience by effective early warning systems, flood control, resilient buildings and infrastructure and better planning particularly through implementation of building codes.

According to agreed international targets, under the Hugo Framework of Action, a minimum of 10 % of all humanitarian funding including allocation for post-disaster reconstruction, and recovery projects should be allocated to disaster risk reduction (DRR). Likewise 1 % of broader development budgets should also be given to DRR. Moreover, the Framework of Action demands that all public development policies should integrate DRR and climate adaptation principles systematically to face the emerging challenges of the changing climate.

Improved DRR measures not only help avoid loss of lives, damage, and distress but also have great value in economic terms. For example it has been estimated that between 2005 and 2011, disasters cost to Pakistan was about US$20 billion. Reconstruction cost after the 2010 floods alone was assessed at $10.9bn, almost one-quarter of the national budget. The Asian Development Bank and the World Bank, which estimated this cost stated that an initial investment of just US$27 million by the Government of Pakistan would cut substantially losses from future disasters. The Government of Pakistan had allocated more than this sum to pay for National

Table 18.3 Top 10 recipient countries of central emergency response funding 2008–2012

	2008	US$m	2009	US$m	2010	US$m	2011	US$m	2012	US$m
1	DRC	41	Somalia	61	Pakistan	52	Somalia	53	South Sudan	40
2	Ethiopia	32	DRC	30	Haiti	37	Ethiopia	46	Pakistan	37
3	Myanmar	28	Zimbabwe	27	Niger	35	Pakistan	32	Syria	36
4	Kenya	26	Kenya	26	DRC	29	South Sudan	23	DRC	31
5	Pakistan	19	Sudan	26	Sudan	24	Kenya	23	Niger	25
6	Afghanistan	18	Sri Lanka	24	Chad	23	Chad	23	Yemen	23
7	Haiti	16	DPRK	19	Kenya	20	Sudan	18	Sudan	20
8	Sudan	16	Ethiopia	16	Ethiopia	17	Cote d'iviore	16	Myanmar	17
9	Nepal	13	Philippines	12	Sri Lanka	16	Sri Lanka	16	Burkina Faso	15
10	Sri Lanka	12	Niger	12	Yemen	15	Niger	16	Chad	15
% of total		**52**		**63**		**64**		**62**		**54**
Total top 10 recipients		**221**		**252**		**266**		**266**		**259**
Total all recipients		**429**		**397**		**415**		**426**		**477**

Note: DRC - Democratic Republic of Congo; DPRK - Democratic Peoples Republic of Korea
Source: Development Initiatives based on Central Emergency Response Fund (CERF) data

Assembly expenses in budget of financial years 2009/2010 and 2010/2011. This initial investment, followed by sustained allocation of resources, could help reorganize the existing parallel disaster management bodies, providing them assistance and hardware support in the 30 most vulnerable districts and longer-term flood risk mapping (Oxfam 2011).

Donor Support is also imperative to ensure strengthening DRR and climate change adaptation measures. Sustained DRR funding along with continued development assistance is indispensible in developing disaster preparedness mechanisms. In the past even outside donors support had low priority for DRR. According to OECD Development Committee, for example, only 1 % of total reported official humanitarian assistance to Pakistan between 2005 and 2009 was allocated to disaster prevention and preparedness (Fig. 18.3).

The OECD Development Assistance Committee data for top ten recipients (including Pakistan) of bilateral humanitarian assistance for 2007–2011 period (Fig. 18.4) reveals that all these countries received very little proportion of this funding for DRR. Pakistan particularly was at the lower end of the scale whereas Haiti and Somalia did much better.

One other important thing to note is that overall financing for disasters is not a priority for the international community. As an example, over 20-year period between 1990 and 2010 the commitment for international aid was just over 3 trillion US dollars (Fig. 18.5). Compared to this the total commitment to natural disaster related aid was 106.7 billion US dollars. A balance sheet of spending, within this reveals that US$13.5 billion or only about 12.7 % was actually spent on disaster prevention and preparedness, compared to US$23.3 billion on reconstruction and a

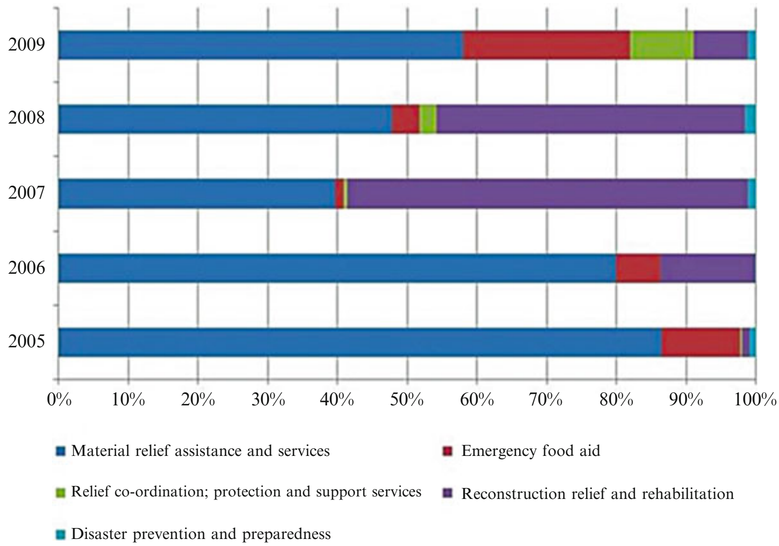

Fig. 18.3 Pakistan: humanitarian assistance by type 2005–2009 (Source: Development initiatives based on OECD DAC data)

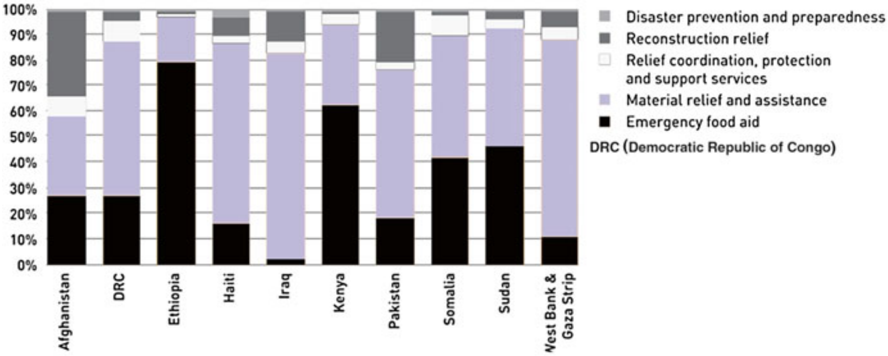

Fig. 18.4 Bilateral humanitarian assistance to top ten recipients by type 2007–2011 (Source: Development initiatives based on OECD DAC CRS data)

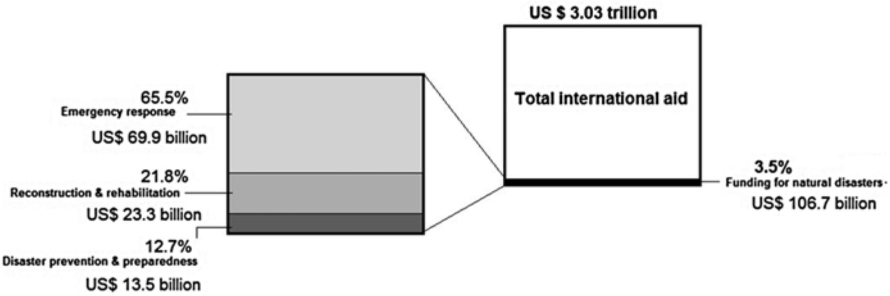

Fig. 18.5 Proportion of disaster prevention and preparedness assistance in international AID

staggering US$69.9 billion on disaster-related emergency response (Fig. 18.5). Thus for every US$100 spent on disasters, only US$12 was spent on either preventing them in the first place, or preparing for them.

It is encouraging however that in recent years, DRR has gained great prominence and international recognition through global initiatives like the Global Facility for Disaster Reduction and Recovery (GFDRR) and the UN International Strategy for Disaster Reduction (ISDRR). DRR, as a result, is now being used as a crucial means to check the impact of natural disasters, avert humanitarian crisis and to promote sustainable development. Most multilateral donors such as the World Bank and Asian Development Bank and bilateral donors such as governments now recognize its importance and are adopting strategic approaches to incorporate DRR within their aid programmes. Further in response to continuing trend of rising disaster losses, even governments of the affected countries are not only acknowledging and appreciating DRR but also investing in it. The Government of Pakistan, for example, through this investment is assessing risk to reduce and ensure that residual risk is managed as efficiently as possible for hazard-resilient recovery and reconstruction.

18.4 Disaster Management Investments: Present Scenario

There was a paradigm shift in Pakistan in recent years from reactive to proactive approach, a large share of investment since the earthquake of 2005 has gone into development of legal framework, institution building, formulation of a National Disaster Reduction Policy and development of a National Disaster Reduction Plan (NDRP). Moreover, a Disaster Management Framework was launched in 2007 to guide entire system of disaster management. The life of the framework was for 5 years. Subsequently, 10 years 'National Disaster Management Plan' (NDMP-2012–2022) was formulated with Japanese assistance. The approved plan identifies short, medium and long-term interventions for public sector investment in the whole spectrum of disaster management. The emphasis though remains on vulnerability and risk assessment, early warning system and human resource development.

The NDMP 2012–2022 has been developed to implement National Disaster Risk Reduction Policy, which provides coverage to both natural and man-made hazards and has been developed in consultations with all stakeholders to mainstream disaster management in development planning. It outlines the country's objectives, priorities and directions for reducing risks from upcoming challenges of disaster management, while providing a guiding framework for DRR friendly development planning focusing on climate change adaptation measures, disaster risk insurance, and community based disaster risk management approaches. DRR mainstreaming strategies for six federal ministries have already been formulated for implementation. The Provinces of Punjab and Khyber Pakhtunkhwa have also initiated replication of similar arrangements by establishing Provincial Working Groups on Mainstreaming DRR within their planning and Development Departments.

18.4.1 Present Mechanisms

In terms of financial mechanisms, besides establishment of national and provincial national disaster management funds, a social safety net has been created, and an ambitious insurance programme is being initiated for the whole country.

18.4.1.1 New Funding Mechanisms

Provision has been made for the following new funding mechanisms for disaster management at both national and provincial levels in the National Disaster Management Act of 2010 as follows:

18.4.1.2 The National Disaster Management Fund

This Federal Fund is the main source of funding to meet any threatening disaster situation or disaster. It will absorb all other existing funds for managing disasters such as Prime Minister Disaster Relief Fund and any other related funds at the discretion of the Federal Government. The National Authority shall administer the fund, which is to be financed from

(a) Federal Government grants
(b) National and international agencies loans, aid or donations
(c) Donations from other sources

18.4.1.3 Provincial Disaster Management Funds

The respective Provincial Governments will establish this fund. The Provincial Authority shall administer the fund, which will be financed from:

(a) Federal and Provincial Government grants
(b) National and international agencies loans, aid or donations
(c) Donations from other sources

18.4.1.4 Budgetary Provisions

The Act also calls upon Federal and Provincial Governments to provide funds from their budget to carry out the activities and programmes included in the Disaster Management Plan.

