A geographical study of farmers' adaptations to climate change in Khyber Pakhtunkhwa, Pakistan

パキスタン、カイバル・パクトゥンクワにおける農民の気候変動への適応

に関する地理学的研究

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DECLARATION

The work presented in this dissertation is solely written and entirely conducted by the author. Material from all previously published work of others, which is referred to in this thesis, is credited to the author and cited accordingly in the text. No part of this work has been submitted for any other degree in this or any other university.

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(Wahid Ullah)

ABSTRACT

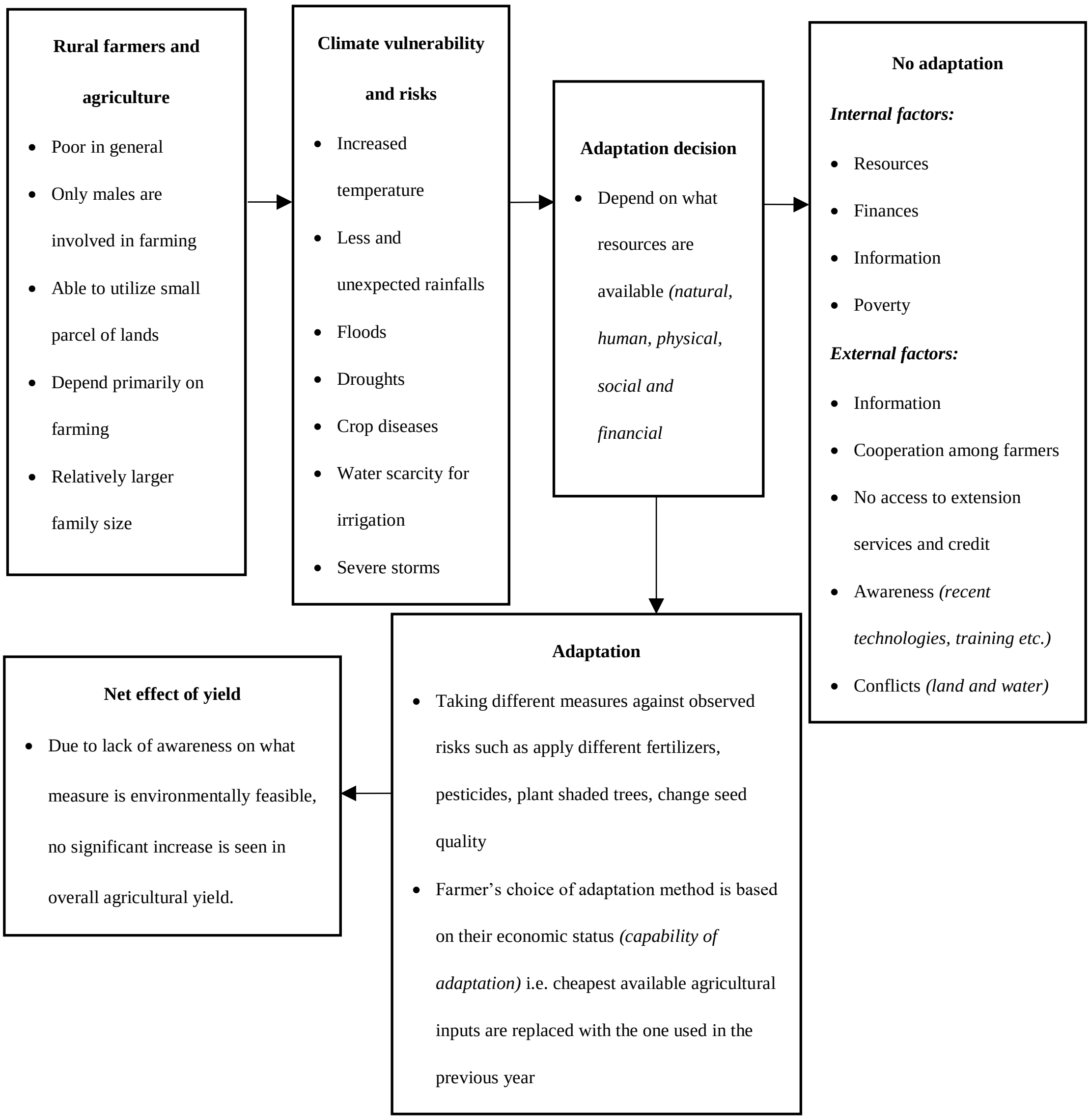
Climate Change is probably one of the most threatening issues of the current century to all nations across the world. This is because of its severe negative impacts observed world-wide especially in the developing world. Pakistan is not an exception to this and in-fact is ranked among the top ten nations hard-hit by the vagaries of climate change and has experienced these effects dramatically over recent years through devastating floods, severe droughts, and catastrophic heat waves. This situation is exacerbated by internal security issues in the country, population bulge, growing energy gap, issues with education and healthcare systems, and increasing unemployment. Therefore, for Pakistan to address these challenges, a comprehensive approach is needed to better respond to it. Moreover, climate change has already enormously affected many sectors of life including agriculture in Pakistan. Hence, it is the need of time to explore the challenges and opportunities to farmers (who in most cases are among the poorest of the poor) to adapt to climatic changes. In this perspective, this study is focused on socio-economic aspects of the farm households' and tried to integrate the science of climate change and seeks impact response model which has been rarely discussed in Pakistan. More specifically, the study explores rural farmers' understanding and perception of risks, vulnerabilities associated with climate change as well as the coping and adaptation strategies they are adopting to minimize impacts of climate change in rural Pakistan at the agricultural farms.

Information was collected utilizing structured and semi-structured questionnaires designed for household surveys, key informant interviews a group discussion in the Charsadda district located in the low lands of Khyber Pakhtunkhwa

province of Pakistan. Among others, primary information gathered included; demographic information, assets for livelihood, indigenous farming techniques, agricultural production, agricultural seasonal calendar, damages caused by climate-induced disasters, perceptions about risks associated with climate change, vulnerability towards climate change and responsive measures taken to minimize impacts of climate change. In addition, both primary and secondary data were gathered from national and provincial level intuitions like Center for Disaster Preparedness and Management (CDPM), University of Peshawar, Pakistan Metrological Department (PMD), National and Provincial Disaster Management Authorities (NDMA, PDMA). Key informant interviews were arranged with officials of the above-mentioned organizations to better understand how climate change is dealt with at government level, it's financing mechanism, disaster risk reduction facilities, and its disbursing methods, collaborations among institutions at all governance levels i.e. national to local level. Moreover, how early warning systems have been set up to promote security at the village level especially of those involved in farming. Other related information needed for this study were downloaded from google scholar using keywords, agriculture, climate change, adaptation, vulnerability, risk perceptions, Khyber Pakhtunkhwa, Pakistan etc.

Results revealed that farming is a male dominant activity in the study area and almost all households primarily depend on farming both for subsistence and income generation. Additional responses included having other sources of income generation such as trading, transportation businesses, and crafts. Local farmers perceive that today's weather and climate is different than in the past. Most of the farmers in the study area acknowledged climate change as increased temperature, devastating floods, unexpected or more precisely delayed onset of rains or change in the rainfall cycle and pattern, frequent drought, increased pest and diseases incidents, increase in summer while shortening of the winter season and severe storms. The effects of climate change include longer periods of heat stress on crops, longer droughts, reduced crop yield, increased crop disease, and reduced soil fertility. Local farmers also feel that their production of wheat and sugarcane have also reduced due to the above causes of climate change. Efforts made to adjust farming to the changing climatic conditions depended on how a certain individual is resourceful, willing and more importantly is informed about such techniques that can reduce threats from climate change and enhance their resilience. Respondents made several efforts to adapt to climate change of which the most commonly and frequently measures taken for adjusting farming to climate change includes mixed cropping, crop rotation, use of fertilizers, pesticides, changing seed qualities, planting more trees around their farming lands to reduce soil erosion and protect their houses in the floods which occur almost every year in the monsoon rainfall season starting from July to September. However, more advanced adaptation techniques such using improved crop varieties that can resist heat, utilizing advance farming technologies, livelihood diversification or migration are rarely applied. Efforts made by government institutions, Non-Governmental Organizations, social, informal, and private institutions related to agriculture to help farmers in adjusting their farming to the vagaries and changes in climate were absent in the study area. However, the previous government did work on the excavation of canal passing through Shabara.

Hence, it is strongly suggested that more deep insight and awareness programs should be carried out to educate farmers regarding the effects of climate change, and help farmers understand how environmentally suitable adaptation measures can improve agricultural yield and in result how it can improve their livelihoods. Moreover, enhancing adaptive capacity and productivity at the farm level can also improve the lives and livelihoods of poor rural farmers. Desired results from such efforts cannot be achieved without the greater help from other related stakeholders such as climate change and agriculture policymakers, researchers to identify best adaptation options and increase awareness among farmers, agriculture extension workers to help farmers in accessing good agricultural inputs, provide information on when and how to adjust to climate change. Finally, there is a dire need for the formal farmers' unions which in most cases are the first to go place at the village level to share knowledge and experiences with each other.



Graphical abstract of the dissertation

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Finally, I would be more than pleased if this research could act as a meaningful medium for the intellectual communities in improving ordinary rural farmers in Pakistan.

LIST OF ABBREVIATIONS

AAL	Average annual loss
AJ&K	Azad Jammu and Kashmir
ARE	Alternative Renewable Energy
BoG	Board of Governors
CC	Climate Change
CCD	Climate Change Division
CDM	Clean Development Mechanism
CDPM	Center for Disaster Preparedness and Management
DDMAs	District Disaster Management Authorities (DDMAs)
DMA	Disaster Management Authority
DNA	Designated National Authority
DRR	Disaster Risk Reduction
EIA	Environmental Impact Assessment
EM-DAT	Emergency Disaster Database
FATA	Federally Administered Tribal Areas
FGD	Focused Group Discussion
GCISC	Global Climate Impact Study Center
GDP	Gross Domestic Product
GFDRR	Global Facility for Disaster Risk Reduction
GHG	Greenhouse Gas Emissions
GLOFs	Glacial Lake Outburst Floods
GoP	Government of Pakistan
HHS	Household Survey

HIES	Household Income and Expenditures Survey
HVI	Human Vulnerability Index
IIASA	International Institute for Applied Systems Analysis, Austria
IPCC	Inter-governmental Panel for Climate Change
KII	Key Informant Interview
LVI	Livelihood Vulnerability Index
MDI	Multiple Deprivation Index
MHa	Million Hectare
MoCC	Ministry of Climate Change
MoE	Ministry of Environment
MoF	Ministry of Finance
NCCP	National Climate Change Policy
NDMA	National Disaster Management Authority
NIPS	National Institute of Population Studies
NWP	National Water Policy
PAR	Pressure and Release
PARC	Pakistan Agricultural Research Council
PATA	Provincially Administered Tribal Areas
PBS	Pakistan Bureau of Statistics
PCRWR	Pakistan Council for Research and Water Resources
PDMA	Provincial Disaster Management Authority
PEPA	Pakistan Environmental Protection Act
PEPC	Pakistan Environmental Protection Council
PEPO	Pakistan Environmental Protection Ordinance

PMD	Pakistan Metrological Department
SVA	Social Vulnerability Index for Africa
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
WAPDA	Water and Power Development Authority
WDR	World Disasters Report
WWF Pakistan	World Wildlife Fund Pakistan

DEDICATION

To my loving parents

who are always the source of inspiration for me.

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CHAPTER 1: INTRODUCTION

1.1 Summary

This chapter primarily focuses on the background and importance of the issue at hand. First, I provide a review of relevant literature that supports the research premise. Next, the basic concepts of vulnerability and adaptation are considered, with the aim of clarifying these complex terms as they are frequently used in this thesis, since this study has its basis on these two concepts. Particularly, I define how vulnerability is best understood in the context of climate change, and how its interpretation varies across different fields, including geography, sociology, economics, and biophysics. Next, the application of the vulnerability concept to climate change is considered in both global and Pakistani contexts. I then shift my focus to emphasize the importance of a bottom-up approach in addressing climate change-related vulnerability to ensure the safety of those who are most vulnerable. A definition of adaptation to climate change is then offered, in addition to an exploration of its use in addressing climate change-related vulnerability. The purpose and necessity of adaptation research is highlighted before reaching the conclusions, which synthesize all major themes discussed in this chapter. In the sections that follow, I briefly explain the justification of this study, and describe problem statement in detail, research questions, main objectives, research framework, and limitations of the present study. Finally, I provide a brief conclusion of the main topics discussed in this chapter in the last section.

1.2 Background of the study

Climate change-induced natural disasters have occurred at an alarming rate during the last decade, and particularly in the last two years globally (i.e., 2017 and 2018). These events have increased in frequency and are major contributing factors in the intensified vulnerability of poor communities (WDR, 2016). Disastrous events were witnessed on a weekly, or at least bi-weekly, basis from June to October 2018, with earthquakes demolishing entire cities, wildfires decimating thousands of acres of forest, and tsunamis and cyclones causing mass flooding. In 2017 and 2018 (the years of this dissertation's completion), numerous devastating events have occurred. Among the natural disasters that ravaged the globe in 2018 were the typhoons Trami, Jebi, Mangkhut, and Kong-rey, hurricane Florence, floods in Japan and India, landslides and wildfires in California, and earthquakes in Japan and Indonesia. The consequences of these disasters are merciless and immeasurable, as high death tolls and property damage wreak devastation on civilians who must confront a long road to personal and communal recovery. The profound impacts of these events not only affect families and cities, but also lead inevitably to political, economic, and social turmoil, exacerbating the tragedy and creating a vulnerable climate. Global data show that metrological hazards affect unprecedented numbers of people; for example, 608 million people were impacted by climate-related events in 2002, compared to an average of 200 million in the previous decade, as reported by the International Federation of Red Cross and Red Crescent Societies (IFRC, 2003). Findings of reports from Centre for Research on the Epidemiology of Disasters (CRED) Emergency Events Database (EM-DAT) concludes that extreme weather events accounted for the majority of the 61.7 million people affected by disasters in 2018 only, of which many events are either not reported or poorly reported, especially from developing countries.

Compelling evidence, given in the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), attests that climate change is a reality and most countries will suffer its effects (IPCC, 2007; McCarthy, 2001). The report emphasized the importance of identifying and implementing adaptive measures, in response to the impact of changing climatic conditions (Smit and Pilifosova, 2003; Smith *et al.*, 2003; Watson and Albritton, 2001). The extensive scientific literature on climate change indicates a broad consensus that further emission of harmful greenhouse gases (GHGs) will cause global temperatures to increase and that precipitation patterns will shift by 2100 (Houghton *et al.*, 2001). The IPCC report further stresses that many underdeveloped and developing countries are particularly vulnerable, owing to their relationally low capacities for adaptation and weaker resilience levels (Adger *et al.*, 2004; Smith et al., 2003). In addition to global warming, substantial increases in sea level and average precipitation are expected, as well as changes in climate variability, including storms, floods, cyclones, and drought (Few, 2003; McCarthy, 2001). Scientists suggest that adaptation is a necessary component in responses aimed at mitigating the severe impacts of climate change (Laukkonen *et al.*, 2009). Cardona (2003) observed that rapidly growing populations, unmanaged and unregulated development, and rapid expansion of infrastructure are the most notable factors that result in the exposure of higher proportions of the vulnerable population to natural disasters and their effects.

The causes of continuous increases in the devastating impacts of natural disasters include the increased vulnerability of people living in dangerous areas, for example, close to river banks, or near areas prone to landslides. Just under 600 disastrous events were reported in 2015, caused by floods, landslides, heatwaves, cyclones, and heavy storms; these events resulted in the deaths of more than 33,000 people worldwide, while around 109 million people were affected (Guillard-Gonçalves *et al.*, 2015). The study further elaborated that, costs of up to US $70 billion in economic damage were reported. The effects of natural disasters are particularly felt in developing countries, such as Pakistan and Bangladesh, where thousands of people die each year as a result of floods, heatwaves, or droughts. Recent devastating and widespread flooding in Japan between June and July 2018, caused by successive heavy rain in the southwestern prefectures, resulted in the deaths of 222 people in 13 prefectures (the Asahi Shimbun, 12 July 2018), and the Japanese authorities were forced to evacuate over 8 million people across 23 prefectures. A similar extreme event that occurred in July 2018, in Kerala, India, bears testimony to the climatic disruption that has already begun. Typhoons Jebi and Trami, which occurred in Japan in early and late September 2018, respectively, resulted in large-scale fatalities and damage to infrastructure. That same month, a major earthquake struck Indonesia's Lombok Island, killing over 1,500 people and causing thousands of casualties. The Indonesian authorities initially issued a tsunami warning after the earthquake, but this warning was later rescinded; the tsunami caused more fatalities than the earthquake had. Therefore, the lack of an adequate, accurate, and reliable early-warning system resulted in increased casualties and deaths. In several regions, including Hong Kong, America, Indonesia, and Japan, severe typhoons, earthquakes, and hurricanes caused significant fatalities and damage to infrastructure in 2018 alone. Based on the number of devastating events that occurred, 2017 and 2018 are described as among the most disastrous years.

In response to these disasters that have damaged lives, livelihoods, and property, recent efforts on the part of scientists and policy-makers have been aimed at addressing these disasters and better preparing communities for such eventualities. Several disasters have been reduced or even prevented, but those in the latter category are all but impossible to measure. Bangladesh, which suffered losses of 300,000–500,000 people to the Bhola cyclone in 1970, reduced casualties to just over 3,000 during Cyclone Sidr in 2007, and 190 during Cyclone Aila in 2009, as a result of being better prepared (the cyclone sizes varied, but this has nonetheless been acknowledged as a reduction in death and damage count as a result of disaster preparedness, as explained by Patwary and Bregt [2013]).

Disasters and vulnerability to the impacts are inversely related to people's capacity to negotiate such events and to their ability to access necessary resources and means of shelter or protection. Generally, people with disabilities, children, women, elderly citizens, and gender and ethnic minorities, are among those most affected by disasters (Wisner *et al.*, 2012). In this context, vulnerability reflects how wealth and power are distributed within a society and traces its roots to social, cultural, political, and economic advantages that lie beyond the reach of those who are vulnerable (Gaillard, 2010).

People's vulnerability to natural disasters is context specific and varies across space and time, depicting a linear relationship with the nature, strength, and diversity of what people do on a daily basis; for example, a farmer is more vulnerable to drought or flood than a shopkeeper is, owing to agriculture's climate-sensitive nature and the fact that crops can easily be damaged if the season lacks sufficient rain or if excessive rain causes floods. Similarly, women who have no access to weather information and largely remain at home, as is the case with much of the female populations of Pakistan and other developing countries in South Asia, can expose females more to disasters than men, who have superior access to weather forecast and information services. Therefore, it is important to acknowledge that people differ in their capacities to negotiate and respond to disasters triggered by natural and other hazards, depending on various factors, including age, gender identity, physical ability, ethnicity, and income level.

As such, a fuller understanding of people's resilience to natural disaster through the lens of their vulnerability requires detailed investigation that relies on both qualitative and quantitative research methods, which can offer a more accurate reflection of the area-specific realities of people's everyday lives (Adger, 2006). These include surveys, structured and semi-structured interviews, testimonies from those who are vulnerable, observations of participants, and group discussions with groups designed with the aim of fostering interaction among all stakeholders, including external researchers, various practitioners, policy-makers, and local populations. According to Adger (2006), the outcomes of qualitative research methods often defy comparison from one context to another, as lifestyles, coping capacities, and spatial conditions of the various areas may differ significantly from one to another. However, when quantitative data that have been collected through survey are combined with qualitative data, a superior assessment of how best to combat people's vulnerability to natural disasters may be achieved. This is particularly applicable to areas in which the socio-environmental and economic situations are similar.

Sensitivity and *exposure* are almost indivisible and inseparable characteristics of a community or a system, and solely rely on the interaction between the system's properties and the attributes of the climate stimulus (Smit and Wandel, 2006). As explained in the preceding paragraph, the vulnerability of an individual or a system depends on their level of exposure to certain natural disasters; for example, a community's exposure to an environmental change risk, such as flood, affects the system's likelihood of experiencing the conditions, occupancy, and livelihood characteristics that will influence its sensitivity to such exposure. The occupancy characteristics (e.g., livelihood type, land use, settlement location, and type) mirror the broader social, economic, cultural, political, and environmental conditions, which are usually recognized as drivers of sensitivity and exposure (Adger, 2006). Among the above-mentioned attributes of a system's occupancy or sensitivity, many impacts or restrict a system's adaptive capacity (Adger *et al.,* 1999). Smit and Wandel (2006) observed that scientists addressing climate change face the significant practical challenge of identifying those processes of climatic conditions and systems' occupancy or vulnerability that are either problematic, risky, or somehow dangerous to the community of interest. Therefore, it is crucial to determine how particular communities can adapt to the negative consequences of climate change-induced natural disasters, by identifying the problematic, risky, and sometimes hazardous processes in a system.

Several studies have attempted to define adaptation in the context of climate change, of which the most widely accepted definition is that offered by Brooks (2003, p. 8), who interprets adaptation as “adjustments in a system’s behavior and characteristics that enhance its ability to cope with external stress.” Smit et al. (2000, p. 225) refer to adaptations in the context of climate change as “adjustments in ecological-socio-economic systems in response to actual or expected climatic stimuli, their effects or impacts.” Pielke (1998, p. 159) defines adaptation as the “adjustments in individual groups and institutional behavior aiming to reduce society’s vulnerability to climate.” Adaptive capacity has also been analyzed from various perspectives depending on the conditions that a system can adjust to, deal with, recover from, and accommodate any consequences thereof (Smit and Pilifosova, 2003; Smit *et al.,* 2000). The forces that enable a system to adapt to these changes are generally termed the determinants or drivers of adaptive capacity (Adger, 2003; Blaikie *et al.*, 1994; Walker *et al.*, 2002).

Experts on climate change agree that adaptive capacity is not universally homogeneous, instead, its value and nature are context specific and change in accordance with circumstances such as location (i.e., community to community, country to country, and region to region), social groups and individuals, and time (Adger and Kelly, 1999; Adger *et al.*, 2004; Brooks, 2003; Füssel and Klein, 2006; Smit and Burton, 2000; Smit *et al.*, 1999). The household environment will determine whether its residents can or cannot adapt to certain aspects of climate change. Therefore, the adaptive capacity of a household is not solely reflective of its residents’ environment but also of the region’s resources and processes (Smit and Pilifosova, 2003). For example, most communities can adapt to, or at least cope with, normal changes in climatic conditions, but are less capable of adapting if they are heavily exposed to extreme events that cross the threshold level of their adaptive capacity (Adger, 2006). In this regard, some scientists regard coping ability as the adjustments that enhance the shorter-term capacity or ability to withstand certain events, while adaptive capacity denotes the longer-term capacity or ability to survive and to make more sustainable adjustments in response to the systemic changes that have occurred (Smit and Pilifosova, 2003). Similarly, Watts and Bohle (1993) apply the term adaptability to shorter-term coping ability, while potentiality denotes longer-term coping capacity, though not exclusively. Many vulnerability and adaptation experts agree that, at the local level, the capacity or ability to adjust or to adapt to certain conditions is influenced by several factors, including, ability to manage, access to financial, technological, and information resources, good infrastructure, the institutional environment within which adaptations are made, political influence, and kinship networks (Adger and Kelly, 1999; Blaikie *et al.,* 2014; Kelly and Adger, 2000; Smit and Pilifosova, 2003; Watts and Bohle, 1993; Wisner *et al.,* 2004). Therefore, “no-regret” adaptation strategies should be assessed, or adaptation initiatives should be planned and implemented to negotiate the risks associated with changes in climatic conditions. Moreover, the enhancement of communities’ abilities to manage or adapt to climate change risks depends on the efficient management of locally identified vulnerabilities, and the assurance that any adaptation measures implemented are compatible with current decision-making protocols (Smit and Pilifosova, 2003). I may conclude that further clarification is merited regarding the definitions of the term’s sensitivity, exposure, adaptation, adaptive capacity, coping capacity, and adaptability and how these concepts may shift depending on context, in response to different situations, cultures, and locations.

This dissertation is divided into seven chapters, each of which addresses a different issue in its own distinct format. Chapter 1 has provided a brief explanation of the background of the study, as well as its overall content. It includes a clarification of the key issues (*vulnerability* and *adaptation*) that are addressed in this study, in addition to offering justification as to why this subject has been identified as an important research topic. It also includes the research questions, objectives, and framework that serve as guidelines for the study. The main objectives of the study are clearly stated and explained in this chapter to provide readers with the necessary background information. This chapter also defines the scope, significance and framework for research.

Chapter 2 expands on the research methodology used, including the theories and concepts that serve as references, tools, or models to explain the key issues that are analyzed further in the ensuing chapters. Mixed methods (i.e., household surveys, key informant interviews, and group discussion) were used as data collection tools for this study. In some cases, photographs and personal observations were used to further clarify the data gathered. The methods include the selected research areas, respondents and participants selection, data collection, and data analysis techniques.

Chapter 3 expands on past and current trends in Pakistan's climate generally and specifically in Khyber Pakhtunkhwa Province. Pakistan is frequently exposed to natural disasters attributed to climate change; hence, it is crucial to determine which climatic factors are changing, and how they might be negotiated in a better way. After exploring the aspects of the climate that are shifting, the history of climate-related damages inflicted on Pakistan and Khyber Pakhtunkhwa Province is explored. Again, the value of this is to ascertain which climate-induced disaster poses the greatest problem. In Pakistan, annual episodes of flooding and year-long droughts are major concerns for policy-makers. Therefore, in this chapter, the disastrous impacts of these events are evaluated with an examination of numeric data from different international and national reports published in recent years.

Chapter 4 investigates the governmental approach to climate change, beneficial institutional arrangements and policies made to combat climate change, and its associated risks at the national, provincial, and district levels. Special emphasis is given to farm level initiatives in policies, as this research focuses on farming communities at the farm level. This chapter also investigates which institutions are involved in addressing climate change and how the government is financing adaptation and mitigation programs at the various levels. Climate change policy is evaluated, with an examination of both its strengths and weaknesses.

Chapters 5 explores risk perception and the factors contributing to vulnerability among farmers due to the negative impacts of climate change. This chapter also provides insights into the causes of the key determinants of vulnerability among farmers and, more importantly, how they perceive changes in the local climate. It also aims to elucidate the effects of these vulnerabilities on farming practices in the region, for example, whether the total seasonal or annual yields have increased/decreased, total production, or loss of human lives due to natural disasters. This chapter also explores how the understanding of risk perceptions regarding climate change can contribute to superior management of farming conditions with the aim of improving agricultural yield. I highlight both successful and unsuccessful examples from across the globe for comparison with the study area at hand and offer suggestions regarding how farmers' perceptions of the effects of climate change can help to improve their farming practices. Next, I discuss the exposure and sensitivity aspects of climate change vulnerability and draw conclusions from this study that can contribute to superior formulation of agricultural and climate change policies in Pakistan.

Chapter 6 primarily explores the adaptation options typically applied with the aim of improving agriculture while addressing climate change. I also address the obstacles that farmers encounter in adapting and investigate how are these measures help farmers to increase agricultural yield. This chapter also offers recommendations for policy-makers to highlight the relevance of a focus on climate change. Additionally, I shift the focus of my discussion to "no-regret" adaptation, which investigates how farmers in Charsadda district can ensure that their adaptation measures aimed at reducing the impacts of climate change on their farms are appropriate and timely, as well as investigating how farmers can improve their yield while experiencing climate change. "No-regret" adaptation methods are relevant both within and outside the context of climate change; therefore, this study offers recommendations of these methods to farmers in Charsadda district. For instance, pipe leakages can result in water loss, while repairs can conserve water. However, these are short-term solutions, and farmers must understand the new climate in which they are living and what the requirements are in terms of adaptation with the aim of negotiating it.