18.4.1.5 Social Safety Net

In order to cope with the severe floods of 2010, the Government of Pakistan (GoP) initiated a program of temporary nationwide social safety net (SSN), which enabled it reach an estimated eight million flood-affected people. This rapid response cash grant program known as, "The Pakistan's Citizen's Damage Compensation Program" (CDCP) was built upon experiences that were gained from two previous cash grant relief efforts first of these was for 2005 Pakistan earthquake victims and the second was for people internally displaced during the 2009 civil conflict. The CDCP did not use Pakistan's existing SSN mechanism – The Benazir Income Support Program that was not developed enough for effective delivery of support at that time. Hence, the federal government initiated this separate program in close cooperation with provincial governments, the National Database Registration Authority (NADRA) and commercial banks. The selected program beneficiaries were issued Visa direct debit cards by these banks, called Watan cards, which could be used to collect their grants from ATM machines or designated Points of sale.

A major advantage of this program that can be of great use in future is that it has led to the development of a SSN disaster preparedness action plan for future disasters and crises.

18.4.1.6 Insurance Provision

Pakistan has developed a plan for its entire population to be covered under a proposed National Disaster Risk Insurance (NDRI) programme which will compensate communities against any natural calamity. It will initiate a pilot phase of the programme first, which is to be implemented through a funding support of the World Bank. The Programme is to provide free or subsidized insurance from Zakat fund. Private Sector fund may also be tapped as part of their corporate social responsibility.

According to the envisaged scheme various insurance companies will provide coverage to communities living in different areas of the country. In the case of occurrence of a disaster, the insurers will have to give a prompt response as per their mandate to the respective area or district (s) affected, by providing shelter, food, and medicines. The burden of rehabilitation and rebuilding of the affected communities will also be the responsibility of the insurer. According to the agreement, the government will only pay the premium.

The Poverty Index Database will facilitate the underwriters and the actuaries along with demographic data collected under Benazir Income Support Programme in ascertaining the financial impact of disasters on the people of a particular area/ town or a district. The vulnerability of every area will be assessed to the probability of disasters together with their financial implications in order to meet the challenge. The respective insurance company of the area in this way will be ready to handle the emergency.

18.4.2 Emerging Challenge

The Government of Pakistan in recent years has also taken positive steps in creating a disaster management framework and institutions. However, a major emerging challenge is to translate the Disaster Management Policy and Plan into effective disaster management systems; particularly at the community level not only to minimize risks but also to support people help themselves when faced with crisis. It would also require fiscal resilience through sustained investment from domestic resources as well as development of innovative financial instruments and mechanisms. The fiscal measures such as the establishment of a Disaster Management Fund and development of Social Safety Net are encouraging steps in that direction. However, there is still a big vacuum, which can be filled only by advocacy through cost benefit analysis of mitigation measures as well as development of a comprehensive risk financing strategy.

18.5 Fiscal Resilience to Disasters

18.5.1 Cost Benefit Analysis of Investment in Mitigation Measures

It is important to demonstrate through robust cost benefit analysis the critical need to invest in mitigation measures to control disasters. This would involve probabilistic risk assessment as well as the information on expenditures needed to reduce the risk. In addition it may also require examination of fiscal impact of medium and large size disaster events that occurred in past two decades. A combination of these could be used for cost benefit analysis to demonstrate the economic and social benefits of investment in mitigation measures at all levels from local and provincial to national. The mitigation measures in this regard could be both structural and non-structural. The example of the former are those which involve flood control structures like river levees and earthquake resistant buildings while that of the later are building codes, land use policies, awareness creation and early warning system. This is extremely important for advocacy to local/municipal, provincial and Federal officials for investments on the implementation of mitigation measures to reduce expected losses.

18.5.2 Risk Financing Strategy

Development and implementation of a viable risk financing strategy, with a range of instruments, is the most logical future option not only for generating and sustaining investments in disaster management but for enhancing fiscal resilience to disasters. Such a strategy would require the commitment of adequate funds, know-how, and human resources on the part of the government along with logistical cum financial support of the private sector, civil society, and the international community. It will also be important to reflect and integrate the strategy appropriately into national development plans and investment policies to make it effective.

The range of instruments both post ante and Ex ante from which the Government of Pakistan can choose to muster funding after a disaster along with the time needed to mobilize funds by these instruments have been shown in Fig. 18.6. Cost, size and timeliness should be the guiding principles for the selection of instruments. Ex ante instruments may cost more, however, they have an edge over the post ante instruments since they are secured before a disaster and therefore enable speedy disbursement after disasters. The two approaches may be combined for an optimal mix as done in the case of Colombia. However, in Australia financial commitments to natural disasters management relies on ex post approaches, while in Mexico, the reliance is mainly on ex ante financing approach (OECD 2012).

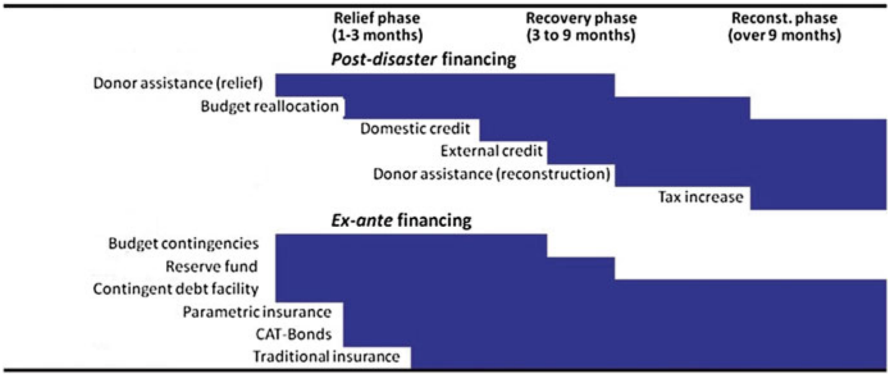

Fig. 18.6 Financial instruments for disaster amelioration (Source: Ghesquiere and Mahul 2010)

18.6 Mechanisms and Instruments of Risk Financing Strategy

The risk financing strategy should have a multi-layered Ex- ante system of instruments including: (i) Reserve or Disaster Management Funds; (ii) Contingency for Emergency Loans; and (iii) Risk Transfer Mechanisms such as Insurance, Parametric Insurance (based on hazard parameters intensity such as earthquake magnitude, sea level rise or wave height, windspeed and rainfall etc.) and/or Catastrophe Bonds etc. Further, the funding base of the strategy needs strengthening with a range of other innovative financial risk transfer mechanisms involving varied stakeholders from private non-life catastrophe insurance for homeowners to agricultural insurance for farmers and micro insurance for the poor. Financing through public-private partnerships would also be extremely useful for the promotion of cost-effective solutions to counter enhanced threats from climate change.

18.6.1 Disaster Management Funds

These constitute dedicated savings or reserves, a source of risk financing obtained mainly through internally generated funds in Pakistan but also include other sources. The Government has already established National Disaster Management Fund at national level. In addition, Provincial Disaster Management Funds have also been established in the Punjab Sindh and Khyber Pakhtunkhwa. Punjab has allocated two billion rupees for the Fund and Khyber Pakhtunkhwa one billion rupees. However, the current domestic resources available for the funds are too little in comparison to the gravity of the problem. It has been suggested to mobilize further resources through urgent widening of the tax base (currently only 2 % of Pakistan's population pay income tax) without disproportionately impacting on the poorest (Oxfam 2011).

18.6.2 Contingent Financing

Immediately in the aftermath of a disaster, the country is confronted with the urgent need to provide emergency assistance to victims and reinstate damaged infrastructure including roads, bridges, irrigation system, hospitals, schools and utilities such as water supply, gas, electricity, gas. This requires immediate financing to reset the infrastructure and utilities in the affected area. Since in the past, it has been demonstrated that the disaster impacts are very high relative to domestic financial bearing capacity, therefore accessing external sources of risk financing such as contingent credit facilities, where loans are provided in the event of a disaster event is therefore important. It would help to arrange for credit to this effect from a source preferably in advance, contingent upon the calamity. It ensures that if a calamity occurs, the lending source will provide a certain amount of credit to the affected country/party at a pre-determined or negotiated rate.

Recently the World Bank has initiated Disaster Risk Management Development Policy Loan, which has a Catastrophe Deferred Drawdown Option (CAT-DDO). CAT-DDO offers finances for immediate relief, recovery and reconstruction. It is a lending mechanism that allows quick government response to emergency needs following a natural disaster. A major advantage of the mechanism is that it gives flexibility to the Government for not diverting resources from development projects or programs. A limit of up to US$500 million or 0.25 % of GDP (whichever is less) has been set for disbursement of Funds when a country suffers from a natural disaster and declares a state of emergency. International Monetary Fund (IMF) also has an Emergency Natural Disaster Assistance (ENDA) Policy, under which Pakistan received US$450 million after the 2010 floods (Laframboise and Loko 2012).

18.6.3 Risk Transfer Mechanisms

Risk transfer instruments such as insurance allow risks to be transferred to an entity or entities whose business is to pool and diversify risks. This could be a traditional insurance or reinsurance or parametric insurance where insurance payments are triggered by prescribed parameters such as intensity of wind speed in a cyclone. It could also include an alternative risk transfer instrument like Catastrophe bonds. There is a substantial literature available on these (Caballero 2003; Freeman et al. 2003; Gurenko and Lester 2004; Hofman and Brukoff 2006; Cummins and Mahul 2009; Ghesquiere and Mahul 2010; World Bank 2010).

18.6.3.1 Insurance

Markets are well developed and well known for households and other economic insurance, which may also include corporate and public assets providing simple and cost-effective financial protection. The insurance, as risk transfer mechanisms, can be helpful in building resilience of communities' to disasters and is particularly relevant to developing countries like Pakistan. The United Nations Climate Change Conference in its Cancun Adaptation Framework 2010 recommended taking enhanced action on risk transfer and insurance. Nevertheless, in order to promote these, it is essential to create awareness and provide financial help to poor and down trodden, who cannot afford to pay the premium. Whether the insurance scheme to be launched by the Government of Pakistan, which envisages payment of premium of poor's from Zakat Fund, would be successful to this end is yet to be seen.

Turkish Catastrophe Insurance Pool (TCIP) provides an example of insurance for disaster risks. It was established in 2000 especially because by tradition Turkey's private insurance market neither provided nor had adequate capacity for catastrophe property insurance. A World Bank contingent loan supplemented the company's capital from domestic resources. Further international reinsurers have reinsured the program. TCIP had covered about three million dwellings by 2010. The insurance under TCIP was designed as a stand-alone property earthquake policy. The maximum sum insured is US$65,000 per policy and the average premium is US$46 with a 2 % deductible. The rates of premium are determined by two factors construction material (two types were identified) and location of the dwelling (five earthquake risk zones were identified). For example the rates vary from a high of 0.60 % for a weak material house located in the highest risk zone to a low of less than 0.05 % for a concrete reinforced house in a low risk zone. Thus by making purchase of insurance compulsory for middle and high income homeowners, the Government of Turkey has reduced considerably the number of households likely to need assistance from the Government in case of an earthquake disaster (Ghesquiere and Mahul 2010).

It is rather important to note that innovation in disaster risk financing and insurance, in recent years, has considerably diversified its scope to bring in a wide variety of stake holder in the ambit of risk transfer ranging from government to private non-life catastrophe insurance markets for homeowners, agricultural insurance for farmers and livestock owners, and disaster micro insurance for low-income population. Innovation is also taking place in disaster risk financing and insurance product development, disaster risk assessment and sharing, and delivery channels, which need to be carefully explored in the context of Pakistan.

18.6.3.2 Catastrophe Risk Pooling

Catastrophe risk pooling is a mechanism whereby a number of stakeholder or parties such as governments, insurers and reinsurers, donors and people pool their resources to split the heavy economic burden of a calamity. The stakeholders may also involve a group of countries, which may share their disaster risk through regional cooperative insurance. The example of former case is risk pooling for livestock mortality primarily due to extreme weather whereby the Government of Mongolia initiated an index linked insurance in order to build resilience of nomadic herders to large livestock losses, with the assistance of the World Bank. A livestock insurance indemnity pool was created, which had a reserve fund and a risk pooling arrangement. The partners supporting the risk included the Ministry of Finance, Mongolia, international reinsurance community and the World Bank (which provided contingent credit). The losses up to 8 % were to be borne by the herders while the remaining was covered by the Government of Mongolia through a safety net programme, and insurance indemnity pool.

The example of second case is the Caribbean Catastrophe Risk Insurance Facility (CCRIF 8), the first regional insurance pool of the world, which was established in 2007, involving a group of 16 countries exposed to earthquake and hurricanes. The facility had its own reserved pool of over US$90 million contributed by the countries and reinsurance to the amount of US$110 million from international financial market thus providing US$200 million to the risk facility. When a disaster event occurs the loss at first is met through pooled reserve while the excess risk is transferred to the international capital market (reinsurance and catastrophe bond markets). The reserved pool gets contribution from countries in proportion to their exposed risk that was initially determined through a detailed study of exposure to catastrophes. Since the insurance is parametric, therefore the disbursements are also on the parameters such as wind speed rather than on actual losses. The CCRIF has provided a higher level of resilience than international standards because its reinsurance strategy has been designed to withstand a series of major natural disaster events, each with a probability of occurrence lower than 0.1 %.

18.6.3.3 Direct Access to Capital Markets

With further increase in the severity of the risks and increase in the size or number of the risk bearers, additional risk transfer instruments or tools are used for direct access to capital markets such as catastrophe-linked securities. In a limited number of cases, countries have used catastrophe-linked securities or bonds to cover higher layers of risk in the context of structured disaster risk financing (e.g., a disaster fund) or risk transfer (e.g., an insurance scheme) mechanisms. Global capital markets have much larger amount of funds available and ideally they can be tapped to deal with major and destructive catastrophes. Some of the instruments that have been used to channel funds from the capital markets such as disaster insurance and reinsurance have already been discussed above. Other channels may include Catastrophe bonds and public private partnerships. The first catastrophe bond or a cat-bond was issued in 1994 and since then risk-linked securities have become well known (Anderson 2002). Aon Benfield Securities, which offers cat bonds, sidecars and collateralized reinsurance reported in January 2014 that as of December 31, 2013, the total limit of cat bonds outstanding was US$20.3 billion (Canadian Underwriter 2014).

18.6.3.4 Catastrophe Bonds

The catastrophe bond or cat bond are different from normal bonds, because firstly they are insulated from variations in the stock market and secondly their revenues/returns are comparatively higher than those from normal securities. In addition they allow investors to diversify their portfolio. A reinsurance company or even a government can take the sponsorship of the bond. It appeals to them because it not only serves their purpose of reducing the basic risk by bringing previously uninsurable risks under the umbrella of insurability but also by attracting investors, thereby increasing the capital inflow. According to Wall Street Journal companies had floated upto US$20 billion in Cat Bonds upto March 2012. The Journal also reported cat bond issuance had climbed to US$1.2 billion, over 100 % in the first quarter of 2014 compared to the same period last year and the issuance is expected to increase to more than US$3.5 billion in the second quarter. "Catastrophe bondholders have rarely suffered losses historically. But investors can lose both interest payments and their principal if the costs of disasters top a preset level, which allows insurers to spend the money" (Well 2014). The bonds usually mature in 3–4 years and have floating interest rates.

Among governments, in 2006, the Mexican Government floated a cat bond (Mexi Cat ILS) to insure FONDEN (its national disaster fund against earthquake risk). The principal for the bond amounted to US$160 million. Swiss Re was the reinsurer, which renewed the contract in 2009 for USD 290 million. Earlier than this, Taiwan Province of China had issued a cat bond, in 2003, to insure its residential earthquake insurance pool with underwriter Formosa Re (Clemence et al. n.d).

18.6.3.5 Public-Private Partnership in Risk Financing

This is another instrument that helps mobilize private market funds when complexity and costs rise due to natural disasters. In such cases public or private institutions alone may not be able to meet the challenge alone yet their joint response could be effective. This is particularly true for Pakistan, which lacks funds in both public and private sector but has to deal with the increasing frequency and severity of natural disasters. "Public-private partnerships, especially those involving reinsurance and capital market solutions, can improve disaster planning and prepare stakeholders for the consequences of climate change. They can also facilitate risk awareness and joint solutions using various risk transfer mechanisms" (Wong 2009). It may also allow the government to provide relief at lower costs on the one hand and improve budgetary certainty with lower debt levels after a disaster, on the other.

18.6.4 Combining Fiscal Instruments: Risk Layering

The instruments available for designing a Risk financing strategy in Pakistan have their own costs and characteristics, as discussed above. These are not either/or alternatives but provide complementary solutions. An effective national financial

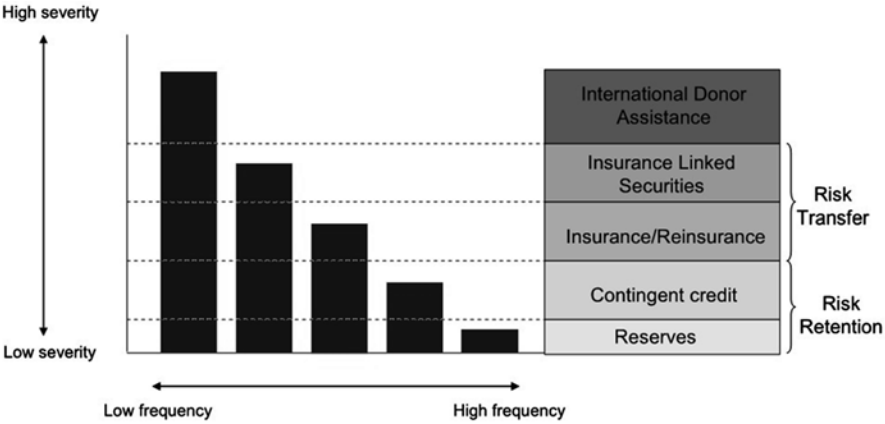

Fig. 18.7 Catastrophe risk layering (Source: Ghesquiere and Mahul 2010)

strategy against natural disasters for Pakistan should therefore rely on a combination of these instruments, taking into consideration indigenous situation such as the country's fiscal risk profile, as well as the cost of available instruments, technicalities involved and the likely disbursement profile after a disaster. Catastrophe risk layering method can be used to design such a strategy (Fig. 18.7). Firstly, the budget contingencies including the reserves in the disaster management funds need to be greatly strengthened and replenished annually. They provide the most important source for ex-ante risk financing that can be utilized in small as well as large disaster events to cover the recurrent losses. Contingent funds or credit including emergency loans could be utilized in medium layer disasters and perhaps insurance could be used if the budgetary contingencies and reserves cannot be accessed or get exhausted. Parametric insurance or catastrophe bonds or other linked securities could be used to finance rare and most severe events. The first preference should be given to secure funds for recurrent disasters events following which the Government should enhance its capacity to finance less frequent but high impact events. There is nevertheless the need to design an optimal risk financial strategy to develop fiscal resilience to natural disasters based on the Governments economic political and social considerations.

18.7 Conclusions

Natural disasters, in past had broad range of economic and social impacts in Pakistan, including loss of human life and injuries, damage to buildings and infrastructure; displacements and unsustainable losses to national economy. The damages in 2005 earthquake and floods of 2010 and 2011 in particular have been colossal and they could have been cut significantly, if the disaster risk reduction measures would have been in place and integrated into physical, economic and social planning and development. The 2005 earthquake was like a wake-up call, which led the Government of Pakistan to change its emergency response paradigm based on ex post risk financing or funding after the risk event, through budget reallocation, creation of adhoc emergency funds, raising taxes and reliance on international assistance, and pay attention to prevention, mitigation and preparedness.

Major positive steps taken in that direction are creation of a disaster management framework, institutions and DRR Policy. The Government is currently facing two major challenges in this endeavor. The first is to translate the Disaster Management Policy and Plan into effective disaster management systems and secondly but equally if not more important is the creation of fiscal resilience through sustained investment from domestic resources as well as development of innovative financial instruments and mechanisms. The fiscal measures such as the establishment of a Disaster Management Fund and development of Social Safety Net are encouraging steps in that direction. However, the fiscal imbalances created by 2010 floods that threatened the national economy revealed that much more efforts are needed to deal with the increasing frequency and intensity of disasters. It has demonstrated firstly the importance of ensuring that in future the economy has the resources necessary for relief, recovery, rebuilding and resuming economic growth in the aftermath of disaster and secondly that it is critical to invest in disaster risk reduction through preparedness, prevention and mitigation. Both these call for the development and implementation of a robust risk financing strategy.

The strategy needs to be based upon advance planning and geared to increase Pakistan's financial response capacity in the aftermath of disasters. It should have a multi-layered Ex- ante system of instruments including reserve or disaster management funds; contingency for emergency loans; risk transfer mechanisms such as insurance, parametric insurance and/or catastrophe bonds as well as innovative risk transfer means for tapping funds from international capital market. Presently insurance markets in Pakistan have comparatively low level of development and need government support and push for its boosting and enhancement. Tapping other innovative risk transfer mechanisms from international capital markets can also be of immense value as they supplement traditional insurance, which is still largely under-developed in the country. They can ensure availability of funds during recovery and rebuilding efforts, on the one hand and protect budgetary resources and enhance financial stability on the other. Further, pre-determined premiums promote budgetary certainty (particularly in a multi-year contract). Likewise, no payback obligation, in contrast to loans, reduces the pressure to divert funds from existing important projects to manage the after effects of disaster.

It goes without saying that a well-designed risk financial strategy for Pakistan is the need of the day as it has several advantages. Firstly, it will reduce the economic and fiscal burden of natural disasters by transferring excess losses to private capital and insurance markets. Secondly, it would create financial incentives for public and private agencies and/or households to take responsibility for risk reduction and mitigation. Thus for accessing disaster risk financing and insurance instruments, it would be mandatory to comply with disaster e.g. earthquake- resistance building codes. Additionally, it would be extremely useful in the promotion of cost-effective solutions to counter enhanced threats faced by the country in the wake of climate change. Finally, it is important to mention that a major step in the development of a Risk Financing Strategy in Pakistan would be the comprehension of risk landscape. Risk assessments and risk modeling techniques provide the basic tools for this purpose as they allow appraisal of the likely economic and fiscal impact of natural hazards upon which such a cost-effective risk strategy needs to be based.

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Chapter 19
Community Based Disaster Risk Management in Pakistan

Amir Nawaz Khan and Mushtaq Ahmad Jan

Abstract It has been observed that due to explosive growth of population, changing priorities, economic competition as well as inflation of the resources for social welfare services at the global level are dwindling. Keeping in view the shrinking position of resources for social welfare and community development the concept of participation emerged in area of social sciences and community development since 1980s. By the early 1980s participatory approach slowly and gradually came into use in the community development discourse. It was followed by a rapid growth in the development of methods for involving rural people in examining their own problems, setting their own goals, and monitoring their own achievements. It is important to note that an actively involved and empowered local population is essential for successful rural community development. This chapter on Community Based Disaster Risk Management (CBDRM) covers a basic introduction to the theory of participation; Paradigm shift in Disaster management, process of CBDRM; participatory risk management planning and implementation and some of the relevant case studies related to various thematic area of the CBDRM in Pakistan.