Finally, Chapter 7 concludes the study by presenting all key findings and highlighting the importance of understanding climate change-associated risks and vulnerabilities that farmers face, by evaluating the adaptative measures taken so far, and addresses how the situation at the farm level might be improved to increase these farmers' yields as they face climate change in the province. The synthesis between the two case studies provides a concise summary of the main arguments adopted and outlines the implications that these present for policy decisions, as well as highlighting areas of interest for future research.

1.3 Defining climate change vulnerability

The definition of vulnerability requires context; there is no single definition of vulnerability and no universally accepted method for assessing vulnerability to climate change. However, many agree on the definition proposed by the IPCC, in its Second

Assessment Report, which defines vulnerability as “the extent to which climate change may damage or harm a system”. It further states that vulnerability “depends not only on a system’s sensitivity, but also on its ability to adapt to new climatic conditions.” The Fourth Annual Report of the IPCC (1997) offers another definition: “the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.” According to the Hyogo Framework for Action 2000–2015, adopted in 2005 by the United Nations World Conference on Disasters, vulnerability comprises a “set of conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of a community to the impact of hazards” (Hyogo, 2005). Therefore, a system can be recognized as highly sensitive to modest changes in climate and seriously restricted in its capability to adapt. Adger (2006), Adger and Kelly (1999), the IPCC (2000a), McCarthy et al. (2001), Parry et al. (2000), and Watson and Albritton (2001), have all offered definitions of vulnerability and, although the specifics may vary, all of the definitions presented in Table 1-1 agree that exposure, sensitivity, and adaptive capacity are key elements of vulnerability. Additionally, the relationship among the three elements is not specific and governed by local conditions, but rather vulnerability is a positive function of the system’s exposure and sensitivity and a negative function of the system’s adaptive capacity (Smit and Wandel, 2006):

$$V = f\,(E, S, AC) \qquad (1)$$

where V stands for vulnerability, E for exposure, S for sensitivity, and AC for adaptive capacity.

In most cases, vulnerability is used in the context of climate change and its associated natural disasters. Until now, extensive literature has been published to highlight climate change-related vulnerability and its associated consequences for communities at various levels and sectors. Some of this work is summarized in Table 1-2 for the benefit of future researchers. Adger et al. (2005) and Mendelsohn et al. (2006) observed that exposure and vulnerability vary across temporal and spatial scales, and depend on economic, social, geographic, demographic, cultural, institutional, governance-related, and environmental factors.

Table 1-1: Various definitions of vulnerability from the literature

Source	Definition
IPCC Second Assessment Report (2001)	“The extent to which climate change may damage or harm a system”. It further states that vulnerability “depends not only on a system’s sensitivity, but also on its ability to adapt to new climatic conditions.”
Watson and Albritton (2001)	“The extent to which a natural or social system is susceptible to sustaining damage from climate change and is a function of the magnitude of climate change, the sensitivity of the system to changes in climate and the ability to adapt the system to changes in climate. Therefore, a system can be called highly sensitive to modest changes in climate and one for which the capability to adapt is seriously restricted.”
Adger and Kelly (1999)	“Vulnerability is the exposure of individuals to stress because of the impact of extreme climate events.”
Adger (2006)	“Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity, and its capacity to deal with the impact that the change may bring.”
Wisner et al. (2004)	“Vulnerability has a social character which is not limited to potential physical damage or to demographic determinants.”
McCarthy et al. (2001)	“The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.”
Parry et al. (2007)	“Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity, and its capacity to deal with the impact that the change may bring.”
Hyogo Framework (2005)	“Vulnerability is a set of conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of a community to the impact of hazards.”

Source: Author’s own modification based on literature, 2017.

Murray and Ebi (2012) focused on the uneven distribution of wealth, inequality in access to education, disability, and health status, as well as gender, age, class, and other social and cultural characteristics as the major causes of vulnerability. These inequalities reflect socio-economic, demographic, and health-related differences, as well as differences in governance, access to livelihoods, entitlements, and other factors. Extreme events will have greater consequences for sectors that are more closely linked to climate, such as water, agriculture and food security, forestry, health, and tourism. Many countries and specific sectors within these countries are vulnerable to these effects of climate change.

Table 1-2 provides a brief overview of research that has been conducted hitherto in the field of vulnerability. The list of researchers included in the table are from different disciplines, and thus inevitably perceive vulnerability differently. For example, some experts believe that vulnerability itself is portrayed in a negative light, as the susceptibility or probability of suffering harm, which is at the core of the IPCC's definition of vulnerability (Adger, 2006). However, it adds that a system can also be regarded as vulnerable if it is unable to cope with or adjust to the changes that occur within or around the system. Almost all disciplines use the term vulnerability with regard to human-environment interactions and relationships. However, environmentalists, human geographers, and ecologists narrow the scope of vulnerability to focus on environmental change. It is well understood that vulnerability does not exist in isolation nor does it occur solely as a result of environmental changes (Adger, 2006); rather, there are several other factors both within and outside of the system that drive vulnerability, including economic, social, cultural, and political factors. Table 1-2 divides the literature into two categories: one deals with the concept of vulnerability prior to the evolution of the concept of climate change, called "antecedents" or "precedents," while the other includes what are called the "successors," published after the evolution of the concepts of climate change and sustainability.

The concept of vulnerability contributes to our understanding of how communities, institutions, or ecosystems, and other social relationships, such as gender, are affected by climate change (Cutter *et al.*, 2008). While natural scientists and engineers consider vulnerability in terms of physical exposure to extreme events and its adverse outcomes, social scientists consider it in terms of socio-political factors that affect certain groups differentially when they are faced with external shocks in the absence of entitlement to resources (Adger, 2006). This indicates that vulnerability does not exist in isolation but is, in fact, highly contextualized in social and political spaces, and it is equally important to highlight those social constructions of vulnerability, as recommended by Mustafa (1998). Vulnerability should be analyzed in the context of opportunities and risks associated with technological development and economic globalization, which affect livelihoods, in combination with demographic shifts, increasing consumption, climate change, and other drivers of change. However, such a broad analysis is beyond the scope of this study. To address the uncertainty inherent in all change drivers, the method for assessing vulnerability must be based on continuous learning. Adger (2006) provides a detailed list of research conducted on various aspects of vulnerability as presented below in Table 1-2:

Table 1-2: List of research articles on climate change-related vulnerability

Vulnerability approach	Objectives	Sources
Antecedents Vulnerability to famine and food insecurity	Developed to explain vulnerability to famine in the absence or shortage of food or production failures. Vulnerability described as a failure of entitlements and shortage of capabilities.	Sen (1981); Swift (1989); Watts and Bohle (1993)
Vulnerability to hazards	Identification and prediction of vulnerable groups and critical regions through likelihood and consequence of hazard. Applications in climate change impacts.	Anderson and Woodrow (1998); Burton *et al.* (1978, 1993); Parry and Carter (1994); Smith (1996)
Human ecology	Structural analysis of underlying causes of vulnerability to natural hazards.	Hewitt (1983); Mendelsohn *et al.* (2006); Mustafa (1998); O'Keefe *et al.* (1976)
Pressure and Release	Further developed human ecology model to link discrete risks with political economy of resources and normative disaster management and intervention.	Blaikie *et al.* (1994); Pelling (2003); Winchester (1992)
Successors Vulnerability to climate change and variability	Explaining present social, physical, or ecological system vulnerability to (primarily) future risks, using wide range of methods and research traditions.	Ford and Smit (2004); Klein and Nicholls (1999); Mirza (2003); O'Brien *et al.* (2004b); Smit and Pilifosova (2001); Smith *et al.* (2001)

Continued…

Vulnerability approach	Objectives	Sources
Sustainable livelihoods and vulnerability to poverty	Explains why populations become or remain poor based on analysis of economic factors and social relations.	Bebbington (1999); Dercon (2004); Dercon and Krishnan (2000); Ellis (2000); Ligon and Schechter (2003); Morduch (1994)
Vulnerability of social-ecological systems	Explains the vulnerability of coupled human–environment systems.	Luers (2005); Luers et al. (2003); O'Brien *et al.* (2004b); Turner *et al.* (2003a, b)

Source: Adapted from Adger, 2006 (modified by author in 2017).

1.4 Climate change vulnerability assessment

Vulnerability to climate change is a concept that has been emerging over the last two decades. The increased occurrence of disastrous events due to changing global climatic conditions have forced experts in climate change to devise solutions aimed at mitigating vulnerability accordingly. Since the concept of vulnerability is explored in different disciplines by different research communities, there is no universally accepted method for specifically assessing vulnerability to climate change; however, analysts including Adger (2006), Blaikie *et al.* (1994), Bohle *et al.* (1994), and Füssel and Klein (2006) and have proposed several frameworks for assessing the vulnerability of natural systems to climate change. These experts have categorically recognized that the analysis of vulnerability must be dynamic enough to suit the context of analysis, and that drivers of both climatic and non-climatic factors, including cultural, political, institutional, social, and environmental, must be considered. Several other analysts, however, have argued that the tools and techniques required for vulnerability assessment should be utilized accordingly, to optimize assessment results (Thornton *et al.*, 2006). Füssel and Klein (2006) have reported that, besides climate change-vulnerability assessments, there are other fields in which vulnerability assessments have been performed, such as food security, unsustainable extraction of natural resources, natural disasters, and risk management. These assessments are aimed at formulating policies designed to reduce the risks associated with the problems mentioned above. In the context of climate change, scientists have focused on finding suitable strategies for assessing adaptation and mitigation, the two fundamental response options to climate change. In the past, mitigation has attracted considerable attention from climate scientists and policy-makers because, by mitigating climate change, all climate-sensitive sectors and systems can reduce the negative consequences that ensue. However, adaptation has more recently garnered equal attention, since mitigation is not possible in all cases, or may be costly; therefore, scientists suggest adapting to the impacts of climate change, which means learning to live with climate change and its effects.

Effective adaptation to climate change entails two important prerequisites: useful information on what and how to adapt and the resources necessary to implement the adaptive measures. If assessment of vulnerable systems is required, research should be conducted to gather basic information regarding the nature of the stressors to which the system is exposed, and the required resources should be distributed as appropriate, including financial support, advanced technological assets, or perhaps even experts who may be of assistance in the disaster-prone region in times of hardship. Programs designed to raise awareness constitute another initiative that several countries have begun developing, but many developing countries appear to lag behind in terms of their accomplishments in this regard. Pakistan is continuously afflicted with natural disaster events, but the country's preparedness to cope with the higher intensity and frequency of these disasters is inadequate.

To capture, assess, and monitor complex and overlapping vulnerabilities, various assessment approaches have been developed and implemented at different scales. Indices developed with separate sets of parameters include Climate Vulnerability (Smit and Pilifosova, 2001), the Livelihood Vulnerability Index (Hahn *et al*., 2009), and the Livelihood Effect Index (Urothody and Larsen, 2010). Vincent (2004) developed an index of social vulnerability to climate change in Africa, which applies the conceptual framework of the global community's alignment of social vulnerability to climate change with adaptive capacity (Klein *et al.*, 2003; Adger, 2006; Gallopin, 2006). An index using a combination of socio-economic and biophysical indicators was developed to examine vulnerability to climate change in seven regions of Ethiopia (Deressa *et al.*, 2008).

1.5 Defining and treating the concept of climate change adaptation

When adaptation is explained in the context of human dimensions of global change it is usually known as the process, action, or outcome in a chosen system, including households and communities, or sectors, regions, and countries. The process aims to ensure that superior coping procedures are in place to deal with all changes that might occur in association with hazards, risks, or even stress factors. Multiple definitions of *adaptation* have been advanced in the literature. Theorist Brooks (2003) argued that adaptation is the adjustment used to deal with a system's behavior and characteristics with the intention of enhancing its ability to better manage external stress (p. 8). In the context of climate change, Smit et al. (2000) defined adaptation as the adjustments made in ecological-socio-economic systems in response to actual or expected climatic stimuli and their effects or impacts (p. 225). Pielke (1998) also defined adaptation as adjustments in individual, group, and institutional behaviors to help reduce vulnerability within society in response to changes in climatization (p. 159). Moreover, Fankhauser et al. (1999) and Smit et al. (2000) observed that adaptation can be either reactive or anticipatory, usually depending on whether the actors are private individuals acting autonomously or governmental authorities implementing planned adaptive measures.

While there are many definitions of adaptation, there are also several associated concepts, including adaptive ability, vulnerability, resilience, exposure, and sensitivity, which all have far-reaching connections in relation to science and global change. Analyses undertaken can vary widely in scale, beginning with the vulnerability and adaptation of an individual or a household to a climate-related stressor, such as drought. There are also adaptations undertaken by communities that face multiple stressors and forces that highlight the vulnerability of humankind or the global ecosystem. Various phenomena influence the applications of adaptation (e.g., biological, economic, and social). Further examination of time scales and frames, including moments, months, years, decades, and centuries, reveals that it is in the field of ecological systems that concepts of resilience have achieved the most development (Berkes *et al.,* 2003; Holling, 2001; Gunderson and Holling, 2002). The resilience of ecosystems and socio-ecological systems is reviewed by Folke (2006).

The term adaptation originates in the natural sciences and has gained attraction in fields concerned with global environmental change. Although there is some dispute regarding the precise definition of adaptation in the natural sciences, it broadly refers to the improvements in behavioral characteristics that enable individuals to adjust to environmental changes to sustain reproduction and survive (Brooks *et al.,* 2005). Individual adaptations are features of organisms that have developed to ensure survival. The consideration of adaptation within the natural sciences encompasses a broad scale ranging from the organism or individual to the population of a single species, or an entire ecosystem.

The application of the term adaptation to human systems has been traced to the anthropologist and cultural ecologist Julian Steward, who used the term "cultural adaptation" to describe the adjustment of culture cores to the natural environment through subsistence activities (Butzer, 1989). O'Brien and Holland (1992) offered their own definition of the processes that take place in adaptation, where a community or group invent new, improved methods of helping individuals to cope with environmental changes. Therefore, adaptation may be defined as a method-making strategy to cope with change (p. 37). Expanding further on "cultural adaptation," Denevan (1983) asserted that it constitutes the adaptation process of change in response to a change in the physical environment or a change in internal stimuli, such as demography, economics, or organization, thereby broadening the range of stresses to which human systems adapt beyond biophysical stress (p. 401).

Social science's treatment of adaptation in human systems has largely concerned itself with the success or survival of cultures. Several anthropologists, including O'Brien and Holland (1992), have suggested that the consequences of choosing to adapt through cultural practices ultimately aids survival prospects. Cultural practices are thus equated with genetic characteristics in the natural sciences; from this Darwinian perspective, a group that lacks adequate means of coping with environmental stress will be unable to compete for scarce resources and will thus fail to thrive. In this application of the term, a cultural practice is an adaptation only if it has been developed to overcome stress; as such, adaptations are distinguished from adaptive features that allow societies to function within their environments, regardless of whether they evolved because of selection (O’Brien and Holland, 1992).

Recent findings in relation to social sciences and cultural practices show that adaptations facilitate the survival of societies and individuals. It has been recognized that societies adapt to a range of stimuli, including, but not limited to, environmental stress. However, Denevan (1983) observed that societies that already have high advantages in terms of adaptation will cope more easily with changes and will be better able to adapt as required.

Adaptation as a concept has been used in both explicit and implicit methodologies within the social sciences. It has been explicitly used in the investigation of natural hazards, ecology (politically), and scholarship. While some scholars have used the method implicitly, ecologically determined biophysical changes appear to determine the flow of materials, energy, information, and the related concepts of resilience, equilibrium, and adaptive management (e.g., Holling, 1986). Others, particularly from the perspective of natural hazards, have focused on the perception of, adjustment to, and management of environmental hazards (e.g., Burton *et al.*, 1978).

The concept of adaptation is usually implicitly applied in political ecology. Its implicit form is generally recognized in the relationships between ecosystems and the economy, both of which are associated with issues that arise during the adaptation process. Smit and Pilifosova (2001) and Smit *et al.* (1999) explained that this occurs as the result of risk management relating to social power, the use of resources, and other global economies. Relatively, food security adaptations are at more risk and under greater stress. Adger and Kelly (1999, 2000) explained how this stress arises due to the lack of adaptation among certain communities in relation to food supplies.

In view of the above, it is evident that the primary element of adaptation is “demonstration,” whereby it is shown how individuals or communities adapt to social, political, and economic processes on larger scales. Similarly, research by Kasperson (2001) into global environmental risk and its social amplification suggests that risk is associated with place adjustments and adaptations, in the context of human driving forces, biophysical constraints, and the social, economic, and political attenuation of risk.

The findings by Blaikie *et al.* (1994) and Wisner *et al.* (2004) indicate that conceptualizations of risks and their manifestation as disasters, including the pressure and release model, identify the environmental stresses associated with hazards and the development of social forces that contribute to vulnerability, including those that relate to adaptive capacity. This view of coupled human–environment systems, which emphasizes the role of human adaptive responses, is further developed in the vulnerability frameworks of Turner *et al.* (2003) and the access model of Wisner *et al.* (2004).

Analyses of adaptations in terms of climate change emerged concurrently with the growing awareness of climate change itself. A very early example is a study by Butzer (1980): he argued that cultural adaptation, also known as human ingenuity in relation to long-term planning, also has the capacity to make predictions regarding climate change and its anticipated impact on world food supply. Since these early investigations, Kelly and Adger (2000), as well as Smit *et al.* (2000), have undertaken various analytical exercises in support of this claim, regarding the changes made to climatic conditions for various purposes.

1.6 Rationale for climate change adaptation research

Both adaptation and its analysis serve many purposes, the most common being the analysis of climate change and the estimation of modeled impacts under different climate change scenarios. An important function of adaptation analysis is the ability to ascertain how findings may be moderated and adapted to suit particular impacts (Mendelsohn *et al.*, 2000; Parry, 2002). These investigative methods aim to address the objectives of the United Nations Framework Convention on Climate Change (UNFCCC), which commits countries to the mitigation of GHG emissions. The main priority of adaptation strategies is to assess what modifications can be made, or what precautions can be taken, with the aim of limiting the negative impacts of climate change. They also aim to acknowledge noteworthy positive impacts to reduce risk levels. Generally, these analyses are conducted in broader terms or on larger scales, where equilibrium or statistical models are available, to investigate and estimate the consequences with and without adaptation and to address the following question: how serious or "dangerous" are specific climate change scenarios (Dessai *et al.*, 2003; Parry *et al.*, 2001)?

To this end, analyses regarding adaptation show that conventional changes are assumed to be hypothetical, with their effect on the system to be estimated relatively (e.g., in terms of costs or savings). Therefore, the focus is on the assumed effect of the adaptations. The purpose is to estimate the likely impact of climate change and to predict what differences adaptation might make. However, it is important to recognize that this selective work does not necessarily encompass empirical investigations of adaptation or examination of the actual processes of adaptation or adaptive capacity; rather, it explores the conditions or drivers that facilitate or constrain adaptation, or examines documents regarding the decision-making processes, authorities, and mechanisms involved in adaptation. It takes certain assumed or hypothetical adaptations that allow the formulation of assumptions regarding the estimated impacts and effects that may ensue from particular climate change scenarios (Arnell, 1999; Tol, 1996). The term vulnerability has sometimes been used to describe the estimated net or residual impacts (i.e., initial impact costs minus net adaptation savings).

Other adaptation experts focus on specific adaptation options or measures available to systems subjected to climate change stimuli. These analyses address articles from the UNFCCC that commit countries to formulating and implementing measures aimed at facilitating adequate adaptation to climate change. The purpose of these analyses is to assess the relative merit or utility of alternate adaptations and to identify those that are “best” or superior (e.g., Dolan *et al.*, 2001; Niang-Diop and Bosch, 2004). The analysis entails the selection of a suite of possible adaptations, chosen by the researcher based on hypotheses, observations, modeling, extrapolation, analysis, key informants, or deductive reasoning.

Multi-criteria procedures are used to rank or rate possible adaptations and its cost-benefit analysis. Among others, several common variables are apparent such as cost, implementation, effectiveness, efficiency, and equity (Adger *et al.*, 2005a; Feenstra *et al.*, 1998; Smith *et al.*, 1998). While the focus of these studies is to rate or rank potential adaptations, they rarely investigate the processes through which these adaptation measures are undertaken, either with regard to climate change specifically (which is very rare) or as a component of the policy and decision-making processes to which these adaptations may relate.

A third group of studies focuses on relative adaptive capacity relating to vulnerability among certain countries, regions, or social communities. These studies involve comparative evaluation or ratings based on specific criteria or variables selected by the researcher or investigator (Adger *et al.,* 2004; Brooks *et al.,* 2005; Kelly and Adger, 2000; Van der Veen and Logtmeijer, 2005). Vulnerability is taken as the "starting point" rather than residually or at the end (O'Brien *et al.,* 2004b), and it is assumed to be measurable based on attributes or determinants selected a priori. The expectation is that adaptative efforts should be directed toward those areas that have the highest exposure levels or lower adaptive capacities. In this third strain of research, the analyst selects the factors, or determinants, of vulnerability or adaptive capacity, obtains measurements of these, adopts an aggregation function over the measures, and calculates an overall vulnerability value for each system.

This work relates to that of the UNFCCC, which obliges already-developed member countries to assist currently developing member countries that are particularly vulnerable to the adverse effects of climate change; that is, the key purpose of these studies is to evaluate the relative vulnerabilities (and/or relative adaptive abilities) of countries or regions, usually using indices, scores, ratings, or rankings. Adger (2006) suggested that the surrogate measures of exposure or sensitivity and the elements of adaptive capacity should be estimated for each system and then aggregated to generate an overall vulnerability score for each system. The intent is to provide information for targeting adaptation initiatives or scarce resources.

The purpose of the fourth type of analysis is to contribute to practical adaptation initiatives. Once all research has been completed, the process mainly focuses on the implementation processes of adaptation. However, this step is still quite uncommon, at least in relation to the adaptive research and climate change fields. As noted by Alwang *et al.* (2001) and Haimes (2004), there is a vast body of scholarship in this area, as it encompasses the fields of resource management, community development, risk management, planning, food security, livelihood security, and sustainable development, which focus on practical implementation rather than research.

The term *practical application* denotes that the researchers are investigating the adaptive capacity and adaptive needs in a region or community with the aim of examining how to enhance the changes that occur during the adaptation process. This approach permits the identification and development of adaptive measures or practices tailored to the needs of that community. The aim is not to score adaptations or measure relative vulnerabilities, nor to quantify the impacts or estimate the effects of hypothetical adaptations; in this process, the priority is to generate documentation regarding the ways in which the experiences of the systems or chosen communities vary according to the changing conditions and the processes of decision-making in this system (or that influence the system), which may accommodate adaptations or provide means of improving adaptive capacity (Ford and Smit, 2004; Sutherland *et al.*, 2005).

By comparison, climate, from the perspective of adaptation, has its own distinctive features characterized within the body of work. Such studies do not tend to focus on the specific variables that represent exposure, sensitivity, or aspects of adaptive capacity, but rather seek to identify these empirically from the community. The focus is on conditions that are important to the community, rather than those that are assumed to be so by the researcher or those for which data are readily available. It aims to apply the experiences and knowledge of the community involved to characterize the pertinent conditions, community sensitivities, adaptive strategies, and decision-making processes related to adaptive capacity or resilience. It identifies and documents the decision-making processes into which adaptations to climate change can be integrated. In this sense, it is sometimes called a "bottom-up" approach in contrast to the scenario-based "top-down" approaches.

1.7 Justification of this research

Although disastrous events have always occurred in the past, however, in the recent past, these disasters and its associated damages got huge national and international attention. Moreover, the frequency of both natural and anthropogenic disasters in the developing world has also increased, resulting in severe damages. Pakistan is ranked among the top ten countries worldwide in terms of its exposure to natural disasters, since its topography and meteorology vary by region, and due to the relatively weak adaptive capacity of its poorer population, particularly in rural areas. The same phenomena are observed in other South Asian countries, including Bangladesh and India, where natural and anthropogenic disasters have affected peoples' lives and livelihoods. Floods, landslides, cyclones, heatwaves, severe storms, and drought are prominent among natural disasters, while anthropogenic disasters such as poverty, terrorism, political instability, fire, war, civil unrest, influx of refugees within and coming from across the border, health epidemics, and transport and industrial accidents constitute major threats to citizens.

Pakistan, a country with a population of around 220 million people, of whom nearly 62 percent live in rural areas, is still primarily dominated by agriculture, which accounts for 21 percent of the total gross domestic product (GDP) and employs approximately 43 percent of the labor force (PBS, 2015). Agriculture's share of the GDP has decreased continuously in recent years for several reasons, including the changing climatic conditions in the region (Khan, 2015). A Pakistan Bureau of Statistics survey report (PBS, 2015) indicated that Pakistan's contribution to GHG emissions is low when compared to international standards. The country's total emissions constitute approximately 0.8 percent of global GHG emissions, placing it 135th in the world in terms of per capita GHG emissions. Therefore, a major concern for policy-makers in Pakistan is to ensure effective adaptation to climate change with particular emphasis on water, energy, agriculture, and disaster mitigation (Asif, 2013). As noted above, Pakistan was ranked among the top ten out of 170 countries on a recent Climate Change Vulnerability Index and is located in a part of the world where projected temperature increases due to climate change are likely to be higher than the global average (Khan, 2015; Mallick and Masood, 2011), making it more vulnerable to disasters than many other countries worldwide.

Despite the challenges currently facing Pakistan, including climate change, the country maintains its strong commitment and dedication to achieving its 2025 Vision, which is a pathway aimed at contributing to the sustainable development goals agenda set by the international community. It also aligns with Pakistan's continuous efforts to address climate change and its associated disasters, as reflected in the National Climate Change Policy (NCCP) as well as national policies on power, energy, water, agriculture, and other sectors (Ministry of Climate Change Pakistan, 2016). Adapting all of these sectors to changing environmental conditions represents a particular challenge for the country, due to its multi-sectoral economy, increasing demand for major infrastructure, distinct climatic zones and ecological systems, and complex administrative arrangements. The authorities have already initiated dialogue on national adaptation priorities and estimated costs per sector in deeper consultation with the provinces and other stakeholders, which will also be conveyed in due course.

Both large- and small-scale farmers in Pakistan are exposed to the severe effects of climate change, but small-scale farmers are more vulnerable because of their less-sophisticated management practices and marginalized socio-economic conditions. They require urgent assistance in building resilience and in undertaking climate change adaptation and/or mitigation efforts, as a matter of survival and the maintenance of livelihoods. Rural responses to climate change are important for a fuller understanding of the greater effects of the changing climate, to investigate and evaluate the options available for a pragmatic response to these effects (IPCC, 2014). Therefore, the main aim of this study is to contribute to this broader ideology established by the IPCC regarding the importance of the rural response to climate change for the effective formulation of climate change policy, by studying rural responses to climate change and its associated damage as caused by natural disasters in the rural regions of Khyber Pakhtunkhwa, Pakistan.

1.8 Key research questions of this study

Studies examining the consequences of climate change for smallholder agricultural practices are relatively scarce; therefore, data that might indicate temporal trends in coping strategies are lacking. It is also crucial to determine whether the changes made to livelihood tactics are satisfactory and if so, to what extent? Thus, the proposed study in Pakistan will examine the changes in occupational patterns and trends in the livelihood strategies of farmers and the efficacy of each adaptation activity. Key research questions are as follows:

- How do local farmers perceive climate change?
- How vulnerable is the farming community to climate change?

- What have been the consequences of natural disasters within the study area (e.g., economic, agricultural, livestock, educational institutions, and human fatalities)?
- What adaptation measures can be taken to manage climate change vulnerability? These might include the development of an early warning system, increased water storage capacity with the construction of new dams, increased storage capacity of existing water reservoirs, improved irrigation facilities for agriculture, access to information to raise awareness, and building human and institutional capacity.
- What is the role of institutions in mitigating the impact of natural disasters? This may include provision of training and workshops, agricultural support, early warning systems, and response, relief, and rehabilitation processes.

1.9 Research objectives of this study

The overarching framework of this study is presented in Figure 1-1. The overall objective of this study is to identify and assess how farmers in rural areas of Pakistan cope with climate change, which I investigated through field surveys and review of the relevant recent literature. However, for the purpose of clarity, this primary objective may be further sub-divided into the following components:

- To understand perceptions of local farmers regarding climate change
- To assess the vulnerability of the farming community to climate change
- To examine the damage associated with natural disasters
- To evaluate the adaptation techniques of local farming communities to natural disasters caused by climate change
- To assess institutional capacity for coping with natural disasters

1.10 Research Framework

This study focuses on three main concepts i.e. risk perceptions, vulnerability and adaptation towards climate change in the context of Khyber Pakhtunkhwa, Pakistan, as shown in Figure 1-1 below. Data needed to fulfill objectives of this study were collected through two field works in two selected villages in Charsadda district using triangulation of data collection methods including household surveys, key informant interviews and focused group discussions. At the later stage, data were brought to the lab for further analysis. Mainly, data were divided into two broad categories based on authors' own judgement i.e. Vulnerability *(including risk perceptions)* and adaptation. Finally, conclusion is made based on significant findings from this study.

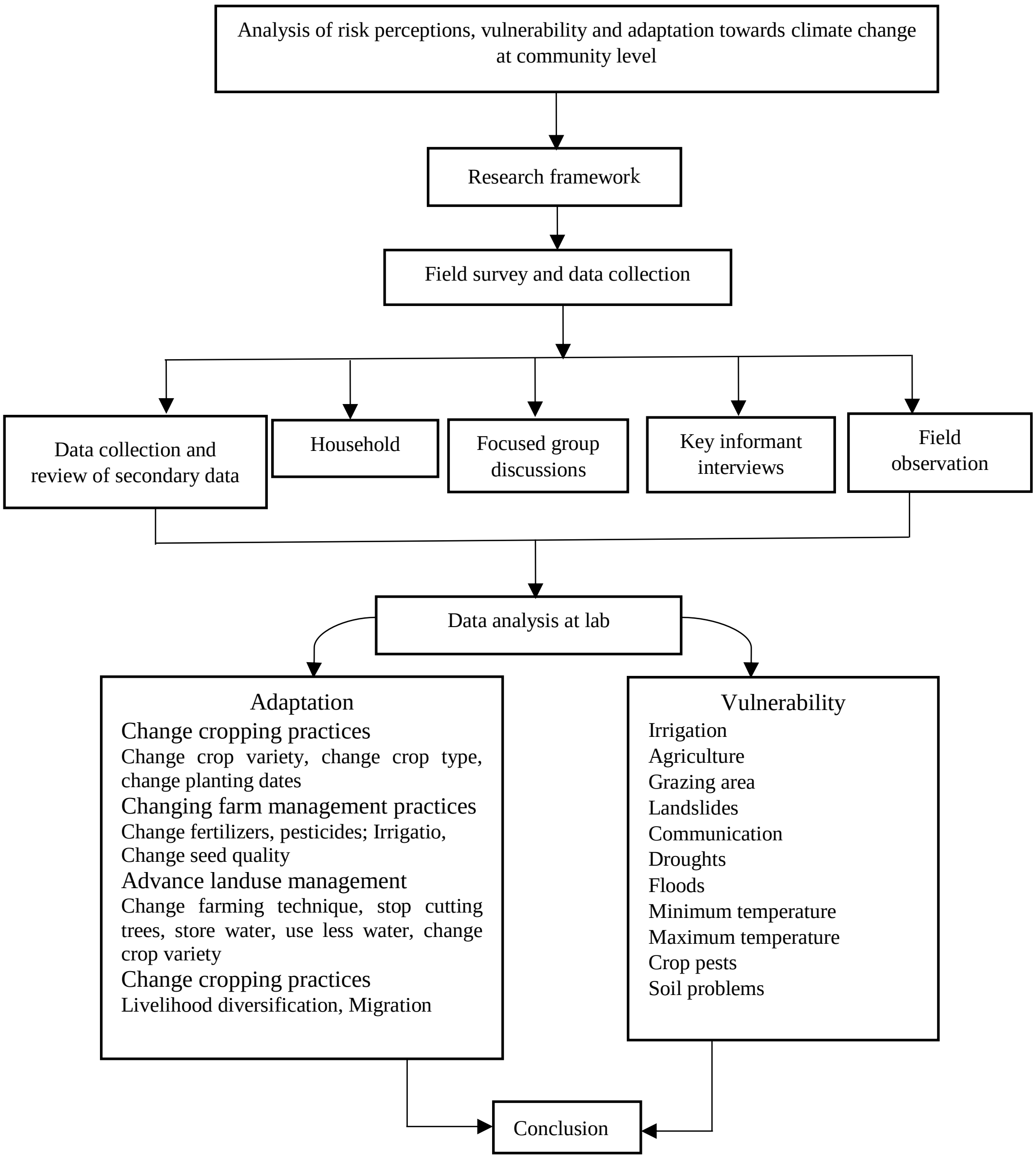

Figure 1-1: Research framework
Source: By author, 2017.

1.11 Conclusion

In introduction chapter, I primarily emphasized on clearing my pathway of how to organize this study by setting a main research question and focusing on main research objectives. For that purpose, I did extensive literature review of the main themes discussed throughout in this study i.e. risk perceptions, vulnerability and adaptation towards climate change. I also reproduced work of other climate scientists who worked in the same domain and provide state of the art literature. I then shift my focus to explore the definitions of vulnerability and adaptation across different disciplines with an aim to set a standard definition for the purpose of this study or the one that best suits my study and its context. In this regard, like many other climate scientists, I choose IPCC's definition of climate change vulnerability. In the later parts, I mainly focused on how climate researchers have tried to assess vulnerability globally and in the context of Pakistan. Rationale for adaptation, start of the art research and theories regarding adaptive capacities, adaptability, risk perception discussed in detail. Next, research framework, thematically explains the flow of this study.

2 CHAPTER 2: METHODS AND MATERIALS

2.1 Summary

The chapter in beginning provides detailed information on the geography of the province of Khyber Pakhtunkhwa and Charsadda district. Moreover, the demographics of Charsadda district are also given briefly. Introduction to the study area is provided in detail. In the later sections, it focuses on discussing the process of site selection, respondents' selection, methods used to collect data and to have a comparative analysis of data collected through field surveys in both villages facing climate induced natural disasters. The chapter explains the process of field work, consultation with different stakeholders to find appropriate case studies. Overall, the chapter is aimed to provide all necessary background information of the country's geography, demography, and explains the process through which I selected the sites, arrived in the area and conducted surveys at fieldwork.

2.2 Country overview: geography and climate

Pakistan is a longitudinal country covering an area of approximately 796,000 km^2 having great variation in its climate from north to south. Temperature in the northern areas drops down to as low as –50°C and stays around 15°C in the warmest months of May to September (McSweeney *et al.,* 2008). Monsoon season (from June to September) is the only main rainy season in the country during which the southern half part mainly receive precipitation through the southwest summer monsoon, whereas, northern and western areas of the southern half of the country get rains mainly through western weather disturbances in winter (from December to March). The summer monsoon accounts for around 60 percent of the total annual precipitation. Mostly, the climate varies from arid to semi-arid where almost 75 percent of the country receive 250mm or even less rainfall annually, except in the southern slopes of Himalaya and the sub-mountain region in the northern segment of the country with average rainfall ranging from 760mm to 2,000mm. Some of the world's highest mountain peaks are found in the northern Pakistan including K-2 (8,611m high), and glaciers like Siachen (70 km long) and Biafo (63 km long) that feed the Indus River and its tributaries (World Commission on Dams, 2000)

The western and southern segments of the country represent the Indus River basin plain and Baluchistan Plateau. The transboundary Indus basin covers 65 percent of the country's total area, including the whole provinces of Punjab, Khyber Pakhtunkhwa, most of the Sindh territory, and the eastern part of Baluchistan (FAO, 2016). Irrigation system along the Indus Basin is the world's longest system accounting for 95 percent of the country's total irrigation system. The average annual rainfall in the Indus plain is around 230mm. The temperature differences between the upper and lower basin plains are quite noticeable: the mean winter temperature (December–February) in the lower plain is 14 ^{0}C–20 ^{0}C, and 2 ^{0}C–23 ^{0}C in the upper plain areas, while during summer (March–June), the average monthly temperature ranges from 42 ^{0}C–44 ^{0}C in the lower lands, and 23 ^{0}C–49 ^{0}C in the upper plain (Chaudhry, 2017).

The Baluchistan Plateau is a vast wilderness of mountain ranges in the southwest of the country with an average altitude of about 600 m. Some seasonal rivers cross this region but most of its northwestern part is a wide expanse of desert like the deserts found in the central part of the country, such as Thar and Cholistan. The rainfall in this region is less than 210mm annually or 20–30mm per month. The Thar Desert is also known as the Great Indian Desert, is mostly arid region. Most part of Thar desert is in India, but it extends to Pakistan as well (Arisar, 2015). This desert covers around 50,000 km^2 within Pakistan. Most of the desert is covered by huge shifting sand dunes that receive sediments from the alluvial plains and the coast. Strong wind makes the sand highly mobile, occurring between July and September (the monsoon season). On the other hand, Cholistan desert sprawls 30 km (19 miles) from Bahawalpur, Punjab, Pakistan and extending to India by passing through Sindh province. According to the Express Tribune (2011), on its way to Sindh and India, many Indus Valley Civilization settlements can be found in the desert. This desert covers an area of 16,000 km^2 (6,200 square miles). Mostly, the inhabitants of Cholistan desert live nomadic and semi-nomadic life, looking for water from place to place for their animals (Arif and Mansoor, 2009).

Pakistan is the sixth most populous country in the world with a population size of 220 million (Pakistan Bureau of Statistics, 2018). With the current average annual population growth rate of 2 percent, it is projected to be the fifth most populous country of the world by 2050 (National Institute of Population Studies, 2013). The density of population is 231 persons per km^2 with almost 37 percent of the population residing in urban areas, of which around 47 percent are slum dwellers. The current total fertility rate of 3.8 is one of the highest in the Asia Pacific region and the country holds the second highest out-of-school population in the world of which two-thirds are girls (World Bank Development Indicators, 2011). The poverty rate estimated at US$ 2 per day purchasing power parity exceeds 50 percent of the total population with stark provincial disparities (Naveed and Ali, 2012). The southern sub-regions of all provinces are noted for a higher ratio of extreme poverty incidences compared to their northern counterparts, except for Khyber Pakhtunkhwa province, where severe poverty is equally high in both sub-regions (Naveed and Ali, 2012). This high prevalence of poverty coupled with the lack of and access to resources.

2.3 Study area

Climate change is affecting every sector of life including agriculture both globally and in Pakistan. Like other parts of the world, both large and small-scale farmers in Pakistan are already feeling the severe effects of a changing climate. But, small scale farmers are comparatively more vulnerable to those effects because of their weak capability, management practices and marginalized socio-economic conditions. They need urgent assistance aiming at building resilience, and at undertaking climate change adaptation and/or mitigation efforts as a matter of survival to maintain livelihoods. IN this regard, rural response to the negative impacts of climate change in Khyber Pakhtunkhwa is important for better preparing for it and to understanding effects of climate change, identify and evaluate options to respond to these effects.

To assess how communities are vulnerable and choose certain techniques for adaptation to minimize negative impacts of climate change, a comprehensive case study approach was chosen. Khyber Pakhtunkhwa province of Pakistan was selected as a study region because it had previously been identified as vulnerable to climate change (Ullah *et al.,* 2015; Rasul *et al.*, 2012; Khan and Salman, 2012; Malik, 2012); its importance for the country's economy especially in terms of its agriculture share of total GDP (gross domestic product), employment and provision of livelihood (Khan, 2012; Khan, 1994).

(Khan, 2013; Khan *et al.,* 2013; Sahibzada *et al.,* 2012; Yousaf and Naveed, 2013; Saifurrehman and Shaukat, 2010).

The province of Khyber Pakhtunkhwa is situated between 31°15’ and 36° 57’ North latitude and 69° 5’ and 74° 7’ East longitude. The maximum length of the province between the parallels is 408 miles and the maximum breadth between the meridians is 279 miles (Government of Pakistan, 1991). The province has three main geographical divisions: (i) the Cis-Indus division of Hazara, (ii) the comparatively narrow strip between the Indus and the hills, constituting the settled divisions of Peshawar, Charsadda, Mardan, Kohat, Bannu and Dera Ismail Khan, (iii) and the rugged mountainous region located between these divisions and the border with Afghanistan (Durand line) known as the tribal belt (Baha, 1978, p. 21). There are 25 districts in Khyber Pakhtunkhwa, bordered by seven agencies and five Frontier regions.

Khyber Pakhtunkhwa and FATA constitute 16 percent of the population of Pakistan. Total reported agricultural land in the province is 13.89 million acres. Of this 22.23 percent is forested and 23.90 percent is under crop cultivation in addition to 22.49 percent cultivable land that is not utilized for want of water (Khan, 2012) The province and adjacent tribal areas have a unique distinction of highly diversified agriculture. The diversity of agriculture of this region is reflected in the map of agro-climatic zones of Pakistan prepared by Agricultural Research Council, where 6 out of 10 zones appear in the Frontier Province (Chaudhry, 2017).

The Kabul, Swat, Chitral, Kunhar, Bara, Kurram, Touchi, Baran, Harroah, and Siran are the main rivers flowing through the province. The Indus travels 200 miles in the province but little use of its water has been made agriculturally. Agriculture engages 48 percent of the total labor force and contributes 40 percent to the GDP of province (Nazir and Jalely, 1992, P. 4). Wheat, sugarcane, and maize are the dominant food crops of the province. Khyber Pakhtunkhwa produces 8 percent and 60 percent of the wheat and maize grown in Pakistan. Crop yield per acre of food grain is far below achievable potential levels. Sugarcane and sugar beet are major cash crops. About 15 per cent of the total sugarcane of Pakistan is produced in Khyber Pakhtunkhwa, in addition to sugar beet production in Mardan and Charsadda. Sugar beet is a very efficient sugar crop and produces more sugar than sugarcane.

The present yield in province is only 23 percent of its potential due to several constraints faced by the farmers (Khan, 1994: p. 38). Climatic conditions and soil of the province are quite conducive to produce fruits and vegetables. About 30 varieties of fruits are produced in Khyber Pakhtunkhwa and orchards spread over 74,130 acres (Government of Khyber Pakhtunkhwa, 1996: 100). Other crops also grow well but due to many constraints including lack of human resources, awareness, access to good agricultural inputs, changing weather patterns, hinders the overall agricultural yield.

In total 24 districts were affected by the country wide flood of 2010 in Khyber Pakhtunkhwa which shifted decision makers mind-set form being active during the rehabilitation and relief stage to the preparedness for such events. In Khyber Pakhtunkhwa, Charsadda district was chosen as a study site due to its high exposure to natural disasters and dependency on farming both for commercial and subsistence purposes. Charsadda is 17 miles from Peshawar located in the west of the Khyber Pakhtunkhwa and is bounded by Malakand district on the north. Mardan district on the east, Nowshera and Peshawar districts on the south and the Mohmand Agency of the Federally Administered Tribal Areas on the west. This district has one of the most fertile lands in Khyber Pakhtunkhwa. The total area of the district is about 996 square kilometers. Total cultivated area is 61 percent, irrigated area is 180,339 acres, i.e. 86 percent of the total cultivated area. There are three rivers flowing in Charsadda: The River Jindi, the Kabul River, and the Swat River; these are the main sources of irrigation for Charsadda.

Kabul is called Doaaba and has an immense importance in the district. The district is administratively subdivided into two Tehsils which contained a total of 46 Union Council. The land of Charsadda is very fertile and beautiful. There are three rivers flowing in Charsadda: The River Jindi, the Kabul River, and the Swat River; these are the main source of irrigation for Charsadda. The three rivers then merge and join the Indus River. The main crops of Charsadda are; tobacco, sugarcane, sugar beet, wheat and maize. Vegetables include potato, tomato, cabbage, brinjal, okra and spinach. Among orchards; apricot, citrus, plum, strawberry and pears are famous. strawberry, sugarcane and tobacco are cultivated vary abundantly in this aria. About 86 percent of the district is irrigated mostly through canals and the rest is dependent on tube well and other sources. In the canal irrigated area where soil is loamy, deep plaguing and regular maturing is carried out and cash crops are widely grown. The land of Charsadda is known to be the most fertile land of Khyber Pakhtunkhwa province and the most commonly grown crops are wheat, maize, and rice and sugarcane.

The Province has a wide range of physical and climatic conditions. Though situated in a temperate zone, the climate of the province varies immensely from region to region. The average annual rainfall varies from 25 to 58 inches (Khan, 2012). Khyber Pakhtunkhwa province is a mountainous region intermixed with the fertile valleys of Charsadda, Peshawar, Mardan and Swabi in the center and the dry plains in the south.

There are many works by eminent social scientists on every aspect of agriculture of Pakistan. Most agricultural economists have interpreted data from Punjab and Sind in their works like Abid *et al.* (2016). Khan (1994) argues that in the case of Khyber Pakhtunkhwa province, research gaps in the field of agriculture are huge and needs thorough analysis and strong commitment at least for two prominent reasons. Firstly, the agricultural problems in Khyber Pakhtunkhwa are in many ways more complex and intractable, and secondly there is the problem of grossly inadequate information and data on these problems (Khan, 1994). However, recently many agriculture and environmental scientist in the country are keen to understand agricultural system at all levels and making all possible efforts to help farmers improve their farm conditions. At national and provincial levels of the government, efforts have been made since then with an aim to improve farming. However, still, there is a lot to be achieved especially in the field of how to adapt farming at village level to the climate change and its variations in the province and in the country overall. This study is such an attempt to address this issue to farm level adaptation to climate change in the Charsadda district of Khyber Pakhtunkhwa.

For the purpose of this research, I selected Union Council[1] Agra because it has been severely damaged by natural disasters in the past and majority of the people depend

[1] Union council refers to the combination of villages (in most cases, a sum of 4 to 8 villages depending on the locality, but there is no restriction for number of villages to be included in it). The term is used mostly in South Asian Context.

on agriculture for their livelihood. Union Council Agra (UC-Agra) is bounded by two main rivers - Kabul and Swat. Agra can be accessed by main Motorway from Peshawar to Islamabad on its east and Grand Trunk Road (GT-road) by its northwest side. Besides those two main roads, there three other local roads (Agra Payan, Gul Abad and Jamat and Shabara village roads) along the two aforementioned rivers are the means of for accessibility to other surrounding areas. These roads play vital role in flooding season for locals to migrate. provides access to the villages and Agra. The total length of these roads is 76 km. Majority of locals use motorcycles, buses, and cycles as means of transportation. Most of the villagers use Grand Trunk (GT)-road for travelling to Charsadda and Peshawar city. Doaba (land between two rivers) is a famous tourist spot and is a source of livelihood for many villagers. Fishing huts in Sardaryab is also famous recreational area for locals as well as people from surrounding places. There are three main bridges on the Kabul and Swat rivers near Agra. Monsoon rainfall are usually severe in this region and these bridges play vital role in rainy season. Villagers believe that these bridges are steep and need to be rebuild high enough to allow passage for greater amount of water during heavy rainfall season. After the construction of Peshawar – Islamabad motorway, bridges build on it hindered the flow of water causing inundation and delayed evacuation of the flood water, particularly in the year 2010. The motorway had given relief cuts to drain out rain water from UC Agra in flood 2010, however, they are small and flood water are more in quantity. The culverts made cannot provide enough passage for all water to flow through it before it can accumulate in huge quantities, which is exactly what happened in the country wide flood in the year 2010. All flood water was inundated due to the high boundary walls of motorway. The flood water reached villages nearby, destroying all standing crops, livestock’s, and killed few locals. In the figure 2-1, I tend to show the study villages (Gulabad and Shabara), located in Charsadda district of Khyber Pakhtunkhwa of Pakistan, where this study was performed.

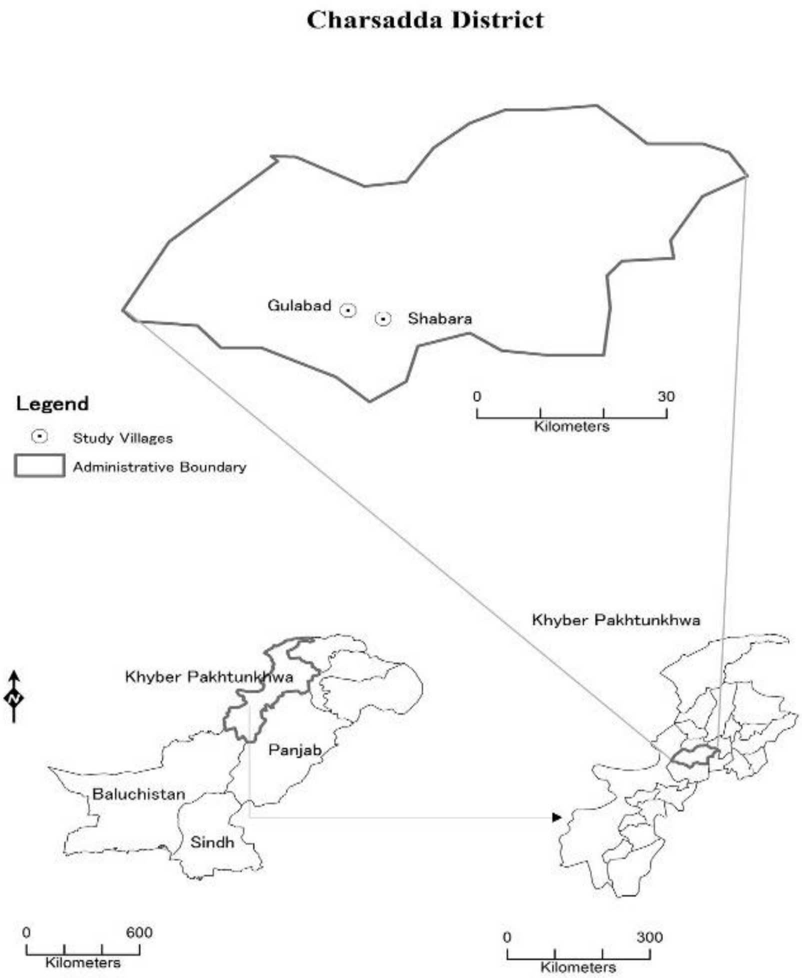

Figure 2-1: Map of the research area

Source: Author’s own illustration, 2016.

2.3.1 Geology

The soil of Kabul River in the study area is calcareous whereas non- calcareous in River Swat. The soil developed from river Swat alluvium occupies the level position and are deep, silt loam to silty clay loam, well drained with olive dark greyish brown color. The soil developed from Kabul river alluvium occupies nearly leveled position and are very deep, well drained, silt loam with olive grey color.

Swat and Kabul Rivers mainly act as drainage outlets for the area. It is one of the highly flood prone union council in the district. The Kabul River emerges from the western mountains and upon entering the study area divides into three creaks of braided channels called Shah Alam, Naguman and Sardaryab due to decrease in gradient. The river Swat enters Charsadda District at Abazai and flows from north to south and meets Kabul river near Charsadda. Another small river called Jindi emerges from the northern mountains of the province and flows towards south, meets Kabul river near Prang village of Charsadda.

Although the main discharge of Kabul river is in Afghanistan, however, its flow also depends on the melting of snow in present in the northern areas of Pakistan. Thus, this flow is seasonal, increasing in spring season because of snow melt. Both these rivers (Swat and Kabul rivers) start rising in the late February, reaching the highest discharge level in June and July when the summer is its peak and the flow is supplemented by heavy Monsoon rainfalls. Afterwards, decline in flow discharge continues till the end of October to January, interrupted by occasional floods due to the irregular rains.

2.3.2 Climate

The climate of union council Agra and surrounding areas is extremely hot during summer and slightly clod during winter. It varies from semi-arid to sub-humid, continental and sub-tropical. The summer season persist from May to September. June and July are extremely hot and dry when the temperature rises to 42 ^{0}C. Monsoon season is spread over July through September. The month of July and August are hot and humid. The rainfall occurs due to monsoon as well as western disturbances. The average rainfall varies from 300mm in the southwest to about 625mm in the northeast. Based on climatic data, semi-arid zone has the maximum rainfall in winter while sub-humid zone in monsoon rainfall in summer.

2.3.3 Demography

The Union Council is spread over about 43.6 km^2 with a population of about 27,200 residing in 3,375 houses. The average household size is about 8 persons per household. The population density is about 620 individuals per km^2. Male population accounts for about 51.1 percent while 49.1 percent are female. Literacy rate among male is 46.9 percent while only 14.1 percent female are literate. The main source of income is farming and is supplemented with farm and farm labor, services and employment.

Table 2-1: Demography of union council Agra with different age groups

Name of village	No. of households	Population statistics (Age structure)					Total
		Male above 18 (years)	Female above 18 (years)	Boys under 18 (years)	Girls under 18 (years)	Children under 10 (years)	
Afsar Abad	40	67	73	36	34	70	280
Agra Bala	150	251	272	135	129	263	1,050
Agra Miana	210	351	381	189	181	368	1,470
Agra Payan	447	661	718	357	341	693	2,770
Awan Abad	200	234	363	180	172	350	1,400
Chargori	100	167	181	90	86	175	700
Dogar Korona	20	33	36	18	17	35	140
Gedarh Kaley	410	685	744	370	353	718	2,870
Gulabad	300	501	544	271	259	525	2,100
Gulshan Abad	100	167	181	90	86	175	700
Kodi Agra	250	418	453	226	216	438	1,750
Manzorai	100	167	181	90	86	175	700
Qudrat Abad	200	334	363	180	172	350	1,400
Sardaryab Korona	120	200	218	108	103	210	840
School Korona	55	92	100	50	47	96	385
Shabara	415	693	753	180	172	350	2,905
Skeikh Kaley	420	702	762	379	362	735	2,940
Vano Ghari	100	167	181	90	86	175	700
Walayat Abad	50	84	91	45	43	88	350
Zangal Korona	20	33	36	18	17	35	140

Source: By author using data from District Census Report, 1998, District Charsadda, 2014.

In the study village (Gulabad and Shabara), 300 and 415 household reside respectively. The total population of both Gulabad is approximately 2100 individuals whereas in Shabara, slightly less than 3000 people live (Table 2-1). The detailed description of the selected sample procedure is explained below in data collection techniques.

2.4 Data collection techniques

Field surveys for collecting all necessary data were organized in September-October 2016 and December-January 2017. In the first phase of the survey, study sites, potential respondents for household surveys, discussion, and interviews were identified with the help of expert from department of environmental sciences, university of Peshawar and locals who carried extensive knowledge of the area. Questionnaires were pre-tested with the students from university of Peshawar before arriving in the field. All necessary amendments were then made accordingly. For example, one of the main questions asked about adaptation to climate change. However, a proper word for adaptation in the local language i.e. Pushto was advised to be included in the questionnaire so that the farmers clearly understand the question and respond properly.

Respondent selection is a sensitive and most important part of the research involving surveys. Choosing wrong respondents, or inappropriate ones can lead to collecting data that is not helpful for finding questions that a researcher wants to explore. Hence, I clearly understood the importance of choosing right respondents. For that purpose, I arranged community meeting with knowledgeable people like teachers, experienced farmers, elected representatives, and clearly explained study objectives i.e. an area exposed to natural disasters, past evidence of damages from disasters, perform farming, access to road, proximity to river, irrigation facility etc. During these discussions, we identify several villages that can potentially be included in the survey. However, due to time and budgetary constraints, I selected two villages with contrasting farming methods. Gulabad with good access to irrigation from river water and Shabara with no access to irrigation at all, but both villages have faced natural disasters. In the later stage, from a list of households, respondents were randomly selected through lottery system. Upon arrival to the respondent's house, if he *(a farmer)* refused to be interviewed, then I had a plan to redraw sample from the households not selected in the first phase of respondent's selection, but, in the field, there were no respondents who refused to be part of the survey, or interview.