Keywords Community • Disaster • Vulnerability • Participation • Resilience • Community development • Risk management

19.1 Introduction

Natural hazards are nothing new to humanity. Floods, droughts, earthquakes, and the like have been accompanying humans from the very beginning. However, a natural hazard in itself does not cause a disaster; a disaster results when a natural hazard hits a vulnerable, exposed and insufficiently prepared community. Disasters

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_19

are now occurring at a scale and frequency that is causing unprecedented impacts worldwide. One simple reason is that the world's population is higher than ever before. On the other hand scientific evidence also indicates that weather-related hazards are becoming more frequent and intense due to the impact of climate change (Inter-Cooperation 2010). Economically and socially marginalized groups in society generally suffer worst from natural disasters. This question of local people's vulnerability and capacity in the context of natural hazards is very important for understanding the potential impact of disasters and making choices about how to intervene. More generally, socioeconomic vulnerability is also now seen as a key to understanding poverty and designing poverty reduction programmes. Community based disaster risk management considers a wide range of environmental, economic, social, cultural, institutional and political pressures that create vulnerability (Benson et al. 2007). People in developing countries are particularly vulnerable to disasters as they often are more exposed, have lower coping capacities and are less prepared. Furthermore, they are heavily dependent on climate-sensitive primary industries – notably agriculture, forestry or fishery. Hence, disasters jeopardize development processes and can indeed eradicate years of local development efforts in a few minutes or hours. Therefore, disaster risk reduction (DRR) has to be seen as an integral part of the community development efforts at the gross root level (Clot and Carter 2009).

19.2 An Overview of the Concept of Community Participation

The concept of community participation originated about 40 years ago from the community development movement of the late colonial era in parts of Africa and Asia. To colonial administrators, community development was a means of improving local welfare, training people in local administration and extending government control through local self-help activities (McCommon 1993). Today, it has developed as one of the major models of development especially related to grassroots community development initiatives and viewed as a basis for project success. It has also received wide acclaim, but also criticism. The roots of participatory approaches can be traced to the activist adult education methods of Paulo Freire and the study clubs of the Antigonish Movement. In this view, an actively involved and empowered local population is essential to successful rural community development. Chambers, a key exponent of Participatory Rural Appraisal, argues that the approach owes much to "the Freirian theme, that poor and exploited people can and should be enabled to analyze their own reality" (Chambers 1997).

Community participation is the involvement of local people in the disaster management initiatives which can be started from the elementary steps of a process and ends in the accomplishment and institutionalization in the community (Salajegheh and Pirmoradi 2013). The World Bank (2004) considers participation as "a process through which stakeholder's influence and share control over development initiatives, and the decisions and resources which affects them". The United Nations

Fig. 19.1 Community mobilization cycle for enhancing participation in community development and disaster management (After Bartle 2007)

(1981) defined community participation as "the creation of opportunities to enable all members of a community to actively contribute to and influence the development process and to share equitably in the fruits of development". Furthermore Murshed and Nural (2002) states that community participation is "an educational and empowering process in which the people come together to identify their problems, recognize needs and more importantly undertake the responsibility to plan, manage, control and evaluate the joint actions that should be needed". Community participation is cost effective, self-help, power sharing and voice gaining process of community (Krummacher 2014). It is a reciprocal way for flow of information (formal and informal) between the external actors and the host community (Murshed and Nural 2002). Figure 19.1 explain how to enhance participation of the local people in each stages of social mobilization/project cycle management.

19.3 Community Participation in Disaster Management Under the International DRR Strategies and Frameworks

On 11 December 1987 at its 42nd session, the General Assembly of the United Nations designated the 1990s as the International Decade for Natural Disaster Reduction (IDNDR). The basic idea behind this proclamation of the Decade was to keep focus on the unacceptable and rising levels of losses which disasters continue to incur and to use the wealth of scientific and engineering know-how which could be effectively used to reduce losses resulting from disasters (Goldammer n.d.). The UN World Conference on Natural Disaster Reduction which was part of a mid-term review of Decade activities was held in Yokohama (Japan), 23–27 May 1994. In conference at Yokohama the international community reached a broad consensus to put more emphasis on Community Based Disaster Risk Reduction programs that involved vulnerable people themselves in planning and implementation. The guiding principle of the IDNDR Yokohama Strategy and Plan of Action for a Safer World states "Preventive measures are most effective when they involve participation at all levels, from the local community through the national government to the regional and international level" (UN 1994).

As its name implied, the IDNDR officially came to an end in 1999. However, during its 10-year span of activities, it achieved such important successes – especially in terms of forging vital links among the political, scientific and technological communities that the United Nations created a successor body to carry on its work. This new body of coordinated action programmes, with a secretariat in Geneva, is International Strategy for Disaster Reduction (ISDR). The UN International Strategy for Disaster Reduction (ISDR) replaced and continued the IDNDR Strategies. The International Strategy for Disaster Reduction (ISDR) is a strategic framework, adopted by United Nations Member States in 2000. The basic aim is to guide and coordinate the efforts of a wide range of partners to achieve substantive reduction in disaster losses and build resilient nations and communities as an essential condition for sustainable development. The United Nations International Strategy for Disaster Reduction (UNISDR) is the secretariat of the ISDR system. The ISDR system comprises numerous organizations, States, intergovernmental and non-governmental organizations, financial institutions, technical bodies and civil society, which work together and share information to reduce disaster risk. UNISDR serves as the focal point for the implementation of the Hyogo Framework for Action (HFA)–a 10 year plan of action adopted in 2005 by 168 governments to protect lives and livelihoods against disasters. The Hyogo Framework of Action incorporated the involvement of the local community in all stages of disaster risk management. The HFA promote community participation in disaster risk reduction through the adoption of specific policies, the promotion of networking, the strategic management of volunteer resources, the attribution of roles and responsibilities, and the delegation and provision of the necessary authority and resources. More specifically priority 3.1, 3.2, 3.3, 3.4 and 3.5 of the HFA focus on the Development of a public awareness system, including world campaigns, International Day for Disaster Reduction, educational booklets (specific hazards, thematic) community and neighbourhood drills, simulation games, Awards etc., mainstreaming of DRR into school curricula and non formal education programs, promote enhanced knowledge management and capacity building through training exercises of the local stakeholders including community (UN 2005). All over the world today CBDRM is a widely adopted strategy for empowering the local people and enabling them to prepare for, mitigate the impacts and respond to disaster on time. The reason for focusing on participatory approach in disaster management by the United Nations has been pointed out by Maskrey (1989), he states that most disaster mitigation initiatives were failed to address human vulnerability to disasters as they had adopted top-down approach and did not involve local community in risks reduction activities. Fischer (2001) has further stated that improving the coping capacity of the local community will enable those to recover quickly from disastrous situation and will reduced human and economic losses resulting from disasters.

19.4 Community Based Disaster Risk Management

Though over the past two to three decades, many approaches have been adopted in the field of disaster management but the concept of Community Based Disaster Risk Management (CBDRM) is globally accepted by vulnerable communities due to its people cantered approach. Currently, CBDRM is recognized a prominent approach for managing disasters at community level (Salajegheh and Pirmoradi 2013). According to ADPC (2003) Community Based Disaster Risk Management (CBDRM) is a process in which communities at risk are actively engaged in the identification, analysis, treatment, monitoring and evaluation of disaster risks in order to reduce their vulnerabilities and enhance their capacities. CBDRM is people and development oriented approach (Salajegheh and Pirmoradi 2013). Participation of local community in risks reduction initiatives is paramount, as they are the most affected by disasters as well as they are the first responders to such circumstances (Jahangiri et al. 2008; ADPC 2003). The basic aim of CBDRM is to identify and address local problems and needs by utilizing indigenous knowledge and capacities of the local people (Krummacher 2014). It aims to empower the most vulnerable social groups and address the root causes of people vulnerabilities to disasters by changing their social, economic and political structures (Shah and Kenji 2004). CBDRM strengthens social structure of the communities and build self-containment among individuals, households, and communities. Furthermore it ensures community ownership, commitment, and people cantered actions in disaster management and results in a wide range of cost-effective and sustainable mitigation solutions (Salajegheh and Pirmoradi 2013).

Community Based Disaster Risk Management includes a wide range of interventions, actions, activities, tasks, projects and programs intended to reduce disaster risks, which are mainly planned by the local people in at-risk zones and are based on their urgent needs and capacities. It has been recognized as a vital tool in order to prevent disasters occurrence, reduced the losses from disasters, build a safer environment, and ensure sustainable development at all levels. It is a multi-stakeholder partnership with clearly defined roles and responsibilities in which community is the primary actor to sustain CBDRM interventions while Government and NGOs have supportive and catalytic role and government has the role to facilitate and institutionalize these efforts (Victoria 1999). It is important to note that coping mechanism and indigenous knowledge of local community play a vital role in risk reduction activities (Morshed and Huda 2002). Community participation in pre and post-disaster phases should be active and learning base as it ensured efficiency and sustainability of disaster risk reduction adopted at community level (Buckle 2004).

19.5 Paradigm Shifts in Understanding and Managing Disasters

Over the last several decades, paradigm shifts have occurred in the understanding of disasters which consequently influenced the evolution of disaster management theory and practice. Initially, natural hazards were seen as "Acts of God" or "Acts of Nature" then rationality and science took over. While there was significant understanding of the natural processes that underlie the hazard events, disasters were still viewed as one-off events and responded by governments and relief agencies without taking into account the social and economic implications and more so the causes of these events.

In the "natural science approach" scientific and technical interventions focused on prediction of the hazard. The "applied science approach" focused on how to modify the impacts of the hazards using engineering and technology to mitigate damage and loss. Plans and actions focused on emergency preparedness, structural and physical mitigation measures, building codes, and land use planning. These approaches looked at disasters as exceptional events, not related to the ongoing social and developmental processes. While the "contingency planning approach" with its preparedness plans, stockpiling of relief goods, and growing roles of relief agencies improved the efficiency of emergency response, it left much to be desired in terms of appropriateness and effectiveness of relief. Till a few decades ago, disasters were viewed as one-off events and responded by governments and relief agencies without taking into account the social and economic implications and causes of these events. With significant advancement in our understanding of the natural processes that underlie the hazardous events, a more technocratic paradigm came into existence which believed that the "only way to deal with disasters was by public policy application of geophysical and engineering knowledge". Gradually this attitude changed to an emphasis on preparedness measures, such as stockpiling of relief goods, preparedness plans and a growing role for relief agencies. This "contingency planning" and "emergency management" approaches certainly improved the efficiency of relief agencies but left a lot to be desired in terms of appropriateness and effectiveness of relief. The alternative/progressive perspective looks at disasters as part and parcel of the "normal" development of societies, as unresolved problems of development. Study of disaster trends from the 1960s to the 1990s revealed an exponential increase in human and material losses from disaster events, though there was no clear evidence that the frequency of extreme hazard events had increased. This indicated that the rise in disasters and their consequences was related to the rise in the vulnerability of people all over the world that was related to development-related socio-economic and political structures and processes. There were large variations in vulnerability across regions, nations, provinces, cities, communities, socio-economic classes, castes and even genders. The "social science approach" focused on how hazards are socially perceived and conceived. From this realization that people's vulnerability is a key factor in determining the impact of disaster, emphasis shifted to using "vulnerability analysis" as a tool in disaster management. In recent years, a more "comprehensive or holistic approach", the disaster risk reduction paradigm has emerged. This approach has at as its process three distinct but inter-related components i.e. hazard assessment, vulnerability analysis and enhancement of management capacity and is more closely integrated with the ongoing development processes. Disasters are no longer viewed as extreme events created entirely by natural forces but as unresolved problems of development. It is now recognized that risks (physical, social and economic) unmanaged (or mismanaged) for a long time lead to occurrence of disasters. There is growing awareness that disaster risk reduction cannot be separated from pressing concerns of sustainable development, poverty reduction, social equity, and environmental protection.