Regarding sample selection, In Gulabad, out of 300 household, 45 respondents were randomly selected through lottery system from a list of households provided during community meeting. The process of sample selection was performed in front of villagers, so that they do not think we choose households based on researcher's desire, instead it was a systematic process. This method of sample selection is widely used across all researches involving data collection through field surveys. Shabara is slightly bigger village, number of households are also more than Gulabad. Hence, I choose larger sample from this village to be representative i.e. 71 respondents out of 415 households living in the village.

Regarding tools used for data gathering, three different techniques were utilized to collect primary data *(Appendix A)* i.e. household level surveys, focus group discussion and key informant interviews. Questions asked in the surveys, interviews can be open ended, closed ended, structure or semi structured. I used a mix of all types to be flexible in getting responses and it also depended on the specific requirement and importance of the information needed. For instance, questions like "do you know what climate change is?" was left open ended to fully understand how local farmers perceive changes in climate and then how do they differentiate climate with weather. The purpose of each method used for data collection is described below in detail.

The objective of the household questionnaires was to understand how individual households experienced climate change and to be able to make a quantitative assessment of their views. These questionnaires ideally targeted household heads who were also household decision makers on livelihoods. However, in cases of unavailability, other adult members of the household were interviewed. The focus of household level surveys was on collecting demographic, socio-economic status, household's assists, agricultural practices, pre-and post-harvest methods, storage techniques, tends in agriculture, provision of agricultural inputs, provision of irrigation facilities and monthly/annual average yield from each parcel of land. The study is also aimed to explore on site specific climatic events occurred in the past, climatic factors that affect agricultural production and farmer's adaptation strategies towards those climatic events were also part of the study.

Focused group discussion was aimed to generate data involving participants to debate, discuss, talk or comment on each other's experiences about a common issue. In general, these discussions are to be held at participant's convenience because it usually takes longer than household surveys. I served cold drinks to the participants whereas they offered hot tea during discussion. This discussion involved old and young, educated and illiterate participants to capture different perceptions. Moreover, focus group discussion was aimed to bring together various stakeholders having different perception of climate change and how it affected their livelihoods, within the villages. Participants of the focus group discussion were village councilors, village heads and local farmers and other traditional and spiritual or religious leaders. Discussion was attended by around 5-10 people ensuring representation of different stakeholders of the area affected by climate change or having valuable knowledge about it. Focused group discussion explored seasonal agricultural activities in the study area, and time when locals face disasters. Seasonal calendar was developed to gain an understanding of livelihood activities, the seasonality of the activities, workload variation (i.e. the busiest and less busy months/seasons) sugarcane production process, selling process, time for high and low demand for labor throughout the year, and the division of labour between women and men in the village. Initially, I planned to do separate discussion with male and females, but it was not possible because of the cultural and religious reasons i.e. men cannot interview women. Specific questions were asked on notable signs of climate change in local communities focusing on precipitation, temperature trends, performance of crops. Questions exploring how livelihoods had been impacted and how communities are adapting to climate change as they experienced it, were also mainstreamed.

In-depth interviews were held with relevant stakeholders such village head, school teachers, and other experienced farmers having knowledge on farming, changing climatic conditions, observed damages from climate induced natural disasters. These interviews were semi0structured and open ended through purposive sampling. The interviews were arranged with experts like community leaders, village head, secretary, religious leaders, experienced and young professional farmers, elected kisan councilor[2] and other specialized knowledgeable person to explore in-depth knowledge on history of farming, trends in agricultural practices, impacts of climatic changes on crops in the past and perceptions about those impacts, future of farming etc. Interviews with Government administrators at provincial level from relevant departments such as Center for Disaster Preparedness and Management, University of Peshawar, and Environmental Protection Agency, Peshawar were held to understand their perceptions about the climate change phenomenon in the area from their specialist perspectives and what has been done to sort out climate challenge.

Besides that, the study also employed observation as a data collection tool. This is an important way of gathering data that usually researchers cannot get through their questionnaires as it is not possible to include everything in questionnaire. Using this approach, the researchers systematically observed the state of the ecological system pertaining to the agricultural lands, crops and water sources amongst other things. Photographs were taken as part of the observation process and are shown in Appendix D. Lastly, secondary data on agriculture and climate of the study area was cited from research articles, dissertations, useful reports related to the subject from provincial and federal organizations such as Pakistan Meteorological Services Department, National and provincial disaster management authorities, agricultural extension offices, irrigation department were also part of the study. Such reports helped in providing secondary data for start of the art review of the already published work in the field of rural farming and climate change vulnerability and adaptation. Past climate trends were observed and included in the study using such previously published reports.

2.5 Data analysis

Experts suggest that during the field work, data collection and data analysis should go side by side if it is possible (Charmaz, 2002; p. 510), otherwise, the researcher might lose valuable information. In my case, I was permitted a brief time for field work

[2]Kisan is an Urdu word, stands for farmer while councilor is the designation he/she occupies. Kisan Councilor is democratically elected through voting for the term of 5 years.

(almost 50 days) by the university and had to achieve my targets in terms of number of respondents, interviews, discussion with focused groups. Hence, I did not solely perform all data cleaning and analysis in the field. However, I was able to handle data by identifying missing data, make list of those data so that I can reach them in the second phase of data collection. Moreover, some other data cleaning was also done in the field with the help of enumerators. In almost all key informant interviews and focused group discussion, I audiotaped all discussions and later transcribed after my return to the university. However, in most cases, I also took notes of all the important and interesting facts participants and respondents would share with me. After cleaning all data, I continued to review, analyze it, and be able to identify cross-cutting themes originating from the data for future research article writings.

As explained earlier, I was lucky by sharing language and other traditions with the people living in the study site, but this could lead into researcher bias in collecting valuable information as explained by Kanuha (2000). I was aware that it is not easy to remove my own observation, comparison and thinking from the original data and there might be some level of biasness but reducing and/or minimizing it to the least possible level was my aim. Moreover, field recording, photographs, and other random personal notes and observations helped in dealing with such biasness. Using three methods of data collection is another way of dealing with researcher bias. For instance, if during household surveys researcher exaggerates, or adds some personal thinking to the actual response of the respondent, but the same set of information comes from key informant interview or focused group discussion potentially can help in removing bias. Hence, using triangulation technique for data collection, helps in verifying information gathered from one source to another.

I was in contact with the experts of climate change, disaster risk reduction of university of Peshawar prior to visiting field. They helped me in selecting research site, reaching the study area and arranged meetings with the government organization as well as villagers where I explained to them about my research objective. I was happy to see that people supported me fully. Although this research was conducted after 6 years of the country wide flood, but people still remember what happened to them and their lands during the flooding time and, how that incident made them aware about what sort of damages flood can bring. Villagers believed that they must be well prepared if it happens again. Villagers clearly explained how vulnerable they were and how they have tried to minimize their exposure on their own but were disappointed with the support given from the government agencies. All these responses were carefully analyzed and are presented in Chapter Five and Six of this dissertation.

2.6 Conclusion

This chapter explained the process of case study selection. Charsadda district was selected after consultation with the department of environmental sciences, university of Peshawar, center for disaster management and planning, university of Peshawar based on the criteria of whether this area is facing from climate change natural disasters lime floods and droughts or not? Further consultation was done with the local knowledgeable people like school teachers, old inhabitants of the area, people's representatives, etc. to identify the specific sites for study. My objective was to reach farmers in the area, hence, I further choose two different villages (Gulabad and Shabara) where majority of the people were involved in farming. Farmers in these two villages grow similar crops, mostly wheat and sugarcane but they have different access to irrigation facilities where farmers in Gulabad have relatively easy access to river water for irrigation while farmers in Shabara mostly rely on tube wells or perform rain-fed farming.

I recruited two enumerators, master students of department of environmental sciences in university of Peshawar to help me in data collection. The enumerators well understood the topic of my study and were familiar with the study area as Charsadda is relatively close to Peshawar and they visit it occasionally. During all our visits to the study location, we found people very hospitable, treated us as guests. Since, we all shared same language, it was easier to mingle and talk, and understand local traditions. Being native and having prior knowledge of the area was our strength. This made our respondents less hesitant and openly assisted us during the survey, even if in some cases it took more than an hour. Women were not part of this study partly because they do not participate in farming activities and because all our research team members were male and due to local Pashtun customs, men are not allowed to mingle with females.

It is important to mention that in 2010 flood of Pakistan; this area was one of the hard-hit locations. Afterword's, many non-governmental organizations, aid agencies helped people with both cash and no-cash aid. In the beginning, the local people conceived us as either government employees or someone form non-governmental organizations and we would again provide material benefit to individuals or to the whole village. However, I explained to them the purpose of our visit and how I will use collected data later i.e. only for educational purpose.

After the survey, I brought all collected data to Japan for cleaning and analysis purpose. Data analysis was performed through line by line coding, comparison, and category development of the themes required to answer research questions. All missing data were re-collected in second field work, however all replies given to please research team were discarded. Besides household surveys, key informant interviews and focused group discussion were also conducted to collected required data as presented in Chapters Five and Six.

3 CHAPTER 3: CLIMATE CHANGE TRENDS AND ASSOCIATED DAMAGES IN PAKISTAN

3.1 Summary

The primary objective of this chapter is to examine the changes that have occurred in Pakistan's climate. This begins with the examination of observed past, current and future climate changes, regional changes in winter, summer and annual mean temperature, precipitation changes in Pakistan. The chapter then explains climate change impacts on various sectors such as livestock, forestry, water and agriculture (analysis of wheat yield in different agro-climatic zones of Pakistan), followed by an analysis of the future projection of changes in rice and maize. Next, the chapter outlines different most vulnerable areas for specific type of disasters (floods, droughts, cyclones, storms, landslides, etc.) in Pakistan by providing maps. These maps are borrowed from literature published by Pakistan scientists and institutions like Pakistan Metrology Department, National Disaster Management Authority etc. Data for historical record of natural disasters in Pakistan since last 30 years is taken from Emergency Disaster Database, Center for Research on Epidemiology of Disasters. Vulnerability is a demanding concept to understand, as it may be defined differently by different people. However, it is commonly agreed that the poorest of population including women, people with disabilities, children etc. are more exposed to climate change vulnerabilities than others. Hence, in this chapter, vulnerabilities among the poorest segment of the population is described in detail with emphasis on identifying the poorest people and mapping those areas so that the government can build capacity of locals living in most exposed areas. Moreover, consequences for human lives, livelihoods, and infrastructures and how the country has demonstrated its commitment to tackling the issue of climate change and reducing its damages from a governance perspective is also highlighted in the chapter.

3.2 Introduction

On an international level, Pakistan faces some of the most pressing challenges regarding climate change. A concerted effort is required on the part of the government and civil society at all levels to mitigate these threats. In the last 50 years, the annual mean temperature in Pakistan has increased by approximately 0.5°C. The number of heatwave days, per year, has increased almost fivefold in the last 30 years. Annual precipitation has historically exhibited high variability but has shown slight increases over the past 50 years. Sea levels along the Karachi coast have also risen by approximately 10 cm in the last century.

By the end of this century, the annual mean temperature in Pakistan is expected to have risen by 3–5 °C as a result of central global emissions, although higher global emissions may yield a rise of 4–6 °C. Average annual rainfall is not expected to show significant long-term trends but is expected to exhibit significant inter-annual variability. The sea level is expected to have risen by a further 60 cm by the end of the century, and this effect is likely to be most apparent in the low-lying coastal areas south of Karachi toward Keti Bander and the Indus River Delta.

Under future climate change scenarios, Pakistan is expected to experience increased variability of river flows due to increased variability in precipitation and the melting of glaciers. Demand for irrigation water may increase due to higher evaporation rates. Yields of wheat and basmati rice are expected to decline and may drive production northward, subject to water availability, which in turn may lead to a decline in water availability for hydropower generation. Hotter temperatures are likely to drive increases in energy demand due to greater air conditioning requirements, while warmer air and water temperatures may negatively affect the efficiency of nuclear and thermal power plant generation. Mortality rates due to extreme heatwaves may also increase. Urban drainage systems are likely to be further stressed by high rainfall and flash floods, while rising sea levels and storm surges may adversely affect coastal infrastructure and livelihoods.

Measures aimed at adapting to these impacts may include the development or use of crop varieties that have superior heat and drought tolerance, modernization of irrigation infrastructure and water-saving technologies, integration of watershed management, reforestation of catchment areas, and construction of additional water storage facilities, diversification of the energy mixture including investment in renewable and small hydropower projects, improved weather forecasting and warning systems, retrofitting of critical energy infrastructure, and the construction of dikes or sea walls.

The National Climate Change Policy of 2012 is Pakistan's guiding document on climate change, setting out the goal of achieving climate-resilient development for the country, by mainstreaming climate change in the economically and socially vulnerable sectors of the country (Javed, 2016; Khan and Munawar, 2011). Approximately 6 percent of Pakistan's federal budget between 2010 and 2014 comprised climate change-related expenditures, predominantly in the energy and transport spheres (MoE, 2009). As described in its nationally determined contribution under the Paris Agreement of the UNFCCC, Pakistan intends to reduce up to 20 percent of its 2030 projected GHG emissions, subject to the availability of international grants to meet the cumulative abatement costs, which are expected to amount to approximately US$ 40 billion (Lohani, 2009). The country's adaptation needs have been identified as ranging between US$ 7 and 14 billion per year.

Temperature and precipitation are the most frequently used indicators in verifying whether the climate in a given country is shifting (Deressa *et al.,* 2009). In Pakistan, as in many other countries worldwide, the devastating effects of climate change have manifested in the form of disasters, including heatwaves, floods, and droughts (Mirza, 2003). The figures presented below clearly illustrate that these disasters have increasingly occurred over a span of 50 years.

3.3 Observed past climate trends

3.3.1 Past changes in the temperature over Pakistan

Pakistan Meteorological Department (PMD) data obtained from Chaudhry *et al*. (2009) showed a significant warming trend of around 0.57 °C in the annual mean temperature from 1901 to 2000. Ahmed and Supachalasai (2014) further explained that, compared to the warming trend in the previous century (i.e., 0.75 °C), this increase was less than that of the mean annual temperature in the South Asia region. Chaudhry *et al.* (2009) further explains that more accelerated trend with a rise of 0.47 °C, was observed from 1961 to 2007 in Pakistan, where 2004 was recorded as the warmest year in the first decade of this century, and the highest increase was observed during winter, when the temperature ranged from 0.52 °C to 1.12 °C (Figure 3-1). This argument agrees with the reported rate of warming throughout the South Asia region during 1998–2007, which was attributed to increases in winter temperatures and post-monsoon changes. In Pakistan, the highest observed increase in winter temperature was in Baluchistan Province, while the northwestern region showed negative temperature trends in summer. The annual temperatures in Pakistan increased by 0.87 °C (maximum) and 0.48 °C (minimum) from 1960 to 2007, as observed by Chaudhry *et al.* (2009).

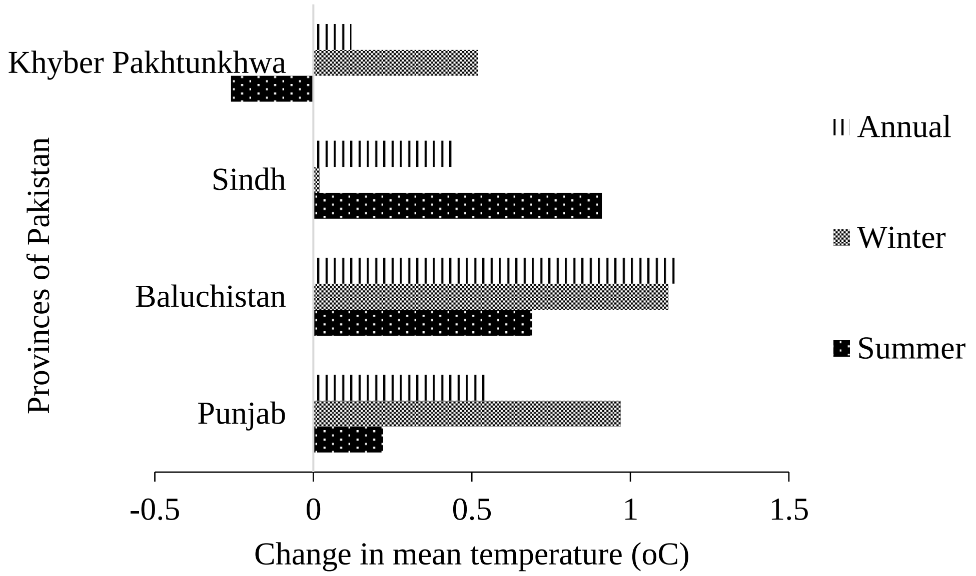

Figure 3-1: Regional changes in winter, summer, and annual mean temperature from 1960 to 2007

Source: Made by author using data from Chaudhry *et al.*, 2009.

Based on data taken from PMD stations for the years 1951 to 2000, a rising tendency was evident in the annual mean surface temperature countrywide (Anjum *et al.*, 2005). In the hyper-arid plains, arid coastal areas, and mountainous regions of Pakistan, an increase of 0.6–1.0 °C was observed in the mean temperature, while an increase of 0.5–0.7 percent was noted in solar radiation over the southern half of the country. In central Pakistan, cloud cover decreased by 3–5 percent, with a consequent temperature increase of 0.9 °C. The northern parts of the country, outside the monsoon region, were affected by increases in aridity during the study period.

The continuous and long-term data, pertaining to various meteorological parameters, from 56 selected meteorological stations attested the behavior of the highest and lowest temperatures in summer and winter over the last decade. Figure 3-2 shows a series of area-weighted mean annual temperatures for the years 1961 to 2013, following the application of a uniform weighting factor, based on the regional surface feature characteristics for all of Pakistan's climatic zones.

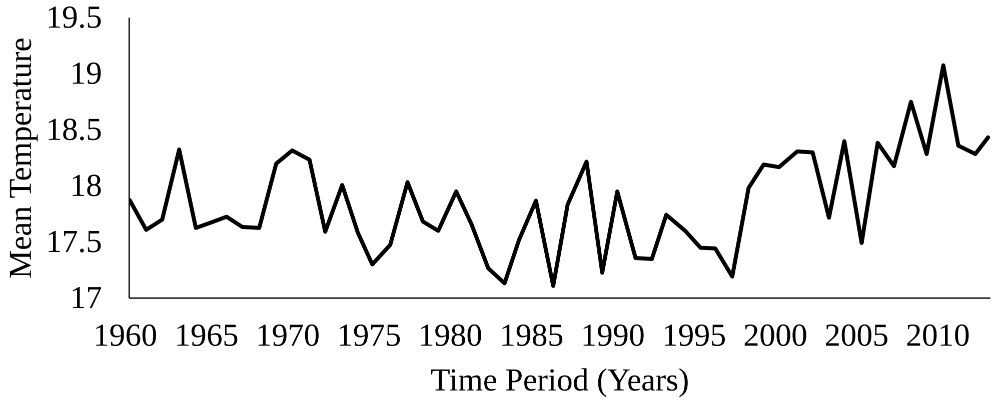

Figure 3-2: Time series of average area-weighted mean daily temperatures during each year from 1990 to 2013.

Source: Made by author using data from Rasul *et al.*, 2012b.

The warming trend during winter was considered to be more significant than that in summer. This indicates that winter has become shorter at both ends and that summer has become longer. A particularly conspicuous rapid change was the increase in nighttime temperatures, which was considerably higher than daytime increases. This change was associated with adverse impacts on animals and agricultural productivity caused by heat stress, increased water requirements, and higher respiration rates. In the last decade, a mixed trend in maximum temperatures was observed during the summer months. However, the minimum summer temperature in central parts of Pakistan exhibited a pronounced warming trend, while in the extreme north and south, a slight cooling trend was evident in some climatic zones. However, the coastal belt and Indus River Delta did not exhibit significant warming or cooling trends.

3.3.2 Regional changes in the past mean temperature in Pakistan

Annual and seasonal trends in the mean annual temperature for Pakistan's various climatic zones are listed in Table 3-1. It is worth noting that (i) the mean annual temperature has been increasing in most of the country, with only the Sub-mountain and Western Highlands and Lower Indus Plains exhibiting a decreasing trend; (ii) all zones have shown rising trends for the pre-monsoon summer months (April–May); (iii) all zones, except Zone V (Baluchistan Plateau, an arid to hyper-arid region), have shown decreasing trends for the monsoon period; (iv) the Greater Himalayan region has shown an increasing trend from December to May; and (v) the Baluchistan Plateau (Zone V) has grown warmer in all seasons (Global Change Impact Studies Centre, 2005).

Table 3-1: Mean temperatures trends in Pakistan, 1951–2000

Climatic regions	Mean temperature trends (°C/year)				
	Annual	Jun–Sep	Dec–Mar	Apr–May	Oct–Nov
I (a): Greater Himalayas	0.04	-0.80	0.32	1.09	-0.06
I (b): Sub-mountain	-0.19	-0.57	0.00	0.13	0.12
II: Western highlands	-0.72	-1.48	-0.65	0.17	-0.47
III: Central and Southern Punjab	0.11	-0.25	0.03	0.83	0.31
IV: Lower Indus Plains	-0.08	-0.55	-0.07	0.35	0.15
V (a) Baluchistan Plateau (East)	0.11	0.46	0.63	0.79	0.50
V (b): Baluchistan Plateau (West)	1.17	1.3	0.43	2.17	1.80
VI: Coastal areas	0.00	-0.18	0.05	0.03	0.30

Source: By author using data from Rasul *et al.*, 2012.

3.3.3 Past changes in the mean precipitation over Pakistan

Between 1951 and 2000, a decrease of 10–15 percent was observed in winter and summer rainfall in arid plains and coastal areas, while a rise of 18–32 percent was observed in summer rainfall in Pakistan's core monsoon region. A decrease of 5 percent in relative humidity was noticed in the Baluchistan Province. Similarly, a decrease of 17–64 percent in rainfall was observed during several strong events attributed to El Niño in the last 100 years. Storms and cyclones originating in the Bay of Bengal and Arabian Sea increased in frequency during the last decade of the 20th century and have affected Pakistan, as well as other countries in the region.

Figure 3-3 was borrowed from Global Change Impact Studies Centre data prepared in 2005. The data used in this figure were obtained from 18 meteorological stations with available data from 1901 to 2007, and five stations that had available data from 1914 to 2007. A 10-year moving average showed that rainfall gradually decreased from 600 to 400 mm per year from the early 1900s to 1940. From 1901 to 2007, a 133 mm increase was observed, with a 61 mm increase in annual precipitation in Pakistan. Moreover, similar trends were observed in monsoon rains, which increased by 22.6 mm, while there was a 20.8 mm increase in winter precipitation (Figure 3-3).

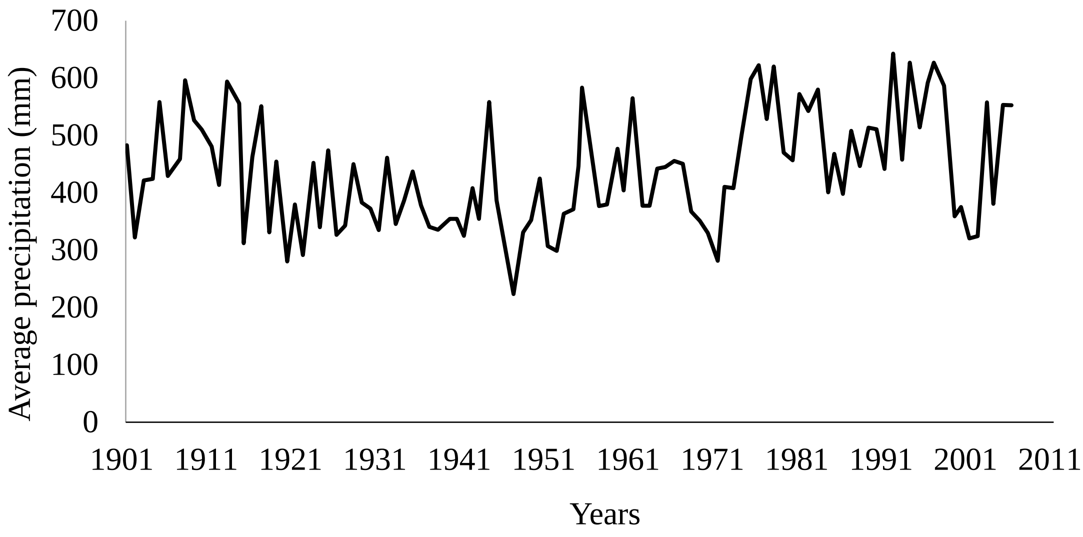

Figure 3-3: Time series annual average precipitation, 1991, 2007

Source: Made by author using data from Global Change Impact Studies Centre, 2005.

3.3.4 Regional changes in the past mean precipitation over Pakistan

A 2005 study by the Global Change Impact Studies Centre showed that annual precipitation in Pakistan has exhibited a general increasing trend (Table 3-2); however, this was not the case in the country's coastal areas. Monsoon precipitation showed the same trend, with the highest increase in the Greater Himalayas (i.e., the northern regions of Pakistan).

Table 3-2: Annual precipitation changes (percent) in Pakistan, 1951–2000

Climatic regions in Pakistan	Mean annual precipitation changes (percent)		
	Annual	June-September Monsoon	December-March Winter
I (a): Greater Himalayas	0.49	1.73	-0.04
I (b): Sub-mountain	0.3	0.38	0.53
II: Western highlands	-0.02	0.22	0.00
III: Central and Southern Punjab	0.63	0.57	0.99
IV: Lower Indus Plains	0.22	0.45	-0.27
V (a): Baluchistan Plateau (East)	1.19	1.16	1.14
V (b): Baluchistan Plateau (West)	0.1	-0.2	-0.4
VI: Coastal areas	-0.82	-1.34	0.00

Source: By author using data from Global Change Impact Studies Centre, 2005.

Winter rains exhibited a mixed pattern, with a decreasing trend in the Western Highlands and part of Baluchistan Province (the Sulaiman and Kirthar Ranges), while the

Greater Himalayas exhibited increasing precipitation during the monsoon period (June–September) and a slight decrease in precipitation during the winter months (December–March).

3.4 Future trends of temperature and precipitation in Pakistan

Using the General Circulation Model for future climate change projection, the Global Change Impact Study Centre (2007) modeled annual temperature and precipitation changes for the future (2020, 2050, and 2080) under two emissions scenarios (A2 and A1B). According to the model, by 2080, temperature increases in Pakistan are likely to reach 4.38°C. Regarding regional changes in annual temperatures, the study further highlighted several assumptions: (i) the temperature increases in both summer and winter were higher in northern than in southern Pakistan, and (ii) the temperature increases in both regions were higher in winter than in summer. Regarding precipitation change percentages, no notable change was projected. However, some increases in precipitation were predicted in summer, with a reduction in winter in southern Pakistan (Iqbal and Zahid, 2014).

Table 3-3: Regionwide climate projections for Pakistan for alternative scenarios, 2011–2050

Region of Pakistan	Precipitation (mm/decade)			Temperature (°C/decade)		
	A2	A1B	B1	A2	A1B	B1
Pakistan	+1.73	+1.26	-0.89	+0.51	+0.41	+0.24
Northern areas	+4.6	+2.9	-1.3	+0.76	+0.63	+0.39
Potohar and upper Khyber Pakhtunkhwa	+6.1	+3.8	-0.5	+0.01	-0.34	-0.01
Central/southern Punjab and lower Khyber Pakhtunkhwa	-2.98	-1.78	-3.5	+0.63	+0.71	+0.05
Upper Baluchistan	+1.48	+0.92	-0.57	+0.15	+0.26	+0.03
Southeastern Sindh	+5.1	+3.0	-0.1	0.00	-0.1	+0.01
Sindh and lower Baluchistan	-1.8	-0.098	-0.05	+0.5	+0.27	+0.01

mm = millimeter

Notes: A2 shows business as usual, A1B shows balanced scenarios, and B1 shows Ideal World (SRES Report IPCC 2001) based on greenhouse gas emissions likely in the 21st century.

Source: Made by author using data from Chaudhry *et al.*, 2009.

The PMD conducted another important study that computed temperature and precipitation changes for different regions of Pakistan from 2011 to 2050. The climate models showed a maximum rise in the northern regions of Pakistan, central and south Punjab, and the lower regions of Khyber Pakhtunkhwa Province. However, mixed precipitation trends were projected over various regions (Table 3-3).

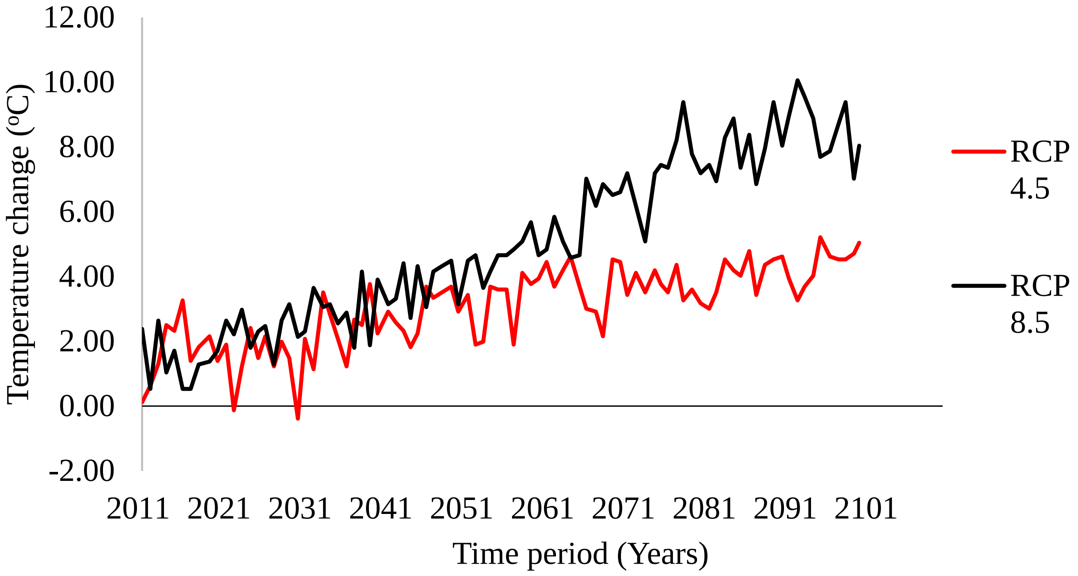

Figure 3-4: Pakistan's mean annual temperature and precipitation deviation projections during 21st century using two different emission scenarios

Source: Made by author using data from Pakistan Meteorological Department, 2015.

An important study projected an almost uniform variation in rainfall distribution over the entire Indus Basin region (Bhandari et al., 2014). At sub-regional levels in the Upper Indus Basin (UIB) and Lower Indus Basin (LIB), the models showed an increasing trend in rainfall over the UIB with a decrease in the LIB, with a slight change in the border zone between the two sub-regions. Winter precipitation was expected to decrease, particularly in the southern part of the basin, with greater warming occurring during winter than in other seasons. Similarly, the UIB was projected to become warmer than the LIB. The model simulations also suggested a rise in the total number of rainy days over the basin, but a decrease in the number of rainy days and an increase in rainfall intensity were projected in the border zone, where the maximum rainfall volume was modeled.

The PMD released a gridded downscaled temperature and precipitation time series (2010–2099) of climate change scenarios at a 10 km resolution, based on four general circulation models, using the World Climate Research Program-Coupled Model Inter-comparison Project Phase 5 (CMIP5). The result was high-resolution gridded projections of temperature and precipitation for the whole Indus River Basin. The downscaled results showed a 3–5 °C rise in mean temperature, under the Representative Concentration Pathways (RCP) 4.5 emission scenario. The mean trend in temperature under the RCP 8.5 indicated a 4–6 °C rise by the end of this century, with a sharp increase after 2050. Rainfall was highly variable in both spatial and temporal domains, and the area of average rainfall over Pakistan exhibited significant inter-annual variability. Sharp rising peaks offered some indication of extreme precipitation events, while negative peaks indicated droughts (Figure 3-4).

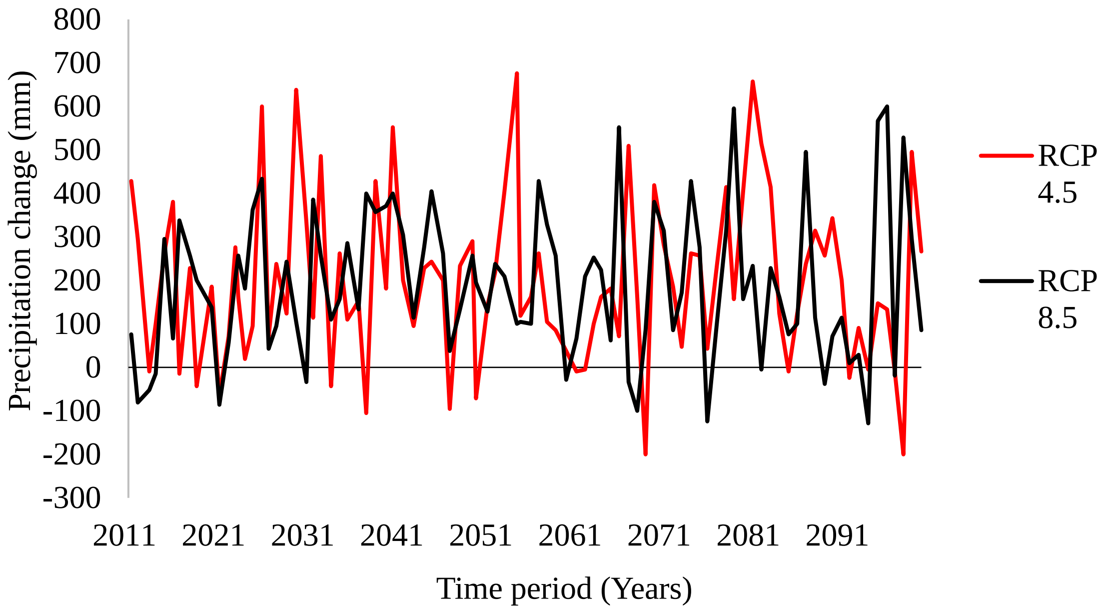

Figure 3-5: Pakistan's mean annual temperature and precipitation deviation projections during 21st century using two different emission scenarios

Source: By author using data from Pakistan Meteorological Department, 2015.

Note: RCP4.5 and RCP8.5 = Representative concentration pathways are emissions IPCC AR5 scenarios where greenhouse gases stabilize by year 2100. In RPC8.5 radioactive forcing does not peak by year 2100.

Figure 3-5 above shows the CMIP5 multimodal mean projections of annual average temperature and precipitation changes for 2046–2065 and 2081–2100, under RCP 4.5 and 8.5, relative to 1986–2005. According to the model, spatial patterns of temperature and precipitation exhibited similar behavior. Pakistan's snow-covered areas in the north showed a larger increase in mean temperature, compared to the central and southern regions, under both RCP scenarios. However, RCP 8.5 showed a more abrupt increase in temperature in the region after 2060, up to 10–12 °C, particularly in northern Pakistan, while RCP 4.5 showed a similar but less intense increasing trend (i.e., 5–6 °C).

3.5 Climate change impacts on various sectors

All sectors of life are individually vulnerable to the vagaries of climate change depending on how reliable it is on the weather and climate. For instance, agriculture is the most vulnerable among all. In the section below, I will discuss in detail how each sector in Pakistan is affected by climate change, with a specific focus on agriculture.

3.5.1 Agriculture sector

Agriculture is a key economic sector that contributes 21 percent of the GDP, employs 43 percent of the total workforce, and accounts for around 60 percent of Pakistan's exports (Government of Pakistan, 2015). The total arable area comprises 23.4 million hectares (Mha), 29 percent of the total reported area, of which irrigated areas make up 18.63Mha (i.e., 24percent of the total area) [(Government of Pakistan, 2015)]. Provincially, Punjab, Sindh, Khyber Pakhtunkhwa, and Baluchistan account for 77 percent, 14 percent, 5 percent, and 4 percent of agricultural land, respectively (Government of Pakistan, Bureau of Statistics, 2011). Currently, 3.8Mha is under Sailaba/Rod-Kohi, riverine, and Barani farming systems, commonly called the spate irrigation farming system, referring to a type of water management that is uniquely used in semi-arid environments. Flood water from mountain catchments is diverted from river beds and spread over broad areas. The potential area under spate irrigation is estimated to be around 6.935Mha, divided as follows: 4.68Mha in Baluchistan, 0.862Mha in Khyber Pakhtunkhwa, 0.571Mha in Punjab, and 0.551Mha in Sindh (Noman, 2017).

Table 3-4: Projected changes in the length of the wheat-growing season and production in different climatic regions of Pakistan by 2080

Climatic regions	Impact of climate change on wheat production by 2080			
	Percent share in national production	Current yield (kg/Ha)	Percent change in yield in 2080	
			A2 scenario	B2 scenario
Northern mountainous	2	2,658	+50.0	+40.0
Northern sub mountainous	9	3,933	-11.0	-11.0
Southern semiarid plains	42	4,306	-8.0	-8.0
Southern arid plains	47	4,490	-5.0	-6.0
Pakistan	100	4,326	-5.7	-6.4

Source: Made by author using data from Iqbal *et al.,* 2009.

Crops are categorized into two distinct types: rabi and kharif. Rabi crops, of which wheat is the principle variety, are sown in autumn (October–December) and harvested in spring (April-May). Crops sown in summer are called kharif crops. The kharif crop season is generally longer in Pakistan, beginning with sugarcane in February, cotton in March–May, rice in June–July, and maize in July–August. The major cropping patterns are (i) rice–wheat, (ii) maize–wheat, (iii) cotton–wheat, (iv) sugarcane–wheat, and (v) coarse grain–wheat, with some other minor patterns.

Crops grown in both irrigated areas and those under spate farming systems are highly sensitive to temperature variability and the amount of water available (Sultana and Ali, 2006). It is estimated that with rising temperatures (0.5–2 °C), agricultural productivity will decrease by around 8–10 percent by 2040 (Dahlavi *et al.,* 2015). Various simulation studies, using the crop-growth simulation model, have estimated a decrease in major crop yields, particularly wheat and rice, and in the length of the growing season in four of Pakistan's agro-climatic zones (Table 3-4). The model predicted the largest decrease (of around 14 days) in relation to a 1 °C rise in temperature in the wheat-growing season length in the northern mountainous region, in contrast to southern Pakistan (Sultana and Ali, 2006). The same study predicted a 6 percent reduction in wheat yield and a 15–18 percent decrease in fine-grain aromatic basmati rice yield in all acro-climatic zones, except for the northern areas, where an increase of around 50 percent in wheat yield was anticipated by 2080 (Figures 3-6 and 3-7). Regarding wheat crops, yield was predicted to be significantly affected by various agronomic and socio-economic factors, including water availability, pesticides, labor supply, household characteristics (including number of women and past experiences), and exposure to extreme and seasonal weather events (Iqbal *et al.*, 2009). High summer (kharif) rainfall was particularly important for winter (rabi) crop productivity and yield.

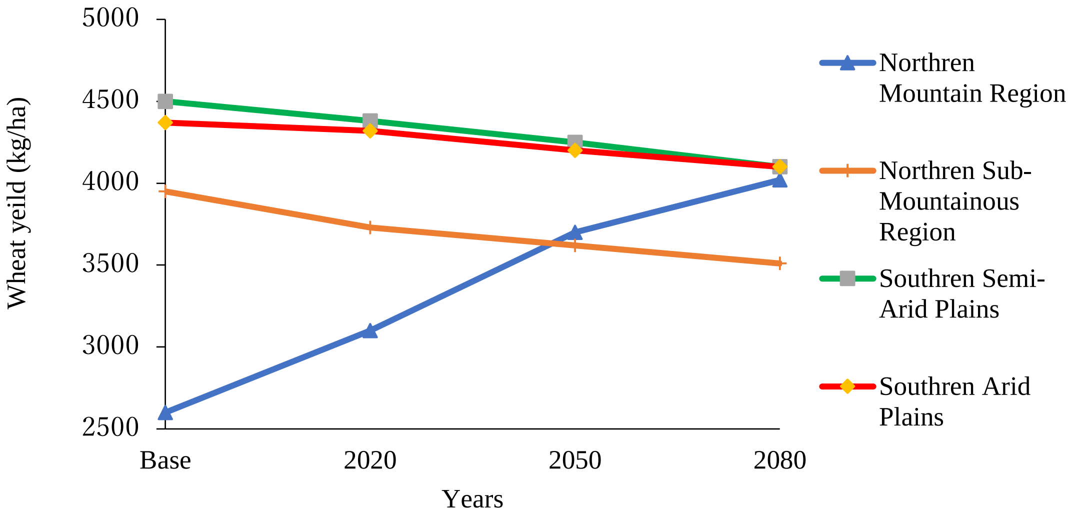

Figure 3-6: Wheat yield in different agro-climatic zones of Pakistan by 2080, under the IPCC A2 scenario

Note: ha = hectare, IPCC = Intergovernmental Panel on Climate Change, kg = kilogram.

Source: Made by author using data from Iqbal *et al.*, 2009.

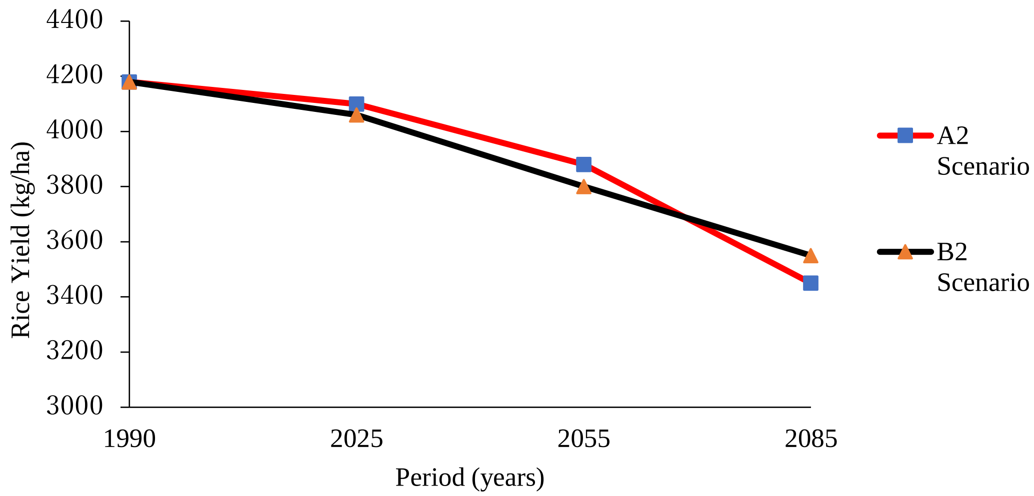

Figure 3-7: Basmati rice production in central Punjab's semi-arid plains by 2085, under IPCC A2 and B2 scenarios.

Source: Made by author using data from Iqbal *et al.*, 2009.

Research performed by Sultana and Ali (2006) showed the same trend as another work done by the International Institute for Applied Systems Analysis in Austria, which reported that yield is likely to decrease for all major crops and cereals by 2080, with the highest reductions in wheat yield. These results are accessible on the World Bank Knowledge Portal and are presented in Table 3-5. The yield changes, particularly in wheat production, are alarming for Pakistan and are likely to necessitate significant adaptive interventions.

Table 3-5: Projected percent changes in major crops yield (2020–2080) compared to baseline yield (1961–1990) under a2 scenario

Crops	Percent Change		
	2020	2050	2080
Wheat	-3.2	-11.0	-27.0
Rice	0	-0.8	-19.0
Maize	-2.4	-3.3	-4.3

Source: World Bank Climate Change Knowledge Portal, 2017.

3.5.2 Livestock sector

In Pakistan, the livestock sector contributes 56.3 percent of the agricultural sector's output and 11.8percent of the national GDP and supports more than 8 million rural families whose livelihoods are directly involved with animal husbandry (Government of Pakistan, Ministry of Finance, 2015). This sector's emissions constitute a substantial proportion of Pakistan's agricultural sector's total emissions; for example, enteric fermentation and manure management alone amount to approximately 90 percent of the agricultural sector's GHG emissions, thereby contributing approximately 40percent of Pakistan's total GHG emissions. Vast rangelands and pastures in the country support the livestock sector, and it is estimated that 60 percent of the land is used as rangeland in northern Pakistan, Baluchistan, and arid and semi-arid areas of Sindh and Punjab. These rangelands support around 93 million livestock, and in Baluchistan alone, approximately 87 percent of the total population derive their livelihood from husbandry (Ahmad et al., 2012). Although there is sufficient accessible evidence regarding how climate change affects crops in the agriculture sector, very little data are available regarding the impact of climate change on dairy and livestock systems worldwide (Thornton et al., 2015). Even the IPCC's Fifth Assessment Report contains very limited information on the projected impacts of climate change on livestock and livestock systems, particularly in Asia. A general assumption is that it will manifest in the degradation of grazing systems such as pastures, and grazing lands due to drought and floods, rising temperature, and ultimately, loss of land productivity, decreased fodder quality and quantity, and increased disease epidemics.

Considering the size of the livestock sector and its importance in supporting rural livelihood it is imperative that the impacts of climate change on this sector be fully explored. However, studies regarding livestock management in the face of climate change in sub-Saharan Africa have indicated that there are restrictions and excessive costs attached to the various adaptation options available for enhancing the resilience of households and food security.

3.5.3 Forestry sector

Forests are an important natural resource, particularly in the context of rural livelihood, providing timber, fuel, food, wildlife habitats, and various important ecosystem services, such as mitigating carbon dioxide levels and controlling or reducing the impact of cyclones and storms in coastal areas. Forested areas in Pakistan constitute 4.19 Mha, representing 5 percent of the total land area. Coastal mangrove forests extend over 132,000 Mha, representing around 3 percent of the country's forested area. The Indus River Delta alone supports 97 percent of the total mangrove forests and is home to over one million people, 135,000 of whom depend on mangroves for their livelihood (WWF Pakistan, 2005).

It is predicted that most of the anticipated impacts of climate change, such as sea-level rise (SLR), changes in temperature and precipitation, and the increasing frequency and intensity of extreme events, will have severe effects on forests, threatening biodiversity and soil quality (Elasha, 2010). Very little research is available on the consequences of climate change for Pakistan's forests. However, a study on the impact of climate change on forest ecosystems in northern Pakistan showed a decrease in forest cover for some plant types and migration of some forest species to a new forest biome, along with an increase in the net primary productivity of all biomes, using the BIOME3 model. The study assessed nine dominant plant types, or biomes, for the effects of climate change. Of the nine biomes selected, three (alpine tundra, grassland or arid woodlands, and deserts) showed reductions in their areas and five (cold conifer or mixed woodland, cold conifer or mixed forests, temperate conifer or mixed forests, warm conifer or mixed forests, and steppe or arid shrublands) showed increases in their areas (Siddiqui et al., 1999).

3.5.4 Water sector

The world's largest contiguous system of its kind, the Indus Basin Irrigation System, is mainly dependent on precipitation, glacier and snow melt, and ground water abstraction. The primary sources of water are rainfall during the monsoon season (50 million-acre feet [MAF]) and river inflows (142 MAF) in the Indus River System. Ground water contributes around 48 percent of surface water available at the canal end of the irrigation system. Water is currently used in agriculture (92 percent), industry (3 percent), and for domestic and infrastructural purposes (5percent). It is expected that future demand on water sector water will increase as a result population growth and the rise of socio-economic development.

Table 3-6: Distribution of water in Pakistan's main rivers

River	Indus river inflows (%)	Seasonal distribution (Summer) [(percent)]	Seasonal distribution (Winter) [(percent)]	Dominant source in summer	Dominant source in Winter
Indus	44	86	14	Snow or glacial melt and monsoon	Winter rainfall and base flow
Chenab	19	83	17	Snow or glacial melting and monsoon	Winter rainfall and base flow
Jhelum	16	78	22	Only snow melt and monsoon	Winter rainfall and base flow
Kabul	16	82	18	Snow or glacial melt	Winter rainfall and base flow

Source: Government of Pakistan, Ministry of Water and Power Pakistan, 2008.

Ground water contributes around 48 percent of surface water available at the canal head of the irrigation system. Water is currently used in agriculture (92 percent), industries (3 percent) and domestic and infrastructure (5 percent). It is expected that in the future, sector water demand will increase due to the increase in population size and the rise of socioeconomic development.

Analyses of river movements from 1947–2003 show a decreasing trend in annual flows (Figure 3-8). There was a particularly rapid decline during 1998–2003, attributed to the persistent drought from 1998–2004 (Ahmad, 2009). The annual variability of river flows is more pronounced in downstream Kotri Barrage, where in a normal year, the annual flow is reduced from 77.3 *million-acre foot* (MAF) to 39.2 MAF. In the post-Kotri/Mangla period, there is on average 33 days with zero flows in the rabi season (Ahmad, 2009). This has serious implication for the Indus Delta regions such as Hyderabad, Thatta, and Badin, where drought is seen severe than any other place in the country.

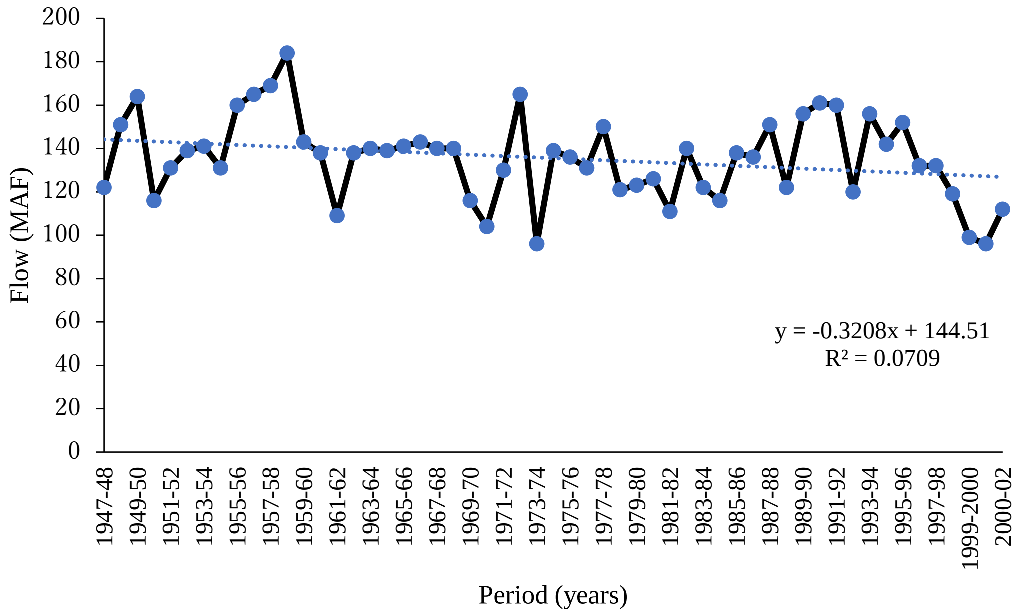

Figure 3-8: Annual river flows of the Indus river system in Pakistan, 1947 to 2002

Source: Made by author using data from Qureshi, 2011.

Note: MAF = million-acre foot

According to a report published in 2010 by the Government of Pakistan, the Task Force on Climate Change identified several climate change-related threats to water security, as follows:

- Increased variability of river flows, due to increases in the variability of monsoon and winter rains, and loss of natural reservoirs in the form of glaciers.

- Increased demand for irrigation water, owing to higher evaporation rates at elevated temperatures in the wake of reductions in the per-capita availability of water resources, and increasing overall water demand.
- Increase in sediment flow due to increased incidences of high-intensity rains, resulting in more rapid loss of reservoir capacity.
- Increased incidences of high-altitude snow avalanches and glacial lake outburst floods (GLOFs), generated by surging tributary glaciers blocking main unglaciated valleys
- Increased degradation of surface water quality, due to more frequent extreme climate events, such as floods and droughts.
- Lack of up-to-date knowledge and monitoring efforts with regard to climate change impacts in the Hindu Kush Himalayan region, and a lack of understanding and modeling potential concerning patterns of glacier melt and rainfall that feed the Indus River System and their corresponding effects on Indus River System flows.

The effects of declining glacier mass on river discharge, as a consequence of climate change, will also be more substantial in the Indus Basin, owing to the high proportion of meltwater discharge. This may cause substantial variations in future water supply in the Indus River System. Western Himalayan glaciers are predicted to retreat during the next 50 years, which will initially cause increased flows in the Indus River. The glacier reservoirs will then become empty, resulting in a decrease of as much as 30–40 percent in flows, over the ensuing 50 years. However, surveys conducted between 1997 and 2002 indicated that some of the large Karakoram glaciers, around 40–70 km in length, exhibited 5–15 m of thickening over substantial ablation zone areas (Hewitt, 2005). These contradictory findings obscure the likely impact of climate change on Karakoram glaciers and Indus River flows.

3.5.5 Energy sector

The energy sector is a major contributor to climate change as a result of high GHG emissions and is also responsive to the impacts of climate change. It is predicted that rising populations, economic growth, and changing consumption patterns, including increased demand for air conditioning in summer, will likely increase energy demand and consequently increase GHG emissions from Pakistan's energy sector.

The energy sector is Pakistan's largest source of GHG emissions. In 2012, energy sector emissions accounted for 46 percent of the total national GHG emissions inventory. The likely impacts of climate change on the energy sector are predicted to manifest in changes in precipitation patterns, rising temperatures, and extreme weather events. The country's current energy needs are heavily dependent on oil and gas, and demand far exceeds supply, translating into a resultant severe energy crisis that has crippled the country since 2006.

The energy crisis, in terms of productivity loss due to many hours of load shedding, accounted for 7 percent of GDP losses in 2013 alone (Government of Pakistan, Ministry of Finance, 2015). According to 2013 data, Pakistan's main energy sources include gas (48 percent), oil (32 percent), hydropower (31 percent), coal (7 percent), and nuclear energy (2 percent), making Pakistan the world's sixth largest consumer of gas. However, the energy dependence on gas and oil is large compared to coal. It is estimated that even under moderate gas consumption, reserves will be depleted by 2025. Pakistan's crude oil imports reached around 44.9 million barrels in 2014, an increase of 6.2 percent compared with 2013. Moreover, the hydropower share decreased from 70 percent in 1980 to its current share of almost 29 percent, mainly as a result of controversies concerning major hydropower projects. Coal has remained almost stagnant at 6 percent of the energy supply since 1995, but its thermal capacity for generating electricity stood at 67percent in 2014.

The energy consumption pattern (particularly electricity) indicates that the household sector consumes the largest portion of energy (47 percent), followed by industry (29 percent), agriculture (10 percent), and other commercial users. To ensure energy security, the government is increasingly considering alternative energy sources, including wind, solar energy, and small hydropower plants; however, most of these projects are still in the pipeline.

Regarding future climate change, the energy sector will be significantly affected by extreme weather events, such as flooding, storm surges, and drought, which will affect energy sources and the supply and distribution infrastructure (Global Facility for Disaster Reduction and Recovery, 2011). Pakistan's water resources are also at severe risk as a result of climate change.