Community-based Disaster Management (CBDM) emerged as an alternative during the 1980s and 1990s. Over the last two decades it has become apparent that top-down approaches fail to address the needs of vulnerable communities, often ignoring local capacities and resources. A top-down approach can increase vulnerability and undermine project improvements in quality of life, security and resilience. The CBDM approach (now CBDRM) emphasizes the active involvement of communities in all phases of disaster risk management. The aim is to reduce vulnerabilities and to increase the capacities of vulnerable groups to prevent or minimize loss and damage to life, property, livelihoods and the environment, and to minimize human suffering and hasten recovery. The shift towards disaster reduction also highlighted the need for local and community participation is disaster risk management (ADPC 2008).

19.6 Participatory Disaster Risk Management Planning Process

In the past, disaster risk reduction programmes often failed to address vulnerabilities, needs and problems of the local people due to top-down approach (Krummacher 2014). In top-down approach local communities and their indigenous knowledge were totally ignored. However to identify and address the vulnerabilities, problems and needs of the local people, they must be involved in the process of disaster risk management because local population have better knowledge of local realities and contexts than external actors (Fig. 19.2; Morshed and Huda 2002).

Though outsiders have financial resources to support the vulnerable communities but these communities possess bulks of skills, knowledge, resources and capacities (Human Resources, indigenous knowledge, etc.). In top-down approach, these assets are often ignored and undermined by external actors. To overcome these problems, local communities need to be directly involved in risks assessment, planning process, implementation, monitoring and evaluation of disaster risk reduction activities (Krummacher 2014). For effective risk reduction results, the bottom-up CBDRM approach need to be connect with the top-down government/national DRR approach. The CBDRM planning process starts from the selection of local community.

Fig. 19.2 CBDRM Planning process (Adapted from Abarquez and Murshed 2004)

It focuses on the selection of most marginalized and vulnerable communities for intervention. In the second phase after selection the approach focus on Rapport building and understanding the community. The main purpose of rapport building is to understand the social fabric, cultural arrangements, community institutions and special distribution of the settlements. In third phase the CBDRM approach focuses on the risk assessment at the community level. The local people are actively involved in the assessment of different types of hazards, position of vulnerability, levels of capacities and also the perception and attitude about hazards and disasters. On the basis of results of participatory disaster risk assessment a participatory action plan is prepared with active involvement of the local communities and other relevant stakeholders. The local people are organized and the intervening organizations try to build their capacities for coping with various types of hazards and disasters. The local people are actively involved in the implementation of various types of plan and in the monitoring and evaluation of disaster management projects.

19.7 Case Study on CBDRM Planning Process

The Asian Urban Disaster Mitigation (AUDMP) of ADPC started in 1995. AUDMP took on the community based approaches in disaster mitigation in the reduction of vulnerability of urban populations, infrastructure, lifeline facilities, and shelter in targeted cities in South and Southeast Asia. The Community Based Flood Mitigation and Preparedness Project (CBFMP) was implemented jointly with the Cambodian Red Cross (CRC), Participating Agencies Cooperating Together (PACT) and the International Federation of Red Cross and Red Crescent Societies (IFRC) in 23 villages in 3 districts in 3 provinces – Kang Mesas District in Kampong Cham, Kien Svay District in Kandal, and Peam Ro District in Prey Veng. CBFMP relied on a network of Red Cross Volunteers (RCVs) and the Disaster Management Committees (DMCs) which were organized in each village to lead communities in identifying flood mitigation and preparedness measures and mobilizing local resources. By June 2000, the project had trained 7 trainers at the CRC headquarters and a total of 159 RCVs. Subsequently, village-level DMCs were organized and resources were mobilized to plan and implement local solutions. The RCVs and DMCs tapped local authorities such as leaders of communes, villages and village groups, wat (temple) committee members, monks and village elders to reach the villagers. From the risk assessment and risk mapping, conducted in the 23 communities, villagers reached consensus on priority mitigation solutions. Opportunities presented by community gatherings at special events or traditional ceremonies were utilized to gather ideas and consensus on mitigation solutions and request for villages' contributions in cash or in kind. Mitigation solutions generally focused on water control structures necessary for livelihood, including repairing dams and dikes; cleaning of irrigation ditches, culverts and water gates; and improving access by raising road levels or constructing small bridges. By June 2000, 14 projects had already been completed. One year after the completion of CBFMP, replication of mitigation solutions in the project areas and in communities outside of the coverage of the project have been implemented.

The step-by-step process by which CBFMP reduced flood vulnerability through building capacities of communities to mitigate, prepare for and respond to disaster in a self-reliant and cooperative manner involved:

(i) Selecting project sites, targeting the most vulnerable communities;
(ii) Selecting community members as volunteers and training them to work with communities in reducing vulnerabilities;
(iii) Organizing communities and establishing village-level DMCs as a coordinating body;
(iv) Identifying, estimating and ranking local disaster risks through risk mapping;
(v) Building consensus on mitigation solutions;
(vi) Mobilization of resources and implementation of community mitigation solutions;
(vii) Drawing lessons from implementation sharing lessons and learning from similar experiences – broad range of mitigation measures, processes and requisites, tools and methodologies; and
(viii) Replication & overall improvement of the CBD Mitigation & preparedness system (Victoria n.d.).

19.8 Institutionalization of CBDRM

Though the concept of CBDRM has been emerged since two decades earlier but still this approach is not properly institutionalized in policy, planning and implementation at all levels. Over the last two decades, this approach is widely practiced by various community groups, national and international organizations and government departments in South East Asian countries (Salajegheh and Pirmoradi 2013). According to Krummacher (2014) non-institutionalization of CBDRM is due to absence of DRR legislation at national and community level, scarce financial assets and lack of capacity and other resources. Community-based Disaster Risk Management (CBDRM) is to build people's coping capacity and mitigate their vulnerability to disaster risks and ultimately develop safer and disaster resilient communities (ADPC 2003). Salajegheh and Pirmoradi (2013) stated that effective institutionalization of CBDRM approach required political will and developing of legislation, policies and allocation of adequate resources at all levels.

The basic assumption of this model is that integration of the concept of CBDRM into overall socio-economic development process and the governance is a prerequisite of the disaster risk reduction (Fig. 19.3). Integration of CBDRM into government policy and planning leads to the institutionalization of this concept. This means that all tiers of the government such as national, provincial, district and community should recognize the need for involving communities and community groups in disaster risk management in their policies and plans, allocate funds for CBDRM activities, assign responsibilities to operational level staff to provide support to community groups, develop appropriate strategies and program to support community action and establish technical resource centres in the country. Therefore, institutionalization of CBDRM requires strong policy support, existence of formal

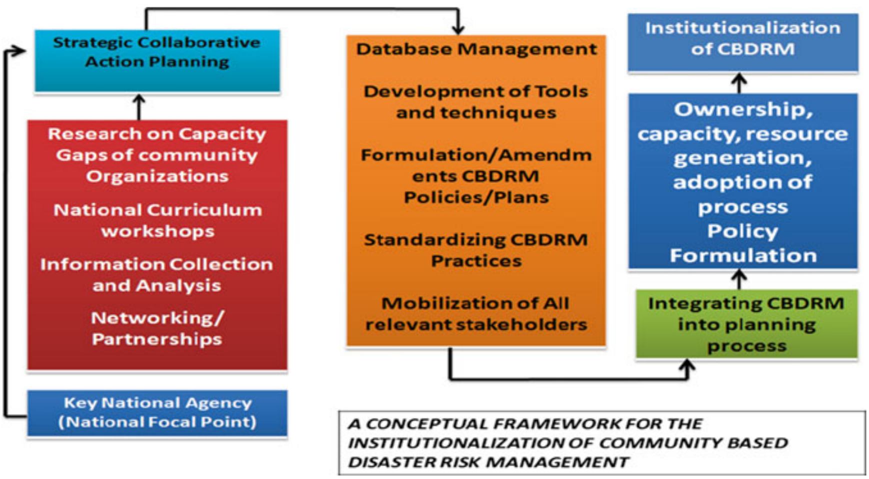

Fig. 19.3 A conceptual framework for the institutionalization of CBDRM (Source: Ashoka 2014)

organizations/institutional support, a framework of disaster risk management, institutionalization of budget, presence of dedicated/ trained and competent personnel and Political wills (Huu 2004).

19.9 Why We Need CBDRM in Pakistan

CBDRM has a pivotal role to play in strengthening the overall DRR/DRM system and structures. Although, there is a world-wide broad consensus on established principles and techniques for CBDRM, different countries, however, have developed CBDRM frameworks and guidelines according to their own national priorities and specific community and cultural needs. In Pakistan, national and international NGOs have largely been implementing CBDRM programs and activities according to their own understanding of the local context. In the absence of a national CBDRM framework, it becomes difficult to create synergies and get maximum benefits for hazard-prone communities out of the CBDRM efforts. Therefore, a national CBDRM framework that could be further adapted and refined at provincial and district levels must be developed (Government of Pakistan 2013). Before 2005 earthquake, the government of Pakistan has always emphasized on emergency response and relief operations. However after 2005 earthquake, the government has put more attention to formulate pro-active policies and legislations about Disaster Risk Management in Pakistan (Ainuddin and Routray 2012). In addition, floods 2010 were also one of the main contributor in formulation of legislation regarding DRR in Pakistan. Similarly CBDRM has increasingly practiced by developmental sector since 2005 earthquake; though the impact of CBDRM was very limited at that times due to which floods 2010 caused immeasurable losses. After 2010 floods the government has given significance importance to CBDRM (ADPC 2003). CBDRM ensured development and long term recovery of disaster affected communities through multi-sectorial approach such as 'shelter, social, economic infrastructure retrieval, and livelihood re-creation' (Zimmermann and Issa 2009). For instance Disaster Emergency Committee (DEC) has provided shelter and WASH facilities in a large number of villages in Sind province and enhance the living standards of the local population against disasters (Murtaza et al. 2012). Now the local communities have strong mutual and systematic capacities to cope with small and large scale disasters. Similarly, Oxfam's provided support to a large number of people in Punjab province in order to enhance their preparedness levels and resiliency to future disasters. The local communities of Chakhama (Kashmir) were more vulnerable to secondary hazard (as landslides) than earthquake. However, Aga Khan Development Network in partnership with the local communities has conducted localized hazards assessments in order to identify earthquake and landslides prone locations. According to Zimmermann and Issa (2009) sustainability, optimal utilization of inherent resources and indigenous knowledge as well as active participation of host communities are essential elements in CBDRM success. The local people showed their keen interest in carrying out structural and non-structural operations in close collaboration with civil societies as these activities increase their reliance to disasters. Based on indigenous knowledge and past experiences, many villages and community based organizations have developed contingency plans for their vulnerable communities in Sind province. Interventions become succeeded when local communities are engaged in planning and implementation phases (Hughes 2012). NGOs worked on building people self-dependency and connecting local people with the external actors in Sind province (Murtaza et al. 2012). In addition simplicity, transparency, accountability and obligation of basic human rights are also the key factors in programmes achievement. CBDRM operations are cost effective with high benefits. In addition CBDRM approach has developed a healthy professional competition among the implementing actor in district Mansehra since 2005 earthquake. It has made implementation and monitoring process easy, practical, localized and acceptable' to all parties in Mansehra. Furthermore, it also helps to sort out the spoilers and drivers. For successful CBDRM Programme, building trust and rapport with local community is the primary requirement (Shah 2013). Similarly CBDRM process should be 'supportive, cooperative and adaptive to local culture and system and there will be no secret agenda. Government leadership and community ownership is essential components of CBDRM process (Moench and Dixit 2007). To overcome hurdles regarding CBDRM; there should be on-going processes of mobilization, trainings and transmission of skills to the target departments, groups and communities.