Presently, Pakistan's hydropower resources provide around 30 percent of the country's electricity and are projected to provide around 32.7 million kW in 2030. The most likely result of global warming that will affect hydropower is the recession of the Himalayan glaciers, which are the largest source of freshwater in the country. Depleted water resources will diminish the reliability of the hydro-electricity supply, which is a key provider of the country's power sector, leading to the reduced reliability of the entire electricity generation system. Variations in water supply will be further aggravated by increased sedimentation in major reservoirs (Government of Pakistan, Ministry of Climate Change, 2012). Climate change-induced natural hazards may damage oil and gas infrastructure due to heavy precipitation, leading to flooding. Around one third of the country's primary commercial energy is supplied by imported oil that is transported via sea, so major gas fields are located near the Indus River. Infrastructural damage to these resources may cause long-term interruption in supply, placing a significant burden on the national economy. Events of this nature have already been witnessed in Pakistan, one example being the flooding in August 2010 that disrupted the supply of natural gas and fuel oil due to severe damage to some major installations and the transportation network. This disturbance resulted in a shortage of more than 3,500 MW of electricity for several days.

Higher temperatures resulting from climate change will in turn increase evapotranspiration rates and result in greater demands for electricity to pump water for agriculture irrigation. Because water is used to cool nuclear and thermal power plants, increased water temperatures will affect power plants' efficiency. Supply gaps may emerge between maximum demand and installed capacity during peak hours in some months, as cooling requirements increase. The growth in the share of space cooling will cause the peak to become more pronounced and the reliability of Pakistan's power system will further deteriorate. The operation and maintenance costs of the transmission and distribution system will also increase, due to the higher rate of failures caused by extreme events (Tariq and Athar, 2017). It is anticipated that sea level will be affected, particularly in coastal areas and, as has already been proven, this may cause considerable inundation of low-lying areas, degradation of mangrove forests, deterioration in drinking-water quality, and declines in fish and shrimp productivity (Global Facility for Disaster

Reduction and Recovery, 2011). Pakistan has a 1,046 km-long coastline that stretches along the border of the Arabian Sea in the south of the country, falling within the administrative boundaries of Sindh and Baluchistan Provinces. The Sindh coastal zone's vulnerability is considered greater than that of the Baluchistan coastal area because of its tidal flat topography and higher population concentration, with marked industrial activities along coastal areas, including Karachi. A 2-m SLR is expected to submerge 7,500 km^2 of the Indus River Delta. Low-lying Baluchistan coastal areas, such as Pasni, may also be affected by a SLR, since the mean sea level in the coastal town of Pasni is around 1.4 m. However, the Baluchistan coast is tectonically active and is uplifted at a rate of 1–2 mm/year, due to subduction of the Indian Ocean plate (Khan and Rabbani, 2012).

Rising sea levels are also expected to increase the rate of erosion along the coastal belt. Creeks in the delta regions, such as Hajamaro, Ghoro, Kaanhir, and Kahhar, are active erosion hotspots, with erosion rates of 31–176 m/year. The south side of the mouth of Ghoro Creek exhibits the highest erosion frequency (176 m/year), with a retreat rate of 425 m from 2006 to 2009 (WWF Pakistan, 2012). Furthermore, the delta region is both shrinking and sinking due to a lack of sedimentation and subsidence. The river sediment has reduced by 80 percent compared to the early 20th century due to extensive damming of the Indus River (Syvitski *et al.,* 2009). The current rate of sediment aggradation of 1 mm/year no longer exceeds the relative projected SLR, and this sediment retention is considered to be one of the primary causes of the effective SLR in almost 70 percent of the world's deltas, including the Indus River Delta (Ericson *et al.,* 2006). In view of the threats it faces, the Indus River Delta is ranked third among all deltas globally in terms of risk.

The sinking of the Indus River Delta is a natural process that generally ranges from less than 1 mm/year to more than 10 mm/year. However, anthropogenic groundwater and petroleum extraction have caused this rate to increase. The subsidence rate in the Indus River Delta has not yet been established, but deltas in Asia tend to have the highest subsidence rate, at 2.1 mm/year. A seminal study conducted by Ericson et al. (2006) extrapolated the baseline effective SLR conditions from 2000 to 2050 to estimate the Indus River Delta's potential vulnerability to sea level incursion; the study indicated that 0.79 percent of the Indus River Delta’s population is at risk, with a potential 2.73 percent of the delta area set to be lost by 2050.

3.5.6 Transport and urban sector

This section discusses the impacts of climate change on transportation and urban infrastructure services in Pakistan as follows.

a. Transportation and roads

A nation’s economy is highly dependent on its transportation system, which relies on infrastructure and vehicles. Alongside other infrastructural frameworks, climate change affects the transport-related features of an area, since these services are concentrated in the same geographical location. The conditions of urban areas with dense populations and high demand for public transport represent particular challenges compared to those in Pakistan’s suburban and rural areas. Old infrastructure, including airports, ports, railway systems, and highways, along with overpopulation, as well as economic and environmental pressures, have placed significant stress on Pakistan’s transportation systems. Severe climatic events that reduce heavy flooding or snowfall can result in adverse effects on the transportation system (Wilbanks and Fernandez, 2014). Similarly, in mountainous areas, landslides can disrupt transportation systems for extended periods of time. In addition to storm surges during extreme weather events, a SLR can increase the frequency and magnitude of floods in coastal areas. Flooding events, saltwater intrusion, and corrosion, resulting from storm surges and wave action, can inflict severe damage on coastal transportation infrastructure. Higher average temperatures and extreme temperature events may also damage or weaken the structural integrity of transport networks, including bridges and road surfaces.

In economic terms, the transportation system is particularly vulnerable to two types of impact caused by extreme weather events. The first is the damage inflicted on infrastructure, such as flood damage to roads, rails, and bridges. The second is the economic cost of interruptions to the operation of transportation systems, which prevent employees from going to work, shoppers from getting to stores, and goods from being delivered to factories, warehouses, and stores.

b. Urban infrastructure services

The impact of climate change on urban infrastructure is primarily attributable to changes in parameters related to weather or climate, either in size or duration. These include changes in temperature (either maximum or minimum), precipitation causing heavy floods, increased frequency and intensity of storms, and SLR. In Pakistan, past experience has demonstrated that infrastructure in areas exposed to such events or close to climate-sensitive features, such as rivers, coastal areas, storm tracks, or arid areas, are particularly at risk from extreme weather events. Usually, urban infrastructural services are interdependent, and failure of services in one infrastructure will, in most cases, result in disruptions to other connected urban services. Climate change may increase the frequency of these interferences in coming years.

For example, on 23 July 2001, a cloudburst resulted in 620 mm of rainfall, recorded over 12 h, in Islamabad. Heavy floods in Nullah Lai (a rain-fed natural stream flowing through Rawalpindi City) and its tributaries inundated nearby houses, bridges, and roads. This urban catastrophe resulted in a death toll of 61 people, destruction of 800 houses, and damage to 1,069 houses.

3.5.7 Health sector

Climate change has the potential to affect both environmental and social determinants of health, including safe drinking water, clean air, sufficient food, and secure shelter. This may occur via extreme heat events, natural disasters, and variable rainfall patterns. Events relating to heatwaves are expected to increase in both frequency and duration. The heatwave that affected Karachi in June 2015 claimed more than 1,200 human lives in Karachi alone, and around 200 lives in other parts of Sindh Province (Parry, 2016). In Karachi, a maximum temperature of 44.8°C was recorded, which is the second highest temperature since 1979. In Pakistan, heatwaves are common during pre-monsoon months (May–June) in the plains of the country.

Variations in rainfall and temperature have been correlated with the spread of various infectious diseases and food security (Malik et al., 2011). During floods in 2010, a preliminary study by the United Nations Development Programme (UNDP) found that the proportion of the population that fell below the minimum level of dietary energy consumption increased by 3 percent, adding a further 5 million to the population of undernourished people (United Nation Pakistan, 2010). Moreover, extreme events have been correlated with deteriorating mental health among the affected population; extreme events generally trigger depression, distress, and aggression (Save the Children, 2011). Rising temperatures also increase the risk that water-borne and vector-borne diseases will spread. Increases in dengue fever and malaria diagnoses are attributed to changes in temperature and heavy precipitation that may have possibly made breeding sites for mosquitoes more ubiquitous (Khalid and Ghaffar, 2013).

3.6 History and damages of natural disasters in Pakistan

Pakistan is situated in South Asia, within 23°35′–37°05′N, 60°50′–77°50′E, covering an area of 796,095 km^2. It is a densely populated country, with its population reported to have risen above 200 million in 2017, making Pakistan the sixth most populous country worldwide. Pakistan is home to three of the world's major mountain ranges, the Himalayas, the Hindu Kush, and the Karakoram, and the Indus River is the country's most prominent river. The majority of the population is concentrated in rural areas, mostly alongside the Indus River. Karachi is one of the country's largest cities and is the most prominent coastal city. Pakistan faces numerous challenges and is vulnerable to natural and anthropogenic disasters. A key factor in the country's susceptibility to geological and environmental hazards is its geographic profile: Pakistan is topographically, meteorologically, and geologically diverse. As such, the country has experienced numerous natural disasters throughout its history, including earthquakes, floods, droughts, landslides, and sandstorms.

Pakistan is a longitudinal country with an arid to semi-arid climate, receiving less than 250 mm of rainfall per year across most of the country. The variability of the climate across the country is attributed to both the latitudinal and altitudinal gradients that exist from south to north. The average temperature in Pakistan is around 27°C, though this varies significantly according to season and altitude, from 10°C to 30°C. Northern Pakistan is located at a high altitude and is a mostly mountainous region that experiences mild summers and extreme winters, while the plain area is divided into the upper and lower Indus Plains, and experiences intense summers and mild winters. The coastal area in Pakistan lies in the south, next to the Arabian Sea, and has a sub-humid climate with relatively high rainfall. Pakistan consists of around 11 climatic zones, some of which are distinct, while others overlap one another. However, overall, the country can be regarded as a dryland country, with 80 percent of the land's area being in arid to semi-arid zones, 12 percent in dry sub-humid zones, with only 8 percent in humid zones. As such, the country's arid zones are prone to intense summers followed by drought and desertification. Some of the southern regions notoriously experience extremely hot temperatures in summer, including Jacobabad and the coastal area of Makran, where temperatures exceed 50°C each year.

The upper and lower Indus Plains combined occupy over 60 percent of the country's land area, distributed mainly across Punjab Province. Therefore, Punjab possesses one of the world's most sophisticated canal irrigation systems and is regarded as a major center of agricultural activity in Pakistan. By contrast, Gilgit Baltistan and Khyber Pakhtunkhwa comprise predominantly mountainous terrain and their agricultural contributions are proportionally inferior. High mountain peaks, such as Godwin-Austen and Chhogori (K-2), are found in Northern Pakistan at elevations of 8,616 m above sea level. By contrast, Sindh and Baluchistan are low-lying provinces containing patches of desert and semi-arid zones that are sparsely populated. Besides Karachi, major cities include Lahore, Faisalabad, Gujranwala, Multan, Sialkot, Haiderabad, Sukkur, Islamabad, Rawalpindi, Peshawar, Mardan, Quetta, Khuzdar, Nowshera, and Swabi.

Pakistan is a developing nation with restricted income from the industrial sector, which contributed 26 percent of the GDP in 2013. Major sources of foreign exchange earnings from the industrial sector include textile production, followed by petroleum refining, metal processing, and cement and fertilizer production. Maritime transportation is another important activity. This tertiary sector represents more than half of the GDP (54 percent in 2013) and employs about 35 percent of the workforce. Finally, foreign remittance and payoffs from Pakistani citizens living abroad constitute a notable fraction of the GDP.

Agriculture is the mainstay of Pakistan's economy, representing a 20 percent contribution to the country's GDP and employing 45 percent of the workforce, making Pakistan an agriculturally based economy. The major crops grown in the country include wheat, rice, cotton, sugarcane, maize, and various vegetables, while tobacco is cultivated as the main cash crop. Additionally, livestock contributes a major proportion of agricultural output, as a source of meat and dairy products. Pakistani cotton, rice, mangoes, and oranges are internationally renowned agricultural commodities exported by the country. However, among the major challenges facing the agriculture sector is a lack of irrigation water, since most of Pakistan depends on rainfall to meet its agriculture-related water demands. Furthermore, of the country's 79.6 Mha of land, only 20 Mha is suitable, in terms of quality, for agricultural production. This 20 Mha includes 16 Mha that is irrigated, while the remaining 4 Mha is rain-fed. The remaining major land-use types in Pakistan include forestland (4.2 Mha) and rangeland (28 Mha).

3.7 Pakistan disaster and risk profile

Natural disasters in Pakistan are mainly attributable to severe weather phenomena, such as floods, storms, cyclones, landslides, and extreme weather. Climate change and variability are major dynamic pressures that increase the vulnerabilities of Pakistani society to disaster. Historically, natural disasters have had significant impacts on human life, health, and economic welfare, and have recently attracted considerable attention as scientific advancements increasingly enhance our understanding of natural processes. South Asian countries, not least Pakistan, are generally prone to natural disasters that have devastating impacts on the economy and welfare of the population. Pakistan is particularly vulnerable to floods, earthquakes, landslides, droughts, sandstorms, and cyclones. However, anthropogenic problems, including terrorism, fire hazards, refugee influx, internal population displacement, epidemics, transportation-related incidents, and industrial accidents, also contribute to social unrest and discontent among the masses. Pakistan's vulnerability to natural disasters is evinced by the fact that around 6,037 people lost their lives as a result of natural calamities between 1993 and 2002, with 8.9 million otherwise affected (World Disaster Report, 2003). These losses ensued mainly from earthquakes, tsunamis, floods, sediment displacement (landslides), cyclones, droughts, GLOFs, and avalanches, killing more than 80,000 people (Atta-ur-Rahman et al., 2011; NDMA, 2014).

Moreover, Table 3-7 shows that, the frequency of occurrence of storms remains the same and mass movement (dry) have a decreasing trend. However, all other natural disasters i.e. flood, droughts, diseases, avalanche, extreme temperature and landslides have been continuously increasing in number and their intensity is becoming severe. Among all those disasters, floods are the primary cause of majority of deaths, injuries, people affected, economic damages impacting lives of people in Pakistan. Furthermore, droughts occur less frequently but according to its nature, it lasts for longer period and hence has a huge effect on people. Total damage cost is estimated in thousands of US$. Costs of damages occurred due to avalanches, diseases, cold waves, and storms was not available and hence cannot be calculated, whereas, for other types of disasters, it is estimated as shown in the Table 3-7 below.

Table 3-7: Historical record of natural disasters in Pakistan since last 30 years (1000 USD)

Disaster Type	Occurr-ence	Total deaths	Injured	Affected	Homeless	Total affected	Total damage
Avalanche	9	415	89	3,833	300	4,222	--
Diseases	6	126	111	14,954	1,000	16,065	--
Cold wave	3	18	--	--	--	--	--
Convective storm	6	90	--	500	594	--	--
Drought	1	143	--	2,200,000	--	2,200,000	247,000
Floods	68	10,165	10,874	61,155,341	2,980,815	64,147,030	19,799,378
Heat wave	11	2,561	324	80,250	--	80,574	18,000
Landslide	12	283	126	26,702	4,345	31,173	18,000
Tropical landslide	8	1,240	175	1,969,286	220,745	2,190,206	1,710,936

Source: Made by author using data from Emergency Disaster Database, Center for Research on Epidemiology of Disasters – CRED, 2016.

Note: -- = no data available.

International Panel on Climate Change reports have also witnessed same results in other countries where frequency of occurrence of extreme weather and climate events have increasing trend and are consistent with the warming of the Earth (IPCC, 2007). Their reports have also highlighted that many important impacts of climate change may manifest themselves through a change in the frequency, intensity or duration of extreme events posing greater threat on societies, economies and natural systems that are already struggling to cope with the many non-climate-related threats (John and Mimura, 2010). Khan and Salman (2012) have also reported that Pakistan has a long history of natural disaster. The economy of the country heavily relies on the climate sensitive sectors like forestry and agriculture (Farooqi, 2005). Majority of the areas in the country are highly exposed to the natural disasters especially floods landslides and droughts. Currently, due to the changes in climate, these disasters occur more frequently and cause more damages (Mustafa, 1998; Khan and Salman, 2012).

Table 3-8 presents the annual average losses in accordance with the respective hazard types. The Average Annual Loss is the expected loss per annum associated to the occurrence of future perils assuming a very long observation timeframe (UNISDR, 2018). Floods are the most significant cause of both human and economic losses, and, compounded by anthropogenic disasters, are expected to increase damage to humans and societies. For example, perennial floods can cause epidemics, resulting in the deterioration of the living environment. A consistent major challenge for Pakistan's authorities is the regular occurrence of natural hazards at all scales. Disaster management in Pakistan, particularly regarding natural hazards, primarily focuses on rescue and relief measures. There is a lack of information and insufficient understanding regarding the processes involved in hazard identification, risk assessment and management, and the relationship between people's livelihoods and disaster preparedness (World Conference on Disaster Risk Reduction, 2005).

Table 3-8: Average annual loss (AAL) by hazard type

Hazard	Absolute (Million US$	Capital stock (%)	GFCF (%)	Social exp. (%)	Total Reserves (%)	Gross Savings (%)
Wind	7.50	0.001	0.025	0.083	0.145	0.015
Storm Surge	18.10	0.004	0.061	0.200	0.351	0.037
Tsunami	0.17	0.000	0.001	0.002	0.003	0.000
Flood	1,029.80	0.205	3.448	11.407	19.973	2.107
Multi-Hazard	1,327.62	0.264	4.445	14.706	25.749	2.716

Source: UNISDR, 2018.

Floods cause substantial loss of human life and destruction to property in flood-prone countries every year (Ali, 2007; Smit, 1992). However, flooding is one type of environmental hazard that can be mitigated and managed with some degree of precision, when planned appropriately. Unfortunately, Pakistani authorities have consistently responded inefficiently to flood events in the country, both as a result of event severity and the government's inadequate preparedness. Therefore, floods have been particularly lethal in Pakistan, affecting the largest number of lives (Atta-ur-Rahman et al., 2011). According to some estimates, Pakistan has been affected by major floods of varying degrees on around 67 occasions since 1900. Some of the most disastrous episodes occurred in 1929, 1955, 1959, 1973, 1976, 1988, 1992, 1996, 2005, and 2010 (Atta-ur-Rahman, 2000; GoP, 2000; Mustafa, 1998). Assessment of the nation's vulnerability to extreme climate events or climate change-induced natural disasters, particularly floods shows that among all of Pakistan's provinces, Khyber Pakhtunkhwa is at greatest risk. Of the flood events that have been recorded, those of 1929 and 2010 had the most catastrophic consequences. The 2010 flood greatly affected Khyber Pakhtunkhwa Province, resulting in the loss of 1,070 lives and an overall economic loss of US$ 1172 million. One reason for the province's susceptibility to natural disasters is its uneven terrain and topography. Hence, other natural disasters, such as GLOFs and landslides, also occur occasionally. Khyber Pakhtunkhwa is also located immediately downstream of the high mountains of the Himalayan, Karakorum, and Suleiman ranges, which are mostly covered with snow or have high altitudes, serving as a catchment area for major rivers in the province and countrywide. A report published by the Asian Disaster Preparedness Center in 2014 concluded that the province is highly vulnerable to climate change-related incidents, such as shifting rain patterns and variations in agricultural seasons.

Khyber Pakhtunkhwa Province faces not only the challenge of managing natural disasters but must also negotiate the anthropogenic disasters that are unique to the province. Consequently, the provincial authorities struggle to manage resources effectively. The anthropogenic problems currently afflicting the province mainly include war against terrorism and domestic terrorism in the form of Talibanization. This has resulted in the internal displacement of substantial numbers of citizens from both Federally Administered Tribal Areas and Provincially Administered Tribal Areas. These citizens have moved temporarily to peaceful areas of the province, where both nongovernment and government organizations are attempting to provide them with assistance. Therefore, the relevant authorities are fighting against multiple fronts to address these citizens' needs, including provision of food and shelter, health and education, compensation, and resettlement.

After the 2005 earthquake, the Government of Pakistan established a provincial disaster management authority (PDMA) in each province, including Khyber Pakhtunkhwa. Among other objectives, the mandate of the PDMA includes the development of strategies and protocols for mitigating disaster in the provinces, in accordance with the National Disaster Management Act. In consideration of both natural and anthropogenic disasters, the PDMA of Khyber Pakhtunkhwa developed their own comprehensive road map for disaster risk management for 2014–2019. This road map is based on the assessment of strategies and challenges with regard to disaster management in the province. There are several similarities and differences between anthropogenic and natural disasters in terms of risk assessment, mitigation, recovery, rehabilitation, and reconstruction. Therefore, one of the key objectives of the disaster road map project is to provide solutions based on integrated approaches in the form of a Provincial Disaster Management Plan, which is aimed at improving the province's potential in the face of disaster and enhancing its disaster resilience.

3.8 Climate change vulnerability of Pakistan towards natural hazards

Pakistan is vulnerable and prone to numerous natural and anthropogenic hazards as a direct consequence of the country's high variability and regional contrasts, in terms of geology, topography, and meteorology (Hewitt, 2014; Khan and Khan, 2008; Rafiq and Blaschke, 2012). The Indus Plain, which extends throughout Pakistan from north to south, occupies more than 60 percent of the country (Akhtar, 2011). Pakistan is one of the world's most arid countries, with an average rainfall of 240 mm. Its population and economy rely heavily on the annual influx into the Indus System (including the Indus, Jhelum, Chenab, and Kabul Rivers, as well as some uncaptured flows from India's Ravi, Sutlej, and Beas Rivers) of about 190 billion m^3 of water, mainly derived from snowmelt in the Himalayas (Hussain *et al.*, 2011). Around 77 percent of Pakistan's population is concentrated in the Indus Basin (Figure 3-9), and 40 million people depend on irrigation water for domestic use, particularly in areas where the groundwater is saline.

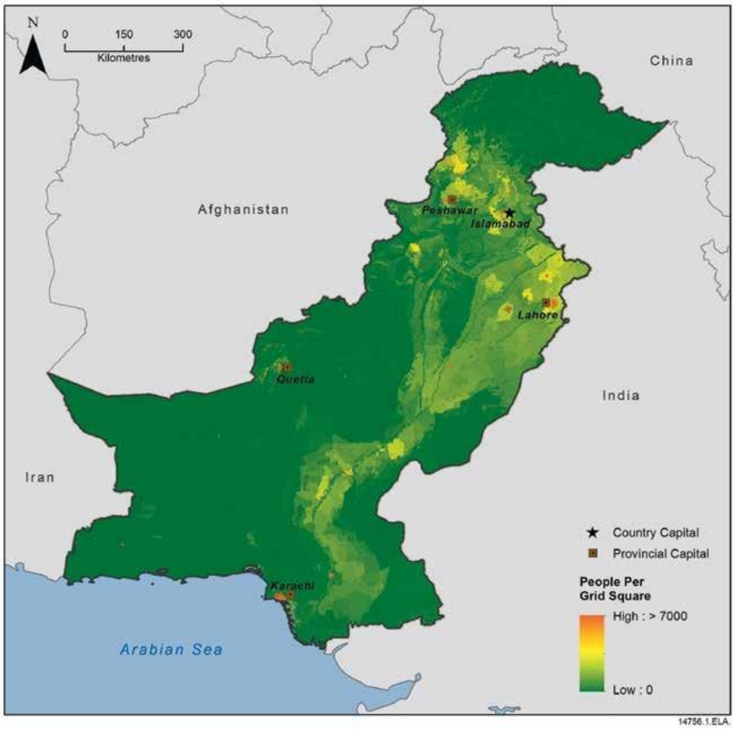

Figure 3-9: Population distribution in Pakistan

Source: Pop Asia, 2016. Permission was obtained from the original authors to reproduce this map for academic purposes.

Agriculture is the mainstay of Pakistan’s economy, with wheat, rice, cotton, sugarcane, fruits, vegetables, and tobacco as main crops, while livestock production is also important. Pakistan is the fourth largest producer of cotton worldwide and has abundant natural resources, most notably copper, oil, and gas. The industrial sector constituted 26 percent of the GDP in 2013, and included textile production, petroleum refining, metal processing, and cement and fertilizer production. Maritime transportation is also important, representing 54 percent of the GDP in 2013 and employing around 35 percent of the workforce.

With over 185 million inhabitants recorded in 2014, Pakistan is the world’s sixth most populous country. Most of southern Pakistan’s population lives along the Indus River and about one third live in urban centers. Karachi is the most populous city in Pakistan. In the northern half of the country, most of the population lives along an arc formed by Faisalabad, Gujranwala, Islamabad, Lahore, Mardan, Multan, Nowshera, Peshawar, Rawalpindi, Sialkot, and Swabi.

3.8.1 Vulnerability mapping

Spatial representation of districts' vulnerability provides a powerful tool for identifying clusters, trends, and patterns (Davis, 2002). Khan and Salman (2012, p. 166) mapped 103 districts of Pakistan based on the proposed vulnerability index (Figure 3-10). The majority of Baluchistan's districts were highly vulnerable, with 46 percent of the two top quintile districts belonging to Baluchistan, followed by Sindh, with a share of 22 percent in the top two quintiles (Table 3-9).

Among the least vulnerable districts, Punjab had the highest share, with 65 percent of the lowest quintile, followed by the Khyber Pakhtunkhwa districts constituting one fifth of the lowest quintile. Only Quetta district in Baluchistan and Karachi West and Malir districts in Sindh had places in the least vulnerable category. Overall, the top 20 districts scored an average of 5.38 on the Human Vulnerability Index, while the lowest 20 districts scored an average of 2.49.

Table 3-9: Provincial Human Vulnerability Index (HVI) of Pakistan

Province	Quintile (top HVI)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (bottom HVI)	Total
Baluchistan	12	7	4	2	1	26
Khyber Pakhtunkhwa	1	4	4	11	4	24
Punjab	1	7	7	7	13	35
Sindh	6	3	6	1	2	18
Total	20	21	21	21	20	103

Source: Khan and Salman, 2012. Written permission was obtained from the authors to reproduce this table in this dissertation.

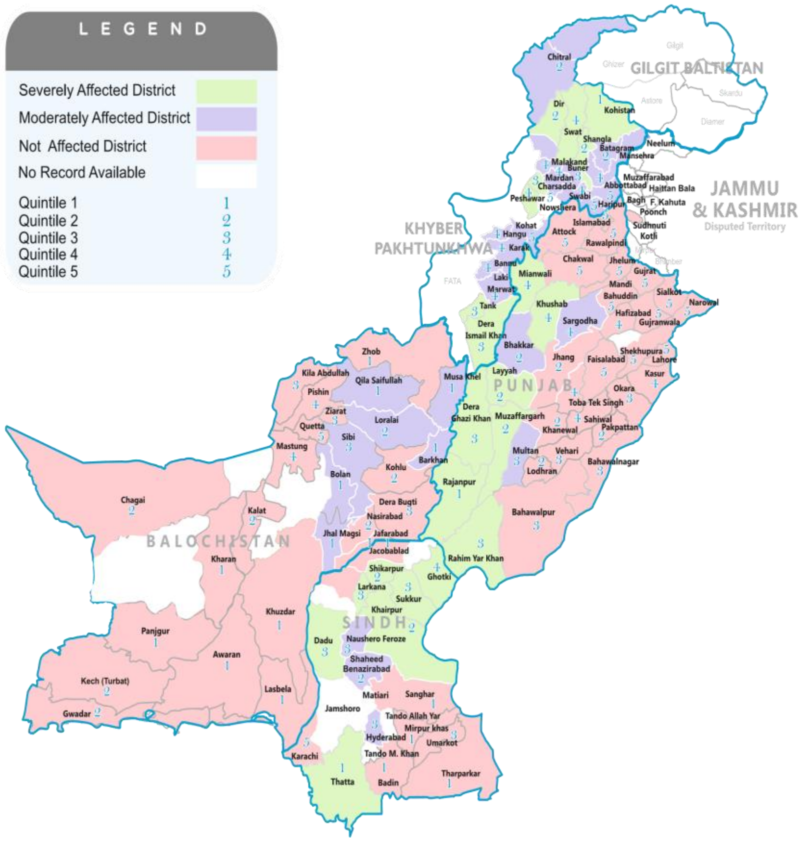

Figure 3-10: Map of the Human Vulnerability Index quintiles and the effects of the 2010 flood.