After 2005 earthquake, German Aid established District Disaster Management Department Authority in Mansehra, Khyber Pakhtunkhwa. This was the first specialized institution developed for Disaster Management in Pakistan at all levels. Though resources were inadequate but it was a role model for other stakeholders engaged in community based disaster management activities in Manshera. The said department was very active in division of responsibilities among concerned institutions, implementation of DRM operations and creating connection among sustainable development disaster management and humanitarian actions. In addition programme sustainability and stakeholder's capacities were build through sharing of knowledge and experience in district Mansehra (Shah 2013). CBDRM is an all-inclusive approach, in which all social groups are included (Krummacher 2014). However host communities are the primary actors to participate in this process (ADPC 2003). Involvement of local communities in CBDRM process can be possible through long term advocacy, proper community mobilization and raising awareness among all stakeholders. Social strength of the local community is very critical in post disaster phase especially in reconstruction and rehabilitation.

19.10 CBDRM Case Studies from Pakistan

19.10.1 Case Study 01: STL Community Based Disaster Risk Management in Kashmir-Pakistan

Support to Life (STL) is a humanitarian aid agency founded with the principal objective of working with communities to help them meet their basic needs and rights (Fig. 19.4). STL started with a recovery mission in Bam, Iran after the devastating

Fig. 19.4 Training of community volunteer on first aid by STL

earthquake in the historic city in 2003. Concentrating recovery efforts in social protection, capacity building and livelihood support, STL moved on to its second mission in the mountains of Kashmir after the earthquake in October 2005. Working with rural communities in Kashmir, STL provided humanitarian assistance in the areas of shelter, food, water and sanitation, emergency education, psychosocial care, infrastructure recovery, school reconstruction, and community-based disaster risk reduction, linking relief with development. The main objective of the Community-based Disaster Risk Management (CBDRM) project, developed by STL, was to build the intervention capacity of target communities in the wake of an eventual disaster. This was achieved through the formation of Disaster Management Committees, training of community volunteers, awareness-raising, and the distribution of emergency response kits.

While majority of the project activities were implemented on the community level, awareness raising and training components also include linkages of community with the relevant authorities at the local government level. Activities of the project relied on a networks of Community Organizations (COs), Disaster Management Committees (DMCs) and the local media. Awareness-raising activities focused on target communities in the villages, schools and among local authorities. Special attention was paid to the creation and enhancement of methods of communication in case of an emergency. STL through its CBDRM programme developed the capacity of local partner NRSP (National Rural Support Program) in disaster risk management project planning in other areas and the integration of CBDRM into its core program of rural development (STL 2007).

19.10.2 CBDRM Case Study 02: Interventions of the Focus Humanitarian Assistance-Pakistan

FOCUS has been working in the mountainous areas of Pakistan since 1998, helping increase resilience of the community through training, establishment of stockpiles, awareness raising, risk anticipation and non-structural mitigation. FOCUS has

Fig. 19.5 Focus community based women search and rescue team

developed a model of Community Based Disaster Risk Management (CBDRM) which empowers and enhances the capacities of local communities to take ownership of the DRR initiatives and help in sustaining them. FOCUS has trained over 25,000 community volunteers to utilize local resources to respond and manage local disaster situations. Volunteers undergo organizational, basic first aid as well as vigorous mountain search and rescue training. At community level, the volunteers are divided into planning and response groups ready to be deployed at short notice. FOCUS also provides stockpiles at community and regional level to support a community's timely and effective response (Focus Humanitarian Assistance 2014; Fig. 19.5). This model has been implemented in Gilgit-Baltistan, Chitral and Karachi and has been instrumental in preparing the communities for disaster risk reduction. FOCUS has established a total of 151 volunteer Community Emergency Response Teams (CERTs). These team members come from the same disaster prone regions and are involved in responding to crises situation. After giving them the necessary training FOCUS has given the ownership to the communities. The CBDRM model of FOCUS has been effective in building resilience of the communities, through development of inclusive preparedness and response mechanisms, while ensuring community ownership and it can be replicated in other parts of the world. From the extensive experience of Focus Humanitarian Assistance Pakistan it is evident that the communities are vulnerable to natural and manmade disasters. After conducting various assessments over years Focus Humanitarian Assistance came up with the community Based Disaster Risk Management approach where the communities are involved in the risk mitigation process and are equipped with necessary trainings and stockpiles (Taj and Nasab n.d.).

19.11 Conclusion

To top down approach in disaster management has totally failed to involve people, address vulnerability and its causes and empower the local community in disaster risk reduction and community development. The effectiveness of participatory approach in Disaster Management is very important for the vulnerable communities of Pakistan. The application of the community based approaches in disaster risk management will correct the defects of the top-down approach in disaster management and development planning. Focusing mainly on structural and technological solutions which relegate community participation to provision of labor in self-help schemes, the top-down and traditional aid approaches ignore the potential of local resources and capacities, and may have even increased people's vulnerabilities. Keeping in view the radically changing patterns of disaster occurrence and loss, the community based approaches in disaster risk management will enable the vulnerable communities in Pakistan in identification of various types of hazards/disasters that are frequently occurring in these areas and will try to identify possible ways to prevent and mitigate the impacts on the local population.

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Chapter 20
Gender and Disaster Risk Reduction in Pakistan

Samiullah, Atta-Ur-Rahman, and Rajib Shaw

Abstract The significance of promoting disaster risk reduction at international, national and local levels has been recognized in the UN-World Conference on Disaster Reduction (WCDR). Under the Hyogo Framework for Action (HFA) 2005–2015, all nations were agreed in 2005 to prepare National disaster risk reduction plan specifically focusing on five priority areas. In this perspective, the Pakistan National Disaster Management Plan was developed in 2012 as a part of institutionalization process. This plan especially attempts to take care of vulnerable peoples such as women, marginalized people, elderly people and disabled people and also clarify the roles of the national and local governments and residents for each type of disaster. When disaster takes place, it does not discriminate the gender and its impacts vary for male and female. In this connection, the Pakistan national climate change policy 2013 also intensifies the measures to mitigate the damages by disasters and to ensure that the elderly, the disabled, children and women get particular focus in evacuation strategies. The analysis further reveals that there should be disaster management training especially for vulnerable groups of people such as the elderly, disabled, children, and pregnant women and this need to be implemented in close coordination with community. It has been found that in any disaster the worst affected section of the community is the women and children and its impact varies depending on resilience capacity of individuals, households and community and to recover from the impacts of disasters. Higher the vulnerability maximum is the impact of disasters. In addition to women, children and disables, usually hit the hard

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Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*,
Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_20

because of their high vulnerability and low resilience. The chapter also discusses the tools for gender mainstreaming and engendered government policy, women and disaster impacts, gender in recovery phase, causes of women vulnerability, women are at risk and gender and DRR in Pakistan

Keywords Gender • Disparity • Discrimination • DRR

20.1 Introduction

The concept of gender refers to the societal relationship, roles and responsibilities of men and women (Enarson and Scanlon 1999). The expectations held about the characteristics, aptitudes and the likely behaviours of both men and women. The knowledge and understanding varies from person to person and it changes over time and also varies within and between cultures (Joerin et al. 2012). In a society, the unequal share of work load, resource distribution, benefits and unrecognized role in decision making increasing disparities and lead to gender gap.

When disaster takes place, it does not discriminate the gender (World Disaster Report 2004). However, its impacts vary for male and female. It has been observed that in any disaster the worst affected section of the community is the women and children. The impacts of disasters are not uniformly distributed, but it varies depending on resilience capacity of individuals, households and community and to recover from the impacts of disasters (Irshad et al. 2012). Higher the vulnerability maximum would be the impact of disasters. In addition to women, children and disables, it is the poor section of the society, usually hit the hard because of their high vulnerability and low resilience (Rathore et al. 2007).

Disaster resilience means putting more emphasis on what communities can do for themselves and how to strengthen their capacities, rather than concentrating on the community vulnerability or their requirements during an emergency (Joerin et al. 2012; Queensland Government 2014). As per the UN declaration and decade of women, the concept of "Women in Development", women should be involved in all social activities. There are a number of key success factors for building disaster resilient communities: building on the knowledge, capacities and priorities of people; mainstreaming gender issues in disaster risk reduction; public awareness of disasters; community based disaster risk reduction and creation of effective partnership and networking (World Disaster Report 2004). Such policies need to be adopted that meet the needs of all components of the society.

In Pakistan, the population is increasing at a faster rate of 2.3 % per annum, whereas the estimated growth figure is 1.80 % for the year 2006 (Table 20.1). The country population is male dominated with 51.88 % male (SDPI 2008). Population is predominantly rural with 67.5 % of the total population is living in non-urban localities (see Table 20.1). As compared to male, the female life expectancy at birth is low. This clearly indicates high women vulnerability and need for gender sensitive policies and action plans to fill the gap.

Table 20.1 Pakistan demographic indicators, 1998 and 2006

Year	Total population (in million)	Female population	Male population (in million)	Urban	Rural	Annual population growth rate	Total fertility rate	Male (Life expectancy at birth)	Female (Life expectancy at birth)
1998	133.32	64.16	69.17	43.32	90.00	2.28	4.7	62.7	60.9
2006 est.	156.26	75.14	81.09	53.85	102.41	1.80	3.28	63.9	63.8

Source: SDPI (2008)

Table 20.2 Pakistan, gender-wise unemployment rate by rural and urban areas (%), 1996–2006

Year	Pakistan			Urban			Rural		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
1996–1997	6.1	4.2	16.8	7.2	5.1	25.2	5.7	3.8	14.6
1997–1998	5.9	4.2	15.0	8.0	5.8	28.6	5.0	3.5	11.9
1999–2000	7.8	6.1	17.3	9.9	7.5	29.6	6.9	5.4	14.0
2001–2002	8.3	6.7	16.5	9.8	7.9	24.2	7.6	6.1	14.1
2003–2004	7.7	6.6	12.8	9.7	8.4	19.8	6.7	5.7	10.9
2005–2006	6.2	5.4	9.3	8.0	6.9	15.8	5.4	4.6	7.7

Source: SDPI (2008)

The data of sustainable development policy institute (SDPI) reveals that unemployment rate varies from minimum 5.9 % in 1997–1998 to maximum 8.3 % during 2001–2002 (Table 20.2). The analysis further indicates that there is high gap between male and female unemployment percentages (SDPI 2008). However, there are more gaps between male and female at urban and rural level (see Table 20.2). The literacy ratio amongst population of 10 years and above was 55 %, out of which male literate were 67 % and female 42 % (SDPI 2008). This indicates that men literacy ratio is higher than women population. It is therefore, the number women employment in formal sector is less than the male population.

In Pakistan, along with other international and national organizations, the Government line agencies are closely working on promotion of gender equalities and gender mainstreaming in all socio-economic and development sectors (SDPI 2008). Japan International Cooperation Agency (JICA) is also one of the partner organizations aiming on gender mainstreaming and minimizing the inequalities. Recently, JICA and SDPI conducted a study on gender development in Pakistan (1999–2007) with a focus on critically examining the policy set-up, socio-economic environment, social norms and values (SDPI 2008). This research has specifically reviewed the gender inequalities, chronic issues, policy gaps and supported the efforts of gender mainstreaming in Pakistan.

In Pakistan, there is wide gap in existing gender related policies as stated in the National Policy for Development and Empowerment of Women (Rathore et al. 2007). Similarly, in National Plan for Action, gender gaps have been clearly identified and recommend ways of its implementation. The struggle behind the women empowerment is to support females as they remained marginalised, traditionally. In gender related policies, attempts have been made to consider both men and women on equity basis. It is pertinent that in Pakistan, the status of women is not considered equal to that of men and therefore gender gap has been found more among women than man (SDPI 2008). The key areas which need reform includes education sector, health sector, agriculture, forestry, fishing and economic empowerments.

All developmental plans and policies have different impacts on men and women lives because of their traditional roles and responsibilities. Therefore, a development plans and policies need to be gender sensitive and to effectively address and attempts to minimize gender inequalities otherwise policies and strategies would actually reinforce further discrimination. This chapter reviews the gender gap with special reference to disaster in Pakistan. Chapter starts with common concept of gender and gender mainstreaming in policy, planning and development. The economic impact of disasters on women and causes of women vulnerability is discussed in the next section.

20.2 Tools for Gender Mainstreaming

20.2.1 Types of Action

20.2.1.1 Gender Analysis

In gender analysis, the calculation of total population and number of affected or vulnerable population with a details of male, female, children, elderly persons and disables. It is also necessary to explore the number of women exposed to various hazards and how to reduce the exposure of vulnerable group to each hazard. It further requires building gender specific disaster resilience initiatives and to enhance the women capacity against the unforeseen events. Women participation in decision making and implementation of disaster preparedness plans need to be ensured, so that the policies and disaster management plans should have clear reflections of gender roles and responsibilities and due preferences be given to women as a vulnerable section of the society. These preparedness strategies will obviously help in minimizing the impacts of disasters.

In a disaster phase, priority needs to be given to women's primary health care, maternity health services, first aid, search and recuing etc. Special care and supervision need to be given to female for minimizing gender based violence, exploitations and social conflicts. In disaster rehabilitation and recovery phase, due preferences need to be given to women and particularly to those where women's are household heads. In house/shelter and other infrastructure reconstruction efforts, women dominating household be given special consideration and attention. In disaster relief distribution efforts, ladies must be prioritised over men because of their physical weaknesses.

20.2.1.2 Gender-Specific Action

In gender specific actions, due attention need to be given to gender explicit policies, plans and practices. It utmost requires to ensure equal opportunities for all vulnerable section of the society. Furthermore, attempts need to be made in minimizing the inequalities and address the same in policies, plans and practices.

20.2.1.3 Start a Process of Institutional Change

The existing and proposed institutions should have gender related sections. They are working on extending mitigation, preventive strategies, search and rescuing and early recovery. But there need to be gender specific policies and preference be given to women as one of the most vulnerable and marginalised group of a society. Giving proper attention to address gender in institutional strengthening is an effective strategy in mainstreaming gender sensitive policies in disaster management plans and policies.

20.2.1.4 Give Equal Voice & Representation to Girls and Women Alongside with Boys and Men

While devising disaster risk management strategies, plans and policies equal representation and weightage need to be given to both women and men. Gender balanced voice will help in building resilience capacity and would help in reducing vulnerabilities at all level. However, in certain stages special women group need more attention. Amongst disaster victims, pregnant and feeding women require more attention and priorities both in response and rehabilitation assistance.

20.2.1.5 Gender Budgets and Audits

Gender budget and auditing is a process of analysing, how government raise financial resources, allocate funds and spend public money in securing women empowerment and securing gender equality in decision making and allocation of fund. Globally, the nations and international forums have given top priority to gender equity, community development, poverty eradication and equitable socio-economic development (UNDP 2002). To keep pace with rest of the nations, Pakistan has established ministry of women in Development in 1990s and expressed its commitment with international forums including Beijing Platform for Action and Convention on the Elimination of all forms of Discriminations against Women (CEDAW).

Now-a-days, gender budgeting has been recognized as a tool for empowering women. It should be noted that the word ‘gender sensitive budget’ is widely used and is being adopted, and need explanations that gender budget is not a separate budget for women or men, but it is an attempt to breakdown the government funds according to its impacts on women and men and being given to community on the name of gender (Goyal n.d). In Pakistan, most of the disaster management policies and plans are implemented via annual development budgets, therefore engendering the budget are of paramount importance. The present budget process, allocation of funds for gender related plans and policies need special measures for engendering the budget. At national level, the national disaster management authority and provincial disaster management authority at regional level and district disaster management authorities at district level are responsible for devising disaster management plans with engendered perspectives and taking proper budgetary approval from the respective finance wings.

20.3 Gender Mainstreaming and Government Policy

Gender mainstreaming means to ensure and integrate, the gender role and responsibility in every stage of disaster management cycle, right from decision making stage to preparedness, response, assessment, operation and monitoring to promote equality between women and men. It specifically appraises, how policies and development plans affect the life and position of women and men and getting responsibilities to address imbalances. It is also of paramount significance to recognise that disaster management policies and plans influence male and female differently. The need for combine process and to achieve sustainable human development and transmitting it into policy, programmes and budgets requires ensured involvement of both women and men. It pave ways for addressing women empowerment throughout the planning process and channelizing women as a target group and mainstreaming gender as a development goal.

Worldwide there is strong indication that a gender-balanced approach in disaster risk reduction benefits both men and women. In addition, it has been established that equal and active participation of women and men in DRR makes it possible to accomplish the Millennium Development Goals (MDGs), sustainable socio-economic development and the overarching goal of the Hyogo Framework for Action (HFA) of building the resilience of nations and communities to disasters.

The World Bank has increasingly integrated gender considerations into Country Assistance Strategies and lending operations, recognizing that gender inequality is a key barrier to poverty reduction. In 2007, the World Bank has launched the Gender Action Plan to improve women's economic opportunity and promote investments on the pretext of women's access to jobs, land rights, financial services, agricultural inputs and infrastructure. The 2012 World Development Report provides a thorough analysis that focuses on the roles of economic growth, households, markets and institutions in determining gender differences in various sectors.

In 1995, the Fourth World Conference on Women, the platform for Action has floated the concept of gender mainstreaming and commitment to integrate gender perspective in all forms of development planning and political process of government. The platform also insisted the governments to incorporate gender perspective in planning activities at national, regional and local level. This was an attempt to promote role of women in all stages of development planning process and address women's values in planning activities and to achieve gender equality. The Employment and European Social Fund (2005) has referred gender mainstreaming to a partnership of men and women in a society and to ensure full involvement in socio-economic development and get equal benefit from the available resources. Gender mainstreaming includes role of in decision making, policy formulation, procedure and practices, access to resources, methodology, and appraisal of alternative courses of action, implementation, monitoring and evaluation. Nevertheless, gender mainstreaming is a slow process and needs inputs from several dimensions over a longer period of time.

In Pakistan, at federal level, the Ministry of Women Development was established with intention to function in public policy formulation and meet special needs of women (SDPI 2008) including women registration and assistance to women organizations, initiation of women related projects, conduction of research on women related issues, country representations at international forums, exploring opportunities in education and employments (GoP 2002). Currently, the ministry has three wings namely, administration and coordination wing, gender equality wing, and development wing.

In the recent past, the government of Pakistan has passed several legislations related to women issues and marginalised and vulnerable section of the society. For such legislations, grounds were provided by National Plan of Action for Women 1998 and the National Policy for Development and Empowerment of Women 2002. The protection against harassment of women at work place Act 2010, Prevention and protection Act 2009, The Prevention of Anti-Women Practices Act 2011, National Commission on the status of women Bill 2012 are some of the glimpses of policy legislations. The Benazir Income Support Programme Act 2010 is a socio-economic support for the poor, whereas the National Commission for Human Rights Act 2011 is an independent commission for protection of citizen rights.

The Government of Pakistan is keen to develop such programmes and policies, which could work for the promotion of women status in the country and ensure women betterment. In such circumstances, a National Policy for Development and Empowerment was developed by Government of Pakistan in 2002. This policy specifically focuses on certain social indicators including health, education, law, gender violence, access to justice, women in community and family, access to micro finance services, poverty alleviation and recognizing role of women in rural and economic sectors (GoP 2002). In planning and practice, stress have already been made on policy initiatives and enhancing political empowerment of women.

20.4 Women in Economic Sector

In Pakistan, small share of women actively participate in the formal economic sector. According to economic survey 2010–2011, only 21.80 % women participate as an active labour force in the formal economic sector and rest of the female labour force work in informal sectors and house-based working folk. It has been found in the literature that female face numerous challenges in relation to social protection. The Gender Inequality Index has recently reported that male participation as active labour force in the market is dominating with over 77 % as stated in the

Human Development Report 2010. Some of the key hindrances factors include illiteracy and social attitude, which restrict female mobility.

In terms of poverty reduction, the Government of Pakistan has initiated several measures to minimize the number of poor heads in the country (UN 2013), which is considered as the root cause of peace and conflicts in the country. Similarly, the gender inequalities and regional disparities are some of hindering factors in achievements of Millennium Development Goals and target. The economic survey of Pakistan (2010–2011) has recently issued a report that a reduction in absolute poverty heads from 34 % in 2000 to 22.3 % in 2006 is recorded. The One UN Programme II defended that this decline in poverty is due to increase in distributional and structural equalities. However, the government heavy dependence on indirect taxation has implications on market prices, which directly influence poor section of the society.

20.5 Women and Disaster Impacts

It has been confirmed from the literature that women has high vulnerabilities from those of men mainly because of its role in the society, pattern of gender inequalities and sometime times discriminations (Fordhan 2004). The available data shows that in extreme natural events the number of women mortalities surpasses over males. In Indian Tsunami 2004, the death rates amongst women across the region were three-times more than that of men (UNEP 2005). In India, in one village only women died due to Indian Tsunami (OXFAM 2005). In Bangladesh, during 1991 flood event, five times more women died than men (Irshad et al. 2012). After one month of 2005 Kashmir earthquake, a situation analysis reveals that injuries, death casualties and illness were found higher amongst women and girls (Mahmood 2006).

After 2005 Kashmir earthquake, gender-wise analysis of injured victims were carried out, which indicates higher rate of spinal injuries amongst women (Irshad et al. 2012). Rathore et al. (2007) found that around 70 % of the patients diagnosed were female. Disasters are mainly triggered by natural phenomenon, their human impacts are impartial. However, in a country like Pakistan, women are mostly indoor workers and housewives that's why they have high tendency and prevalence of disaster sufferings. Women are at high risk largely because of inequalities in access to resources, low resilience and little opportunities to withstand disaster impacts (Irshad et al. 2012).

It was pointed out that high mortality amongst women is mainly because they have low capacity to resist the force of disasters and in case of floods, women are often unable to swim or climb tree. Similarly, in case of disastrous events, their self-rescuing and evacuation efforts are hampered as they try to save their children, housed disables and elderly. Bangladesh is experiencing the increasing number of high profile disasters and it is evident that there are some gendered centred factors, which increase women's vulnerability in some cases (Cannon 2010).

20.6 Case Study: Women Role in Flood Disaster Phase

The flood of 1997 in Red river Canada provided feedback for researchers to study the gender pattern in disaster cycle. In disaster response phase, the women attracted the photographer's eyes, when they were rescued by men, expressed tearful emotions, worked in stereotype roles including cooking for sandbaggers and watching the scenes of rising water level and particularly those women filling sand bags also drew attention of journalists (Enarson and Scanlon 1999). Furthermore, it was found from the same flooding event that it closer the couples during flood emergency, shared their worries, pooled their labour, found things to enjoy and value during their week dislocation and reconstruction efforts (Enarson and Scanlon 1999). During flood disaster, men moved heavy furniture, domestic gadgets, constructed earth embankments, shifted their movable properties to safer location, protected outdoor equipment's, livestock, packed household possessions, in addition to helping neighbours and relatives in packing and shifting valuable properties (Enarson and Scanlon 1999). As a consequence it was found that women were more worried and panic than men because of their sensitive nature.