Source: Khan and Salman (2012). This figure is reproduced with the permission of the copyright holder (29 October 2018).

3.8.2 Hazards and physical exposure

i. Flood

Pakistan is one of South Asia's most flood-prone countries. The floods that regularly afflict Pakistan can be classified into four main categories: riverine flooding concentrated in the Indus River Basin, flash floods, GLOFs, and coastal flooding associated with cyclone activity. Figure 3-11 shows a map of the most flood-prone populations in Pakistan.

River-related floods occur mostly in the Indus River Basin and broadly inundate floodplains along the major rivers (i.e., the Indus, Jhelum, Chenab, Ravi, Sutlej, and Kabul Rivers). Such riverine floods are at their most severe in Punjab and Sindh Provinces, and have recently caused extensive damage on an almost annual basis. In these regions, agricultural damage is primarily inflicted on standing kharif crops. However, in some cases, the inundated lands dry slowly and ultimately impede the sowing of rabi crops. Specifically, in the lower part of the Indus River (in Sindh Province), which flows at a higher elevation than in the adjoining lands, water spills do not return to the main river channel and may extend beyond the extent and period of inundation, resulting in a more significant impact. For example, the 2010 flood event was immense, affecting almost all of Pakistan, and costing an estimated US$ 9.7 billion in damage. Agriculture and livestock, in particular, suffered immensely, while the flooding also destroyed and damaged many houses, roads, and irrigation facilities.

According to Pakistani authorities, more than 1,700 people died as a result of the flooding in 2010, while over 20 million individuals were displaced; the total number of individuals affected by the flooding exceeded the combined total of individuals affected by the 2004 Indian Ocean tsunami, the 2005 Kashmir earthquake, and the 2010 Haiti earthquake. The 2011 flood affected a further 8.9 million people and destroyed 1.5 million homes in 37,000 villages in Sindh Province alone.

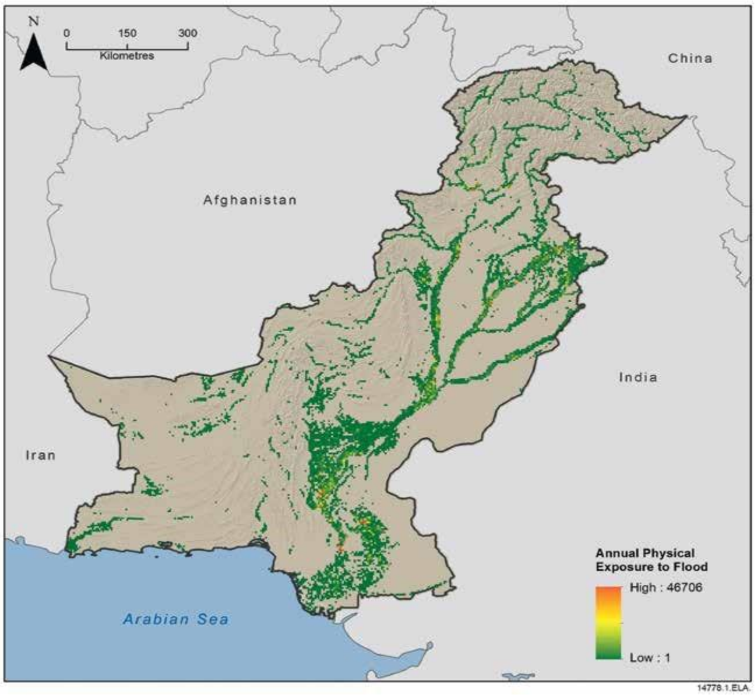

Figure 3-11: Expected average annual population exposed to floods in Pakistan.
Source: UNEP-Grid Preview (2016). Permission was obtained from the original authors to reproduce this map for academic purposes.

Flash floods originate from highly localized convective rainfall, or cloudbursts, over small to medium-sized basins in hilly terrains and foothills. Such events, prevalent in Baluchistan, Khyber Pakhtunkhwa, and northern areas, can severely damage farmlands and livestock and dramatically affect urban centers. For example, in July 2001, the Nullah Lai flooded and inundated nearby houses, bridges, and roads as a result of continuous heavy downpours. According to official figures, at least 10 people died, 800 houses were destroyed, and 1,069 houses were damaged in Islamabad. In 2009, 26 people were killed in Karachi, and hundreds of homes were damaged.

ii. Drought

Pakistan's climate is generally characterized by low rainfall and extreme temperature variations, and as much as 60 percent of the country is classified as semi-arid to arid (particularly Baluchistan, Sindh, and southern Punjab). Arid regions experience less than 200 mm of rain per annum and are extremely vulnerable to minimal changes in rainfall regimes or the usage of the limited amount of water available. The most susceptible regions experience droughts lasting two to three years in each decade. Regions with no surface water and low or brackish groundwater are most vulnerable to climate variability. Figure 3-12 presents a map of the most drought-prone populations in Pakistan.

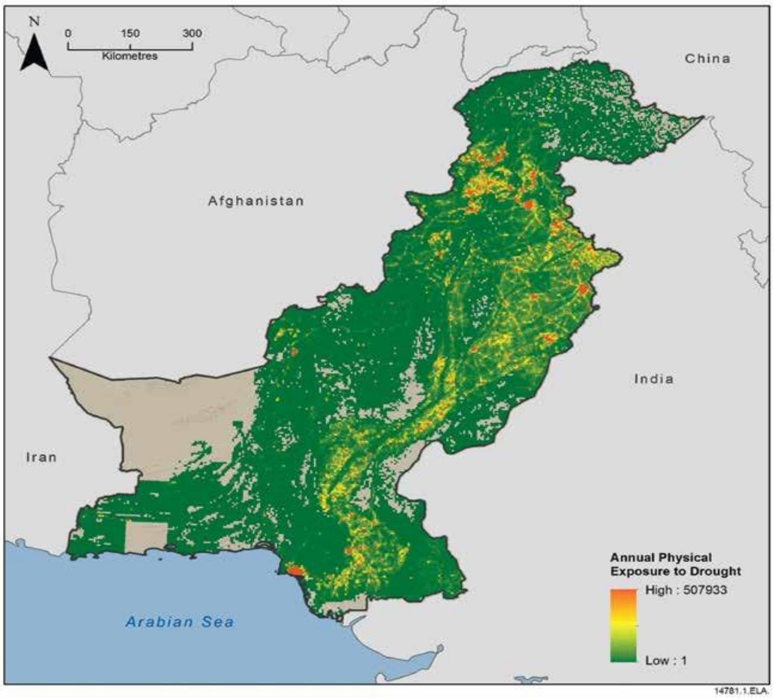

Figure 3-12: Expected average annual population exposed to drought in Pakistan
Source: UNEP-Grid Preview (2016). Permission was obtained from the original authors to reproduce this map for academic purposes.

Drought is a complex phenomenon that is closely linked to its socio-economic context and is usually closely associated with poverty and non-adaptive land, water, and agricultural practices that lead to the overexploitation of groundwater, deforestation, and the depletion of grazing pastures.

In 2000 and 2002, Pakistan experienced severe droughts that destroyed many individuals' livelihoods. According to Global Facility for Disaster Risk Reduction (2012), more than 3.3 million people were affected in Baluchistan and Sindh Provinces, where thousands of people were forced to migrate, and millions of livestock were killed. According to one estimate, 15 million cattle died, and economic losses amounted to US$ 2.5 billion. The 2001 drought was so severe that the economic growth rate was reduced from an average of 6 percent to a mere 2.6 percent (Global Facility for Disaster Risk Reduction, 2012).

Since the beginning of March 2014, severe food and water shortages have been reported in the Tharparkar district in Pakistan's south-eastern Sindh Province. Several children have reportedly died of malnutrition and a state of emergency was declared by the provincial government. Between March 2013 and February 2014, rainfall was recorded at 30 percent below the normal. Yet, some observers have suggested that the drought is not the only reason for the recent deaths, but that the extreme situation resulted from an ensemble of factors, originating from endemic poverty exacerbated by drought and an outbreak of disease that killed livestock (Relief Web, 2014).

iii. Tsunamis

The history of large earthquakes along the Makran subduction zone is indicative of the vulnerability of Pakistan's coastline to tsunamis. In 1935, an earthquake measuring 8.5 on the Richter scale triggered a tsunami along the Baluchistan coastline, killing nearly 4,000 people in the fishing town of Pasni, Gwadar, also threatening Karachi. Figure 3-13 presents a map of the most tsunami-prone populations in Pakistan.

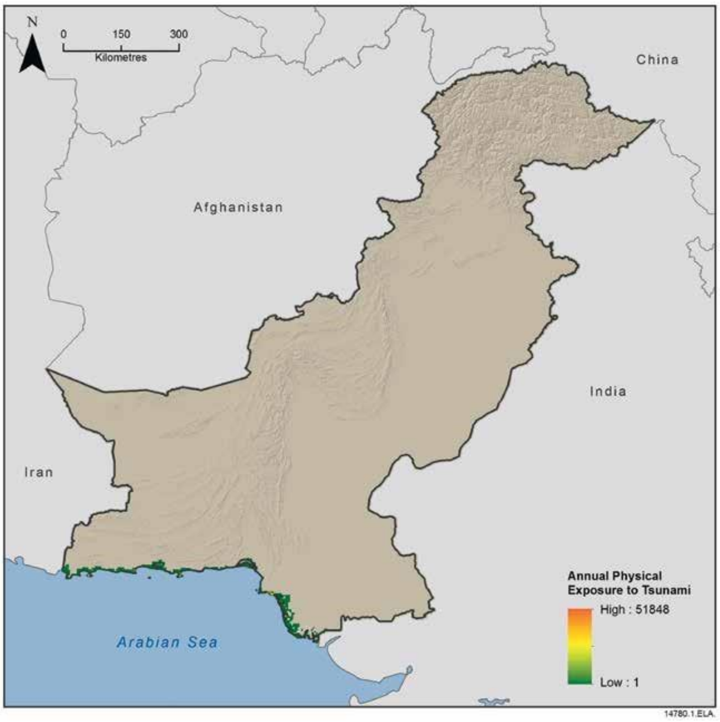

Figure 3-13: Expected average annual population exposed to tsunami in Pakistan
Source: UNEP-Grid Preview (2016). Permission was obtained from the original authors to reproduce this map for academic purposes.

iv. Cyclones

In the period between 1971 and 2001, 14 cyclones were recorded in Pakistan. Although cyclones are rare over the Arabian Sea, the low-lying coastal belts may suffer significant damages from occasional cyclones, since cyclones mostly strike the Sindh coast rather than the Baluchistan coast. In 1999, cyclone 2A, a category 3 hurricane, ravaged large tracts along the coastal districts of Badin and Thatta, wiping out 73 settlements and affecting close to 600,000 people. Extensive property and agricultural damages of up to US$ 12.5 million were recorded. Figure 3-14 presents a map of the most cyclone-prone populations in Pakistan.

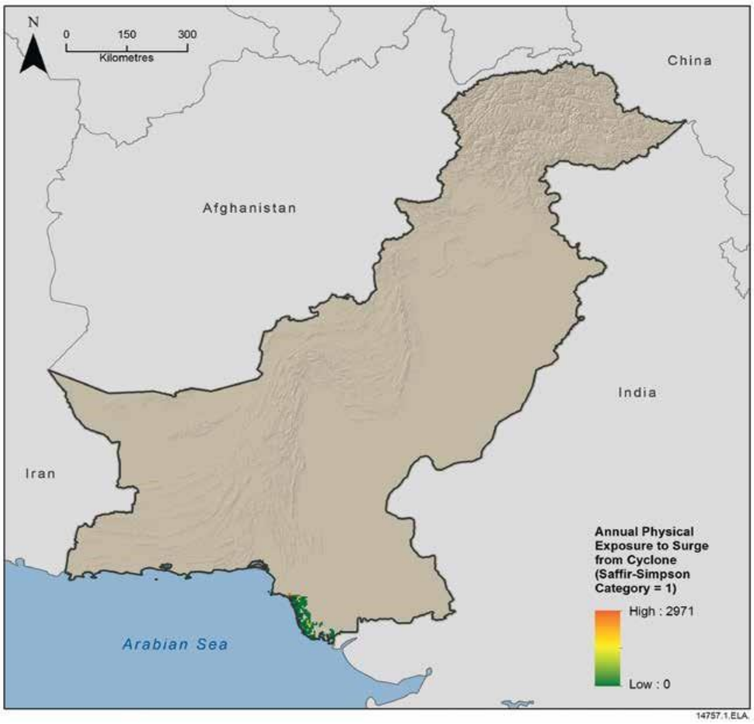

Figure 3-14: Expected average annual population exposed to cyclone in Pakistan
Source: UNEP-Grid Preview (2016). Permission was obtained from the original authors to reproduce this map for academic purposes.

v. Landslides

The region of Kashmir, northern areas, and some areas of Khyber Pakhtunkhwa Province are highly exposed to landslides. Aside from the young geology and fragile soil type of mountain ranges, accelerated deforestation, cultivation, and construction are other major causes of the increased incidences of landslides. Small-scale, isolated landslide events occur frequently in the above-mentioned regions. A total of 13 landslide events have been recorded since 1926, causing 413 deaths. Figure 3-15 presents a map of the most landslide-prone populations in Pakistan.

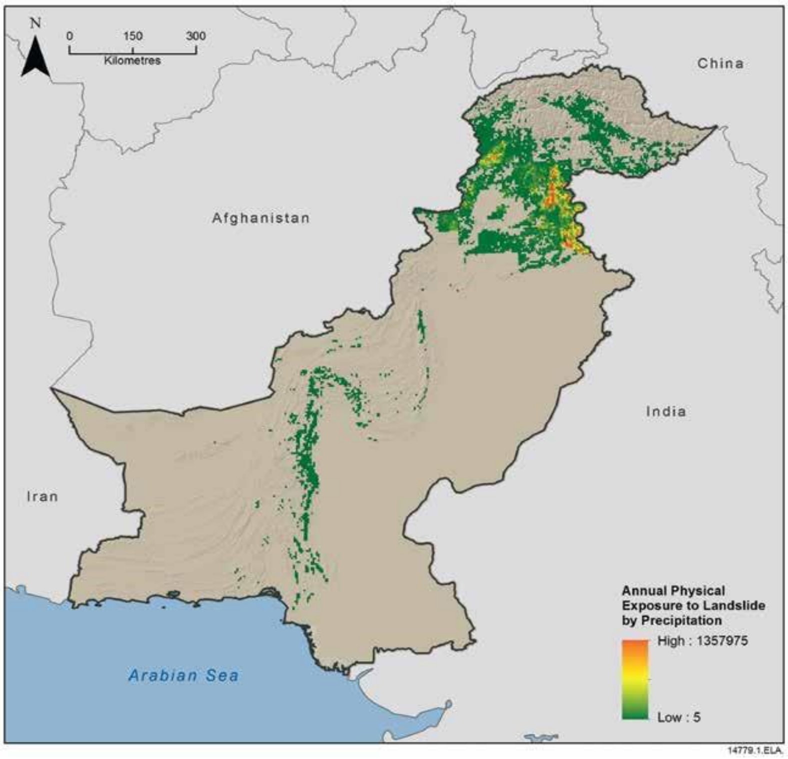

Figure 3-15: Expected average annual population exposed to precipitation triggered landslides in Pakistan
Source: UNEP-Grid Preview, 2016. "Permission asked from original authors to reuse this map for academic purpose"

3.8.3 Hazard impacts and trends

Natural hazards in Pakistan originate primarily from meteorological phenomena (NDMA, 2012). Weather-related hazards accounted for approximately 76 percent (139 events) of the total number of natural disasters recorded between 1980 and 2013 (Figure 3-16), with floods (riverine flooding and flash floods) accounting for 46 percent of all hazards. Negative impacts associated with all types of hazards, excluding drought, are expected to occur almost every second year. Earthquakes and floods of all types occur more frequently and are expected to strike annually and up to three times a year, respectively. It must be mentioned that only a single drought event was recorded in the International Disaster Database EM-DAT for the 1980–2013 period, although its duration exceeded 2 years. National Disaster Management Authority (NDMA) reports and further analysis of data borrowed from EM-DAT revealed that, in terms of hazard impact, 85 percent of the population affected by hazards between 1980 and 2013 were affected by flood events, with riverine floods accounting for 74 percent, concentrated along the Indus River floodplain, of which more than 35 percent could be attributed to the 2010 flood. Drought affected only 3 percent of the total population during the same period. Despite the lower frequency of occurrence, droughts may affect a larger proportion of the population and usually last longer than other disasters.

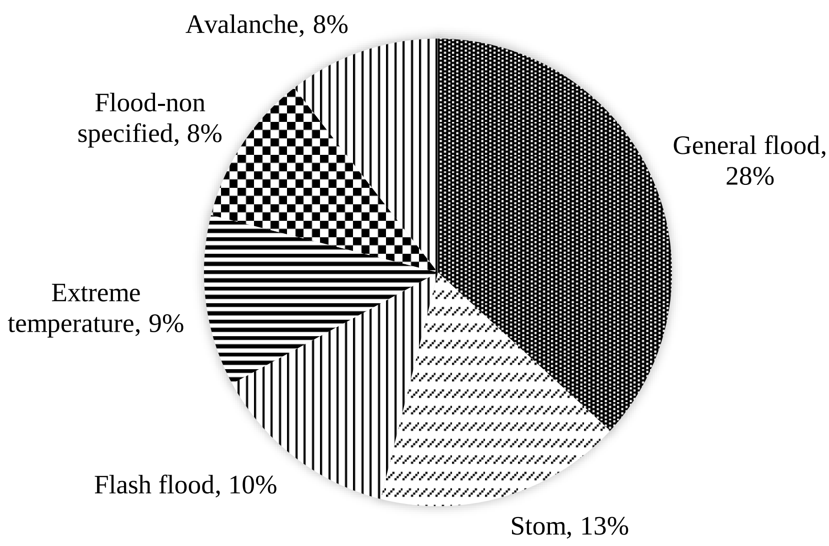

Figure 3-16: Proportion of hazards between 1980–2013 in Pakistan
Source: By author using data from the Emergency Disaster Database, Center for Research on Epidemiology of Disasters (2014).

Figure 3-17 shows the annual frequency of hazard occurrences in Pakistan. Floods occur more frequently than any other disaster (1.5 to 2 times per year). Droughts occur less frequently but, as noted above, may affect more of the population on a larger scale.

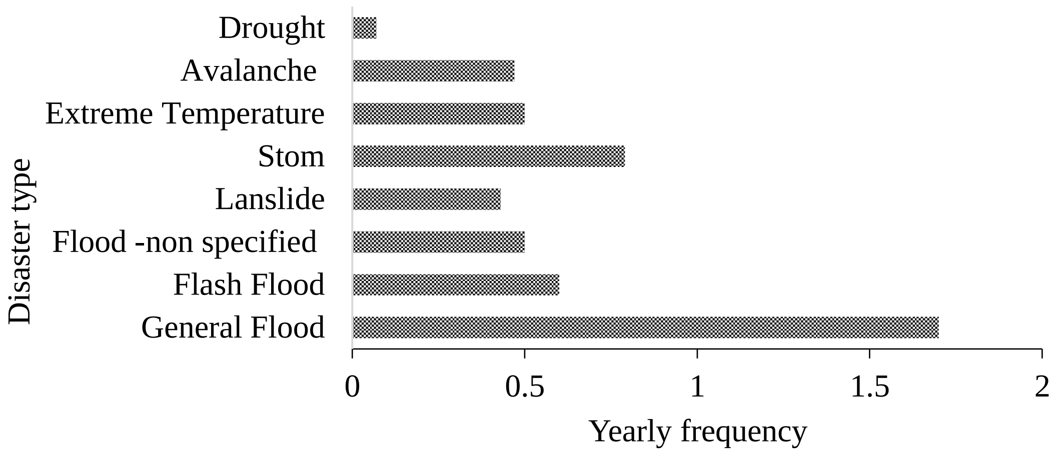

Figure 3-17: Yearly frequency of hazards between 1980–2013 in Pakistan
Source: By author using data from the Emergency Disaster Database, Center for Research on Epidemiology of Disasters (2014).

In terms of overall economic damages, the proportional impact of riverine flooding is high, representing 69 percent of the total economic damages from all hazards during the same period (Figure 3-18), with the 2010 flood event representing more than 50 percent of this share.

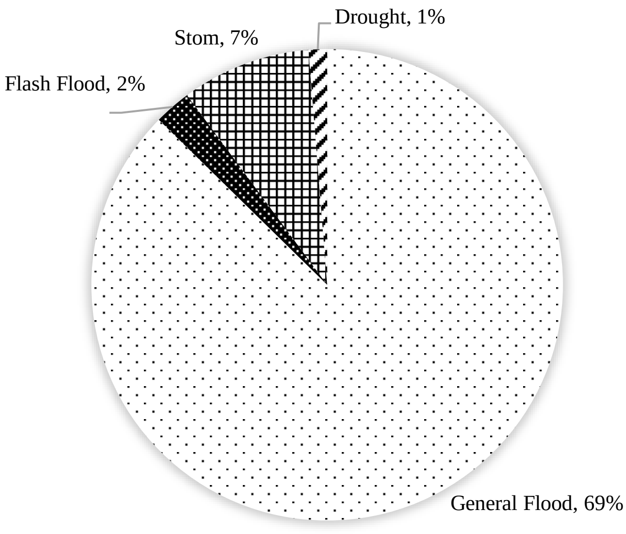

Figure 3-18: Proportion of economic damages by hazard type in Pakistan between 1980–2013
Source: By author using data from the Emergency Disaster Database, Center for Research on Epidemiology of Disasters (2014).

Historical trends related to the impact on the population and economic damages caused by all hazards, and the proportion of damages associated with general flooding (originating from the Indus River and its main tributaries) are presented in Figures 3-19 and 3-20. A considerable increase in the extent of damage and the affected population was noticeable beginning in 2005, when an earthquake caused considerable damage and death, and floods affected a substantial portion of the population. More specifically, in the past four to five years, riverine flood events have predominated, accounting for almost 100 percent of the total damages and affected population.

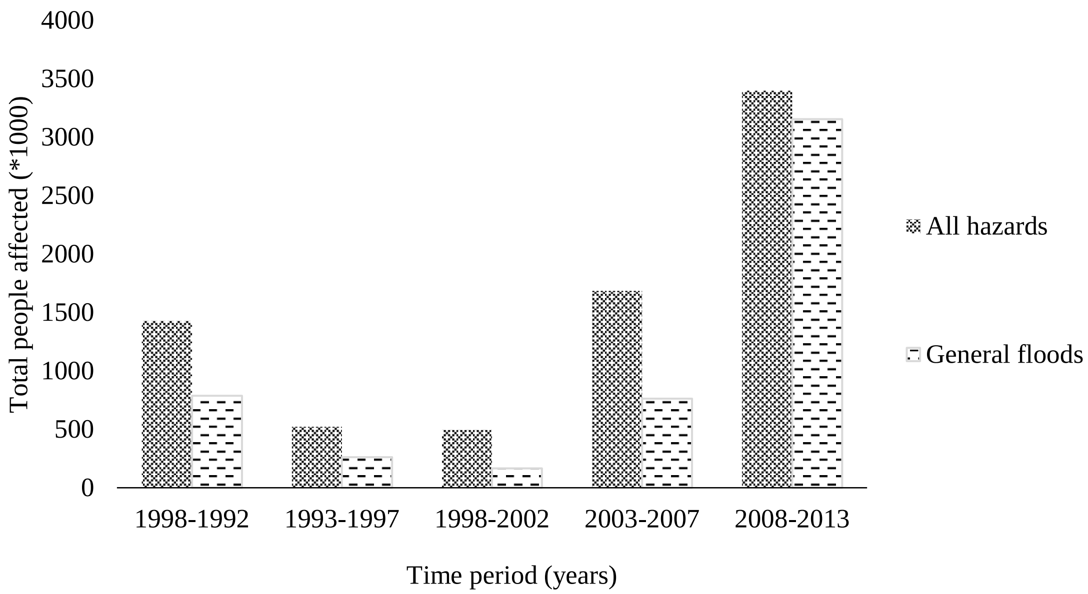

Figure 3-19: Population affected by natural hazards in Pakistan between 1980 and 2013 Source: By author using data from the Emergency Disaster Database (2014).

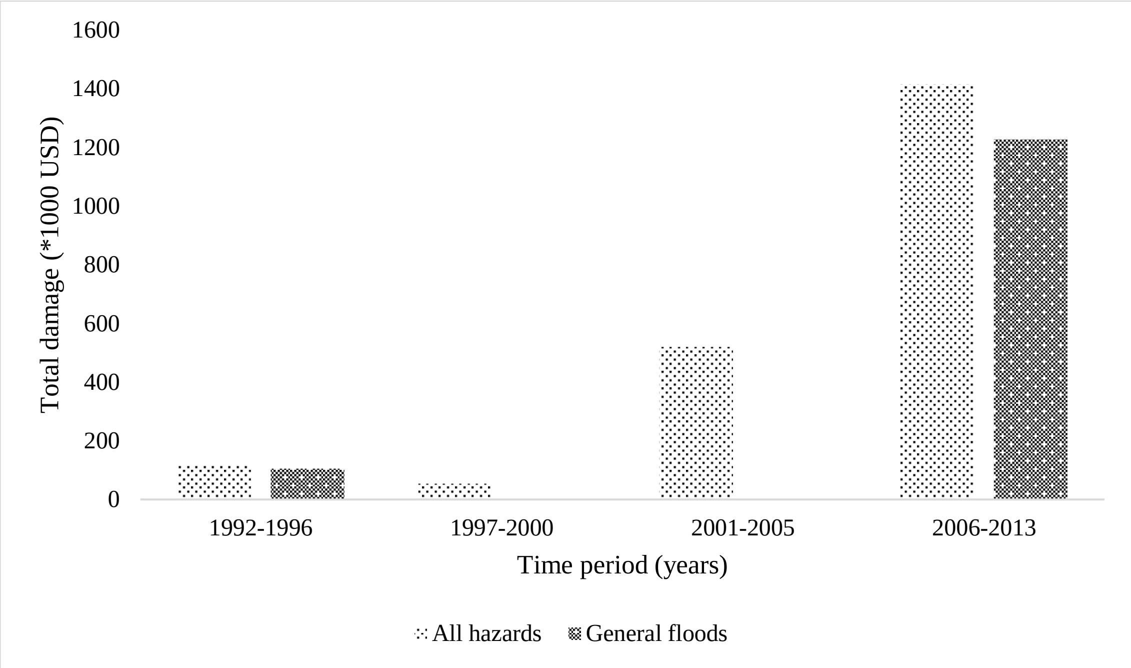

Figure 3-20: Economic damages from natural hazards in Pakistan between 1980 and 2013

Source: By author using data from the Emergency Disaster Database, Center for Research on Epidemiology of Disasters (2014).

Floods appear to be the most prevalent danger in Pakistan, followed by droughts and storms. General riverine flooding along the Indus River has resulted in the largest impact on human and economic activities, and such hazards have occurred almost annually since 2010. It should be noted that drought is difficult to capture in statistical analyses; due to its slow-onset characteristics and lack of structural impact, drought is often disregarded and goes unreported, unless serious problems ensue (Mishra and Singh, 2010; Svoboda *et al.*, 2002). Furthermore, due to the complex nature of droughts, it is particularly challenging to collect objective field information on drought events (e.g., geographical extent and timing) and their direct or indirect impacts (Horion *et al.*, 2012). Under such circumstances, the true impact of droughts, particularly among the poorest of the population, is likely to be underestimated in Figures 3-18 to 3-20.