20.7 Gender in Disaster Recovery Phase

In disaster recovery phase, usually the role and contribution of women is ignored and overlooked. However, it is only women who can sole implement particular type of activity in the disaster hit community. In a country like Pakistan, the Islamic culture and values are preferred and strictly followed by most of the citizens. It is women force, who can actively work and join hands with the local women in restoring the normal life amongst the victims.

One of the key issues in recovery phase is to support and restore the Primary Health Care Services within the community with specific reference to the management of common health problem. Lady Health Workers (LHW) and Lady Health Visitors (LHV) are government official bearers and they can play due role in extending health care cover to the entire section of disaster hit community. LHV and LHW have technical competency in first aid medical care and specifically serving in the community as midwife. Such health workers offer and promote preventive, curative and rehabilitative care for the disaster affected communities. Extending lifesaving services at the door step is the primary goal of national health policy. They are distributing free of cost medicines and primary health services including child health and preventive maternal health at community level. They can serve in dispensing, vaccination and ensure effective health education.

After 2005 Kashmir earthquake and flood-2010, flood-2011, 2012, 2013 and recent flood of August 2014, the government has mobilized the medical team to extend emergency response and fulfil the increasing health needs of affected communities. Numerous sad stories of child health and maternal health cases have been reported. Additionally, outbreak of communicable diseases and malnutrition were other factors responsible for increasing health risk amongst the vulnerable section of the society. In case of flood disasters, the prevalence of waterborne diseases such as diarrheal, cholera, malaria, typhoid and hepatitis were common health related features.

20.8 Causes of Women Vulnerability

Before discussing the extent of women vulnerability, it is pertinent to highlight the strength and resilience capacity of women. The women have several strengths, which needs to be properly mainstreamed, while devising strategies for disaster risk reduction. Women have strong mental preparation and strength. In disaster phase, women are always eager to safe guard household belongings from the impacts of extreme events. They can play a key role as an efficient volunteer. Similarly, nursing, cooking, caring for children, restoring food and seeds and organizing other women can easily be done by a woman. It is also a prime responsibility and local conception to store food, collect fuel/firewood and save or find livestock and pet animals lost in disaster.

There are numerous causes of high women vulnerability and exposure to hazards (Rathore et al. 2007). Physical insecurity is one of the major causatory factors responsible for high female vulnerability. Women are physically more fragile and sensitive than men and therefore need more attention in policy, planning and practice. In case of Pakistan, the women has more indoor responsibilities including maternity services, child care, elderly person responsibility, safe shifting of domestic gadgets, food and cooking etc. and males have outdoor responsibility and considered as major bread earner for the family (Irshad et al. 2012). Contrary to these indoor responsibilities, women have less timely information about the hazardous events and similarly means of information dissemination is not properly suit the social set-up (Mahmood 2006). Social obligation and movement from risky location to safer place is also some time cause conflicts between couples. Therefore, in country like Pakistan, preference is always given to husband permission (Rathore et al. 2007).

There are some cultural factors that also lead to gender inequalities (UN 2013). For example women can find adequate shelter without shame and harassment. They are not condemned to poverty and increased vulnerability when divorced or widowed (Cannon 2010). These are the challenging issues already on the agenda of sustainable development in reducing women vulnerability to hazards. There are certain gendered factors that need to be kept in mind while devising strategy in reducing women vulnerabilities (Schmuck 2002). The disastrous impact of an equivalent hazard on different communities with varying level of social vulnerabilities will have different impacts. Such kind of vulnerability has five levels depending upon the socio-political factors affecting group of people differently such as initial condition of a person, livelihood resilience, the strength of self-protection, social capital and access to social protection (Cannon 2010). It clarify the concept that there is need to understand the component of vulnerability of different group of people and its relationship with disaster risk (Cannon 2000; Schmuck 2002).

Education and awareness amongst women is one of the major factors responsible for high female vulnerability and low level of resilience. In Pakistan, literacy level is high in males than females. During past couple of decades, the gender disparities have been marginally reduced (SDPI 2008). Similarly, out of total drop-out at primary level, the outstanding number is that of girls (UN 2013). In Pakistan, Education sector suffer from numerous problems including meagre allocation of funds for education sector, cultural constraints and acute regional and gender inequalities. Poor implementation of education policy and heavy reliance on foreign aid are other factors, increasing gender inequalities in education. Higher the awareness maximum would be the power to perform in disaster management cycle, right from preparedness, response to recovery stage. The educated women may be trained in First Aid, child care and maternity services. It is pertinent to accelerate disaster and climate change education among women. This would have high impacts on building women's individual, household and community level capacity.

20.9 Why Women Are at Risk?

The literature reveals that women are more vulnerable because of low resilience capacity and high needs. Similarly, female have minimum access to resources. In a society like Pakistan, majority of women are housewives and primarily responsible for household activities including cooking, washing, cleaning, childcare and care of elderly or disable persons. In rural areas, active participation in agricultural economic activities is an additional contribution. After fall of a disaster, female have very little liberty to work as a labour and share the losses with male member of their family. Similarly, disasters increase women vulnerability and multiply women's responsibilities as head of the household and domestic violence.

The scientific literature together with the filed observation that both women and men equally benefited from gender balanced approaches to disaster risk reduction and management. Like other countries, in Pakistan women are less educated, lack of disaster and climate change knowledge, limited access to resources, meagre awareness of their rights, limited mobility and exposure to external environment, little interaction with the society and few life skills. These are the reasons and responsible factors that make women extremely vulnerable in any event of disaster.

The UN Human Development Report 2008, taking Gender Empowerment Measures has ranked Pakistan as 82, out of 93 registered nations. This methodology quantitatively calculates the women empowerment at country level. It includes the basic parameters of inequality in control over economic resources, role in economic decision making and participation in political decision making (SDPI 2008). The process of women empowerment is to act as an important role player in resource distribution and to minimize the impacts of disasters on individuals, family and community. The constitution of Islamic Republic of Pakistan specifically highlighted the equal rights to both women and men. Nevertheless, in practice women are rarely equal to their male counterparts. In Pakistan, during the past devastating disastrous events, ignoring women in disaster preparedness planning, response and recovery need key amendments in disaster management planning process. This clearly indicates the absence of gender sensitive planning and practices which further intensify the gender gap.

Women have low capacity to withstand disaster situation and perform a function in outdoor search and rescuing activities and emergency response. However, in emergency situation unlike men, they are fully devoted their household belongings and safe shifting of movable properties. Some time, pregnant women need more attention and unable to move freely to safer location and can travel long distances. It has been observed that due to close ties with the household belongings, women prefer to stay at home during disaster situation and as a result become victim of devastating events. Most often, women are dependent on husband and wait for his decision, which in turn increase the likely impacts of disasters. In Pakistan, women have very low disaster and climate change education and awareness, which lead to difficulty to effectively function in pre, during and post disaster situation. In case of earthquake 2005, the frequent cases of child kidnapping, women harassments, sexual abuses are some of the key negligence on the part of both government machinery and community.

20.10 Gender and DRR in Pakistan

A gender inclusion in disaster risk reduction approach is desirable and to bring several stakeholders collectively and address gender mainstreaming through political, technical, social, developmental and humanitarian processes. It is important to underline that the focus of the interventions shifts from short-term relief and emergency response to building resilience of communities and promote long-term sustainable responses. Similarly, in participatory approach, the equivalent and gender-sensitive involvement of women and men in risk analysis, leading to better policy-making and programme design. It is due to highlight the significance of enhancing the participation of men in addressing gender-related issues in disaster management at all levels – institutional, community and individual.

The national disaster management plan 2012–2022 has been prepared and fund is allocated. As per approval of the plan, monitoring is the responsibilities of national disaster management authority in consultation with relevant stakeholders. The national disaster management plan was developed as part of institutionalization process (GoP 2012). One of the aims is related to gender specific and insisting to take special care of vulnerable and marginalized people such as women, children, disable and elderly people. The plan further stresses on, to ensure that women, elderly persons, disables and children got due attention in evacuation measures.

In Pakistan, 19 resident UN agencies has provided support for a joint development initiatives through five key programmes including Disaster Risk Management as one of them with a cross-cutting issues of gender equality, refugees, human rights and civil society. The one UN programme has highlighted the need for resilience to disasters and climate change, humanitarian assistance, temporary relocated persons, gender equality and disease transmission. Similarly, knowledge sharing, lessons learned and good practices in DRR and capacity building at federal, provincial, district and community level are other recommended strategies.

In a strategic priority area 3 of One UN Programme is focused on increasing national resilience to disasters, crises, and external shocks. The outcome of this priority area includes establishment of national, provincial and district capacities to prevent, assess, reduce and manage disaster risk. In addition to other targets, the regional disaster management authorities also perform functions with effective coordination mechanism and have integrated gender concerns, district level disaster management plans, cities with enhanced disaster resilience and multi-hazard mapping.

It is the dual role of both male and female to recover from the impact of disasters. Male are mostly responsible for reconstruction efforts, whereas women perform the job in rehabilitating the household social and economic sector of the household. However, women capability in mitigating hazards have not been addressed and kept in account. Women are mainly seen as the helpless victims and their potential skill and disaster education in disaster cycle has not been sufficiently recognized. It is therefore, now-a-days attempts has been made to integrate and keep gender perspective in disaster risk reduction planning and actively involve women in decision making and implementation planning process. This will ultimately help in minimizing women's susceptibilities to disasters. Furthermore, gender equity and empowerment is another effective tool for increasing women's role in mentoring, leadership, management and policy formulation. According to UNISDR (2002) women's are not mere a disaster affectees, but she can act as change in disaster risk reduction planning.

In National Social Protection Policy, active women involvement in disaster management planning and implementation has been suggested with intention to boost-up the vulnerable groups. Furthermore, establishment of gender responsive disaster management strategies is particularly highlighted. This requires and to make sure that the financial support is aimed on women and other vulnerable groups and guarantee equitable access to opportunities and resources.

20.11 How to Manage Disaster Risk?

There is utmost need to reduce risk to women. In disaster related activities, active involvement of women is of paramount importance in training, planning activities and decision making. In each community, the women should have full knowledge and understanding of evacuation centres, cyclone, flood and tsunami shelters, health care centre, and relief centres etc. Women should also keep liaison with different women organization in relief and rehabilitation activities. It is also important that women should have information about water supply source, food items, treatment and extension of law and order services. Organizing women volunteer system and establishment of mechanism for ensuring social security are other key factors responsible for reducing women vulnerabilities. It is also pertinent to include women in various disaster risk reduction committees and sub-committees. Effective steps need to be taken in making women aware and alert about any danger.

The community need to be ensured about the security set-up to protect property, dwellings and belongings and security of women, children and disables. Reactivate female groups in disaster preparedness and rehabilitation stage and make women's friendly programmes. Similarly, shelters should be made more women approachable and to keep in mind the socio-religious norms and values into considerations. The shelters should have sufficient access to clean drinking water, light, and lavatories as well as cooking and washing. Preference and special care need to be given to those families who faced sufferings and injuries to their family members. Console the suffered and physical victims to cope with the disaster situation, loss of family members and establish a strong net with them. If required take help from local community in restoration and relief process.

In NDMA, provincial/state/regional disaster management authorities have established Gender and Child Cells (GCC) in their respective organizations. The aim of this GCC is to explore and respond issues concerning inequalities in gender and other vulnerable groups. The purpose of this programme is to develop a strategy for better results in four areas of gender equality, child protection, and social security to elderly and with special disabilities.

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