Owing to their diversity in terms of climate and topography, each province and region faces a diverse range of hazard threats. For example, the coastal areas of Pakistan are prone to cyclones and tsunamis, southern Punjab is mostly affected by the threat of droughts and flooding, Baluchistan is at risk of drought, earthquakes, and flash floods, Sindh faces the possibility of droughts and flooding, and Khyber Pakhtunkhwa is affected by earthquakes, landslides, avalanches, and flooding.

3.9 Exposure and vulnerabilities among the poorest segment of the population

3.9.1 Identification of the poorest people

To develop the proposed disaster insurance fund, it is critical to identify and document the poorest inhabitants of Pakistan and understand their vulnerabilities to different hazards. Several studies have attempted to identify, rank, and map poverty at the provincial and district levels, using a range of classification techniques and socio-economic indices. Arif and Farooq (2011) and Cheema and Sial (2012) previously reviewed the extensive literature available. Some studies have focused on agricultural and acro-climatic zone classifications. Pinckney (1989) proposed the first classification of poverty based on kharif crops. Malik (2005) and Irfan (2007) derived poverty incidence statistics based on the 2004–05 Household Integrated Economic Survey (HIES) and acro-climatic zones and differentiated between urban and rural zones at the provincial level.

Although poverty patterns emerged, Irfan (2007) suggested that differences in land distribution and ownership structures, within provinces and districts, were also significant factors in the incidence of poverty. These studies identified poor regions in Punjab that were reliant on cotton and wheat, and low-intensity zones consisting of seven districts, namely, Bahawalnagar, Bahawalpur, Bhakkar, Dera Ghazi Khan, Layyah, Lodhran, Muzaffargarh, Rahim Yar Khan, Rajanpur, and Vehari situated in south and south-west Punjab. In Sindh, the cotton and wheat zone has commonly been identified as a poorer region. Rural areas of the remaining two provinces, Baluchistan and Khyber Pakhtunkhwa, have been considered as two separate zones also among Pakistan's poorest regions. According to this regional or zonal classification of rural areas, South and West Punjab, the cotton and wheat belt of Sindh, and the rural areas of Baluchistan and Khyber Pakhtunkhwa Provinces represented Pakistan's poorest and most vulnerable regions.

Cheema (2010) used a poverty-mapping technique to rank districts; the findings did not differ from those based on zonal and regional classifications. Districts located in the southern part of Punjab were identified as the poorest districts, including Bahawalpur, Lodhran, Muzaffargarh, Rahim Yar Khan, Rajanpur, and Vehari. In Sindh Province, Badin, Dadu, Larkana, Shikarpur, and Thatta were identified as the poorest districts. In

Khyber Pakhtunkhwa Province, Batgram, Bonair, Kohistan, Malakand, Shangla, and Upper Dir were identified as the poorest districts, while the poorest districts identified in Baluchistan Province were Chagi, Jhal Magsi, Lasbella, Pishin, and Sibbi.

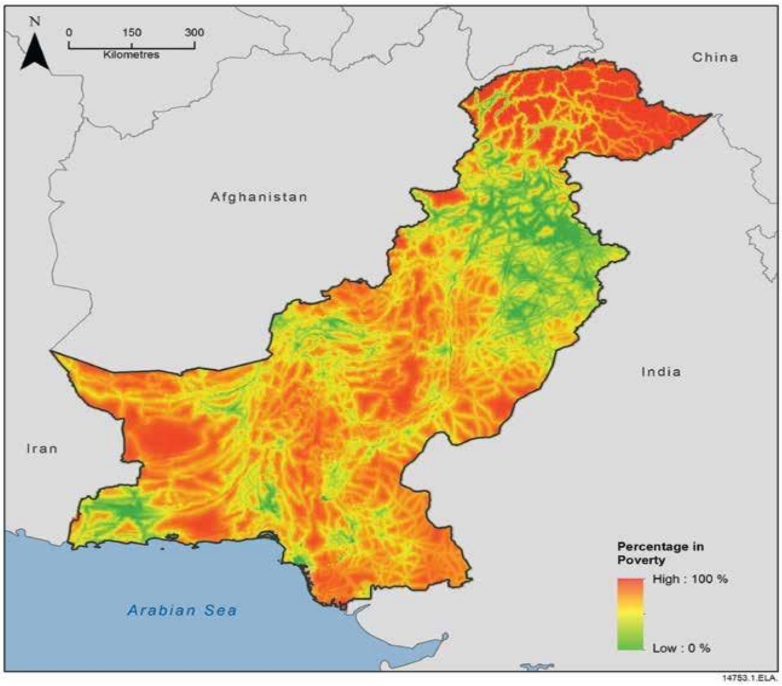

Figure 3-21: Percentage of the population living in poverty in Pakistan as defined by the multidimensional poverty index (Oxford Poverty and Human Development Initiative). Source: World Pop (2013). Permission was obtained the from original authors to reproduce this map for academic purposes.

Jamal et al. (2003) developed a Multiple Deprivation Index for each district based on the combined education, health, housing quality, housing services, and employment sector indices. Similarly, Said *et al.* (2011) developed a basic need index and an asset index using the Pakistan Social and Living Standards Measurement Survey (2008–2009) dataset. As noted by Arif *et al.* (2011), most studies have identified similar poverty patterns at the district level, regardless of the approach adopted. Figure 3-21 shows the distribution of the population of Pakistan living in poverty as of 2013.

3.9.2 Vulnerabilities among the poorest people

Vulnerability is the human dimension of disaster and is the result of a range of economic, social, cultural, institutional, political, and psychological factors that shape people's lives and the environments that they live in (Twigg, 2004). Vulnerability can be a demanding concept to understand, as it may be defined differently by different people, in addition to the fact that it is often described using a variety of terms, such as "predisposition," "fragility," "weakness," "deficiency," and "lack of capacity."

Previous definitions of vulnerability have included exposure and susceptibility to harm. However, it is now understood that the exposure element is distinct from the susceptibility element of vulnerability, since it is possible to be exposed, whilst at the same time not being susceptible, to natural hazards. Although some debate surrounds the precise meaning of vulnerability, most professionals agree that understanding vulnerability requires more than analyzing the direct impacts of a given hazard. Vulnerability also concerns the wider environmental and social conditions that limit the abilities of people and communities to cope with the impact of disasters (Birkmann, 2006).

Vulnerability relates to a number of factors, including physical factors (e.g., poor design and construction of buildings, and unregulated land-use planning), social factors (e.g., poverty and inequality, marginalization, social exclusion, and discrimination by gender), social status (e.g., disability and age), psychological factors, economic factors (e.g., the uninsured informal sector, vulnerable rural livelihoods, dependence on single industries, and globalization of business and supply chains), and environmental factors (e.g., poor environmental management, overconsumption of natural resources, decline of risk-regulating ecosystem services, and climate change).

Although vulnerability does not solely concern poverty, extensive research over the past 30 years has revealed that the poor tend to suffer most in the wake of disasters (Molinari *et al.,* 2015; Twigg, 2004; Wisner *et al.*, 2004). Poverty is both a driver and consequence of disaster risk (particularly in countries that have weak risk governance), since economic pressures force people to live in unsafe locations (i.e., exposure) and conditions (Wisner *et al.*, 2004). Poverty and the other multi-dimensional factors and drivers that create vulnerability mean that susceptibility to the impacts of hazards is often, though not always, associated with certain groups, including women, children, the elderly, the disabled, migrants, and displaced populations, amongst others.

To understand and capture the potential impact of different hazards on the poorest populations, it is necessary to establish the vulnerabilities of physical assets and the dependency of the poorest populations on those physical assets (e.g., crops). A considerable amount of research has been conducted with the aim of identifying the poorest among Pakistan's population, based on both quantitative and qualitative research. Such studies have named the following rural groups as the poorest: landless households, sharecroppers and small landowners, agricultural workers, construction workers, female-headed households, large households, and *zakat* recipients (Arif and Farooq, 2011).

From field surveys conducted in Punjab Province, Mustafa (1998) noted that a lack of infrastructure (e.g., schools, hospitals, and irrigation systems) was a contributing factor to vulnerability at the macro level. However, exposure and vulnerability were not equally distributed within communities, and were primarily a function of powerlessness and poverty. The spatial distribution of settlement favors the wealthiest; the poorest sharecroppers and landless tend to inhabit the low-lying fringes of the main village, while landlords and affluent individuals usually live on higher ground beyond the main inundation zones.

In Pakistan, rural housing, and particularly the housing of the poorest, is traditionally made of adobe structures classified as *pacca* (solid structures made of stone, brick, or cement) or *katcha* (timber frame), which are inexpensive to construct, using raw materials that are widely available and cheap. The vulnerability of such structures to meteorological and geological hazards has been documented in numerous studies, both in Pakistan and throughout different regions worldwide (Macuabag *et al.,* 2008; Maheri *et al.* 2005; Shah *et al.,* 2013). Most recently, Rafi *et al.* (2012) developed comprehensive fragility curves associated with different grades of damage. Understanding the source of salary among the most vulnerable is also a vital factor in identifying dependencies on other vulnerable physical features, such as crops. Large landowners and small farmers reported significantly higher income-loss percentages (67 percent and 77 percent, respectively) during flooding than did the landless (41 percent). Small farmers and landless households constitute a proportionately higher number of people with non-farming sources of income (Mustafa, 1998). They report seeking off-farm employment as insurance against a total loss of income in the event of flooding.

Irfan (2007) analyzed the dependence of households on various sources of income. The analysis confirmed the dependence of the poor on wages and the diversification of income sources. The role of wages was more significant among the landless and gradually declined as the size of one's landholdings increased. The share of non-farming (or enterprise) income was highest for the landless (33 percent), followed by small landholders (0.5 to 12.5 ha, 22 percent). For the remaining landowners, enterprise income accounted for less than 15percent of their total earnings. Income from crops and livestock accounted, on average, for more than 40 percent of the total income for those who owned more than 2 ha, and over 57 percent for the largest landowners (i.e., 10 ha or more).

In conclusion, extra-village and off-farm labor-market participation represents a response to lower levels of income from crops and livestock, either due to the scarcity of land resources or the concentration of land ownership amongst a limited number of inhabitants, as is the case in South Punjab and rural Sindh. Non-farming (or enterprise) employment has emerged as more important for the landless and small landholders, who supplement their income by engaging primarily in the low-productivity informal sector, most likely as a deliberate measure aimed at increasing their resilience in the event of a hazard.

3.10 Conclusion

Strong institutions play a vital role in smartly dealing with climate change. Clear policies and policy targets are also another key indicator of successfully addressing climate change. As discussed in Chapter-3, climate change impacts are now clearly visible in Pakistan and in rest of the developing world. Efforts to meet those impacts of climate change should also be in the same pace but so far, the countries have failed to achieve that pace due to financial problems, rapid population growth, lack of advance technologies, building resilient structures that can withstand natural disasters etc. Pakistan has started preparing for hydro metrological hazards after 2005 earth quake. It has established Ministry of Climate Change *(the first focal institution for climate change in the country)*, Green Climate Fund, Billion Tree Tsunami, building dams to address future water scarcity issues, improving infrastructure, communication within and among institutions at all level *(national to local)*.

Pakistan's National Climate Change Policy primarily focuses on adaptation compared to mitigation, by stipulating a set of policy measures for adaptation in the water resources, agriculture and livestock, human health, forestry, biodiversity, and other vulnerable ecosystem sectors. Similarly, regarding mitigation, a set of policy measures were recognized and prioritized in the energy, energy efficiency and conservation, transport, industries, agriculture and livestock, and forestry sectors. This national policy also acknowledges improved socio-economic gains by eliminating poverty, mainstreaming gender, and better town planning.

Furthermore, appropriate measures relating to disaster preparedness, capacity building and institutional strengthening, technology transfer, and international cooperation for *"Naya*[3] *"* Pakistan's stance regarding climate change at various international forums have also been incorporated as important components of the policy. In recent years, climate change policy of Pakistan has been shifted towards adaptation. Previously, a lot of attention was given to mitigation measures. However, now it is realized that mitigation efforts generally take longer than adaptation measures. It is evident from national climate fund that now more funds are allocated for adaptation than previously. Moreover, adaptation techniques are considered easy to do even at a smaller scale if not national. Though, funds have been raised, but in agriculture sector, however, help from government bodies is not yet visible on the ground which can assist rural farmers' in reaching "no regret adaptation" situation.

[3] Naya is an Urdu language word which means new or in the context of this study it also means better Pakistan

4 CHAPTER 4: CLIMATE CHANGE GOVERNANCE IN PAKISTAN

4.1 Summary

The main goal of Chapter four is to identify institutional setup, and its role for dealing with climate change, disaster management, and explore policies at all levels (national, provincial and district/local) made to combat climate change. The role of strong institutions is crucial in efficiently addressing climate change. However, this is not always the case in the developing world. Pakistan is also not an exception. However, in the recent decade, Pakistan has made steady progress in establishing institutions and documenting policies for combating climate change and its associated risks especially at national and provincial levels. Institutions at local level are yet to be made active on the ground.

This chapter starts with setting a background for the importance of how strong institutions can play effective role in smartly dealing with addressing risks and provide details about progress on institutionalization of climate change in Pakistan. Later, it documents disaster risk management arrangement, organizations and line-ministries responsible for reducing damages from disasters such ministry of climate of change, and its linkages to key sectors such as agriculture, forestry, and environment. The analysis also explores the 2013 framework for implementation of climate change policy, its strengths and weaknesses. Role of environmental protection agencies, funding landscape for climate change mitigation and adaptation at national, provincial and domestic level are also part of the analysis. In the last section of the chapter, all arguments made are concluded and suggestions are made based on its thesis.

4.2 Introduction

Robust institutions play a significant role in effectively addressing climate change and mainstreaming the problem in national policies and development agendas (Adger, 2006). Such institutions ultimately assist in building resilience and promoting adaptation. However, developing countries, including Pakistan, suffer from inefficient and weak institutional structures, ultimately yielding inferior governance systems.

The institutionalization of climate change in Pakistan has its roots in the early environmental efforts that were initiated as early as the mid-1970s (Chaudry, 2017). Pakistan signed and ratified 14 international environmental commitments from 1971 to

2001, including the UNFCCC and the Kyoto Protocol, which acted as stimuli in initiating and guiding policy processes and efforts on climate change in the country. Considerable progress has been made in establishing institutional structures for guiding the country's environmental initiatives (Abid *et al.,* 2015). However, over 40 years later, these efforts remain fragmented, with insufficient coordination, political support, and ownership. After the 18th constitutional amendment was passed in 2010, the Ministry of the Environment was devolved to the provincial level, and a new Ministry of Disaster Management was established in 2011. This was later retitled as the Ministry of Climate Change in 2012, thus raising the profile of the climate change issue to a cabinet-level portfolio. In 2013, the Ministry of Climate Change was downgraded to a division of the Cabinet Secretariat and remained in this position until early 2015, when it was upgraded to the level of a ministry again. Table 4-1 outlines the institutionalization of the environment and/or climate change in Pakistan.

The present chapter explores the institutional structure that is in place to deal with climate change and evaluates Pakistan's disaster management system. The chapter provides an overview of disasters in Pakistan, the causes of Pakistan's vulnerability to disasters, and climate change impacts, as well as the legal framework for disaster management in Pakistan. Institutional and organizational arrangements and problems in the current system are also discussed.

Frequent changes in policy focus and status within a single institution convey two important messages. First, all stakeholders and decision-makers fully understand (or at least understand to an evolving degree) the linkages and interdependencies of environmental issues, initially with regard to disaster management, and subsequently within the broader theme of climate change. Key policy documents support this gradual increase in framing climate change, such as the Economic Survey of Pakistan (2012–2014), the Poverty Reduction Strategy Paper II (2009), compiled by Amin (2009), and the Framework for Economic Growth (2011). Second, it reflects a rather reactive and divided approach toward managing environmental and climate change-related issues, without a concrete course of action. This creates confusion among the key policy-makers when it comes to linking and decoupling the two issues, which can be traced, again, through key policy documents. For example, the Economic Survey of Pakistan (released by the Ministry of Finance) had acknowledged the Climate Change Policy since 2012, albeit under the environment section.

Table 4-1: Institutionalization of climate change in Pakistan

Year	Accomplishment	Purpose and/or Function
1974	Environment and Urban Affairs Division established at the Federal level	Follow-up to Stockholm Declaration in June 1972
1983	Pakistan Environment Protection Ordinance enacted	First comprehensive environment-specific legislation
1989	Environment and Urban Affairs Division upgraded to Federal Ministry of Environment, Forestry, and Wildlife	
1991–1993	National Conservation Strategy prepared National Environmental Quality Standards adopted in 1993	It provided the broad framework for addressing environmental challenges
1995	Cabinet Committee on Climate Change established	Acted as policy coordination forum for climate change
1997	Pakistan Environmental Protection Act enacted	First environmental act of the country
2002	Global Centre for Impact Studies on Climate Change established	This research center on climate change functioned for 10 years as a developmental project
2004–2005	Prime Minister Committee on Climate Change convenes National Environment Policy	Included Prime Minister, Ministers of Water and Power, Food and Agriculture, Science and Technology, Environment, Planning Commission, and Special Advisor to the Prime Minister
2006	National Energy Conservation Policy National Renewable Energy Policy Clean Development Mechanism National Operational Strategy	
2010	18th Amendment to the 1973 Constitution	Devolution of power to the provinces
2011	Ministry of Environment ceases to exist New Federal Ministry of Disaster Management established	Functions transferred to the Planning Commission

Continued…

Year	Accomplishment	Purpose and/or Function
2012	Ministry of Disaster Management renamed to the Ministry of Climate Change National Climate Change Policy approved by Federal Cabinet Punjab and Baluchistan Environmental Protection Act prepared and enacted "Green Benches" established in all High Courts and Supreme Court of Pakistan by the Chief Justice of Pakistan National Disaster Management Plan approved National Sustainable Development Strategy	Elevate climate change issue to a cabinet level portfolio A dedicated policy on climate change Deals with environmental cases; 2013 decision prioritizes environmental cases in the High Courts
2012	Ministry of Disaster Management renamed to the Ministry of Climate Change National Climate Change Policy approved by Federal Cabinet Punjab and Baluchistan Environmental Protection Act prepared and enacted "Green Benches" established in all High Courts and Supreme Court of Pakistan by the Chief Justice of Pakistan National Disaster Management Plan approved National Sustainable Development Strategy	Elevate climate change issue to a cabinet level portfolio A dedicated policy on climate change Deals with environmental cases; 2013 decision prioritizes environmental cases in the High Courts
2013	Ministry of Climate Change downgraded to Division of Climate Change Global Climate Change Impact Studies granted autonomous status National Disaster Risk Reduction Policy approved	Becomes part of Cabinet Secretariat Serves as the secretariat for the Prime Minister Committee through "GCISC Act 2013"
2014	Framework for Implementation of Climate Change Policy adopted	

Source: Qamar, 2017.

In the ensuing subsections, I briefly discuss the various institutional arrangements that support climate change, directly or indirectly, at the federal and provincial levels. I also examine the challenges encountered in mainstreaming climate change in the country, information gaps, and ownership.

4.3 Evolution of climate change institutional arrangements in Pakistan

Pakistan's first comprehensive piece of legislation concerning the environment was enacted in 1983 as the Pakistan Environmental Protection Ordinance (PEPO). It established a number of institutions, such as the Federal and Provincial Environmental Protection Agencies (EPAs) and the Pakistan Environmental Protection Council (PEPC). The Pakistan Environmental Protection Act (PEPA) later repealed PEPO, in 1997. The PEPA provided the framework for the implementation of a national conservation strategy, establishment of Provincial Sustainable Development Funds, establishment of Environmental Tribunals, and the appointment of Environmental Magistrates for these. It also established the Initial Environmental Examination, and the Environmental Impact Assessment.

EPAs and councils are currently established at both the federal and provincial levels. The Prime Minister chairs the PEPC, which comprises 35 members, including the chief ministers of various provinces. Historically, the PEPC has been relatively inactive; it convened only once in the first 10 years of its existence after 1984, and there does not appear to be a more frequent meeting schedule imminent. After the 18th constitutional amendment, various powers of the federal EPA were delegated to provincial governments. However, the rule-making power of the federal government under Section 31 and regulatory power of the federal EPA under Section 33 were not delegated. Currently, both the EPA and the PEPC function as attached departments of the Ministry of Climate Change.

4.4 Disaster risk management arrangements

According to a report by the NDMA (2011), various activities are undertaken by different organizations to manage Pakistan's disaster risk. For example, mitigatory measures should be applied to infrastructure by the relevant governmental organizations during the pre-disaster phase. The necessary resources, in case of emergency and evacuation drills, should be procured by everyone during the pre-disaster phase. While a disaster is ongoing, search and rescue teams should rescue people at the disaster site. Coordination among the relevant organizations for relief goods should be conducted appropriately during a disaster. In the aftermath of a disastrous event, infrastructure should be reconstructed by the relevant governmental organizations. Everyone should invest effort in the recovery and reconstruction process. Therefore, disaster risk management encompasses a range of activities that must be enacted by various parties.

To enhance a society's resilience to disasters, it is necessary to clearly identify all parties involved in disaster management and strengthen their capacity so that all necessary measures may be implemented (Walker *et al.*, 2002). To clarify the targets and content for human resource development in the field of disaster management, it is important to know what types of stakeholder groups exist in relation to disaster management and which competencies each type of stakeholder group requires, so that their roles in disaster management can be effectively and efficiently maximized.

It is crucial to strengthen the capacity of stakeholder groups that invest self-help efforts, mutual-help efforts, and public-help efforts in the mitigation of disaster damage (NDMA, 2011). When these three types of effort are exerted to their highest potential, society's resilience against disasters is significantly enhanced. Self-help efforts constitute the measures implemented by everyone aimed at minimizing the damage inflicted by disasters, such as confirming evacuation routes, keeping emergency bags, and reinforcing buildings against disastrous events. Mutual-help efforts involve the activities undertaken by community-based organizations, such as preparing a community risk map, conducting evacuation drills within the community, and providing mutual assistance at evacuation camps. Public-help efforts constitute the strategies implemented at the government level aimed at risk reduction, such as mitigating the risks of public infrastructures, maintaining emergency equipment, providing search and rescue services, managing evacuation camps, and implementing recovery measures. The stakeholder groups that are expected to invest these efforts (i.e., the main stakeholder groups) should be prioritized for enhancement. Figure 4-1 indicates the stakeholder groups that exist in Pakistan with regard to these three types of effort.

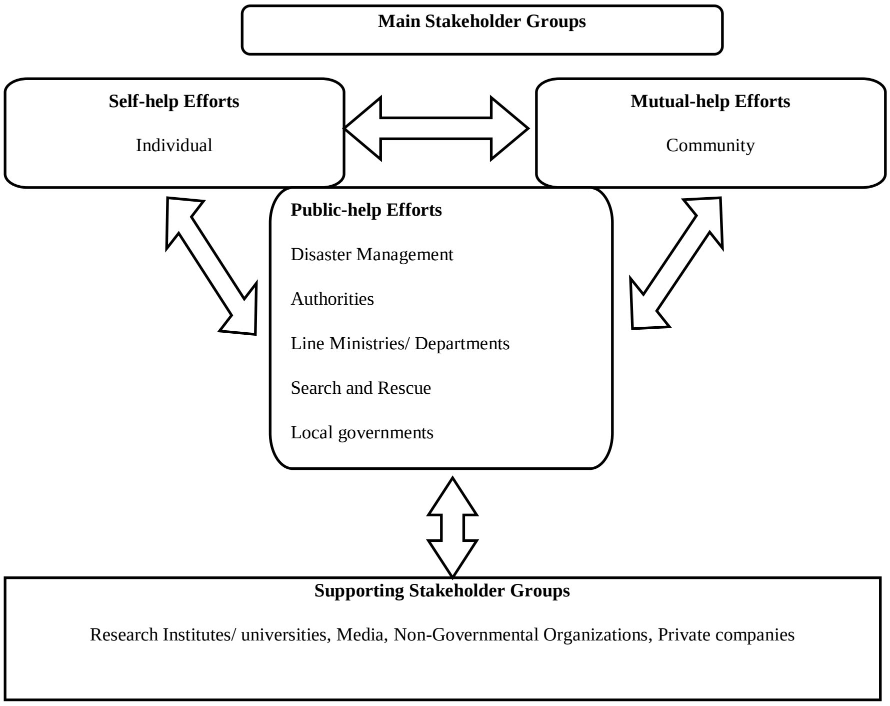

Figure 4-1: Stakeholder groups in disaster management in Pakistan
Source: By author using data from National Disaster Management Authority, Pakistan, 2016.

The October 2005 earthquake caused the death of more than 75,000 people in northern Pakistan. As a result of the extensive destruction, Pakistan commenced national efforts to develop a structure for disaster management, focusing on avoidance, mitigation, and integration of responses by conducting a review of traditional disaster management systems and policies on emergency response.

Pakistan has three levels of governance: national, provincial/state, and district. At the provincial/state level, the Provincial/State Disaster Management Authorities (F/G/S/PDMAs)[4] are the focal points of disaster management. Just as at the national level, the Provincial Disaster Management Commission is headed by the Chief Minister (or the Prime Minister of Azad Jammu and Kashmir) of the respective province, who acts as Chairman of the Commission. At the district level, District Disaster Management Authorities (DDMAs) are established in selected hazard-prone areas.

[4] Disaster Management Authorities (DMAs) exist at the regional level in special administrative areas (i.e., Federally Administered Tribal Areas and Gilgit Baltistan), at the state level (AJ&K), and at the provincial level (in Punjab, Sindh, Khyber Pakhtunkhwa and Baluchistan). The abbreviations F/G/S/PDMA are applied at these regional levels.

At present, the institutional setup for disaster risk reduction in the country is a prime representative of the cross-sector mainstreaming of climate change in government. This is evident from its effective and prioritized mainstreaming through appropriate policy, legal and institutional arrangements, and implementation of strategies and programs to minimize risks and vulnerabilities. Since its existence, NDMA has gained strong political support and ownership from the legislature and executive branches of the government.

The National Disaster Management Council, headed by the Prime Minister of Pakistan, is an apex national policy-making body for disaster management. Other members of the National Disaster Management Council include the leaders of the opposition parties in parliament, the chief ministers of all provinces, the governor of Khyber Pakhtunkhwa, the chairperson of the Joint Chiefs of Staff Committee, ministers for defense, health, foreign affairs, social welfare, special education, finance, communication, and the interior, and representatives of civil society. The Disaster Management Authority is present at the national (i.e., NDMA), provincial (i.e., PDMA), and district (i.e., DDMA) levels to manage and coordinate disaster-related activities. The NDMA serves under the Ministry of Climate Change, and unfortunately suffers from a lack of a separate and dedicated budget line; therefore, its response to risk mitigation is mainly reactive and is enacted on an ad hoc basis. Furthermore, institutional incapacity arises from a lack of access to research on climate change impacts and discrete adaptation and/or mitigation plans.

4.5 The Ministry of Climate Change

The Ministry of Climate Change is the focal institution for climate change in Pakistan. It evolved from the Ministry of Environment after the 18th constitutional amendment in 2010, when the Ministry of Environment was dissolved as a result of the devolution of power to provincial governments. While the environment is now under the jurisdiction of the provincial governments, climate change remains a federal concern, given the need for a national response and representation in international climate change negotiations.

Pakistan is highly vulnerable to climate change impacts; the future cost of climate impacts is estimated at US$ 6–14 billion per year over the next 40 years (Khan *et* *al.*, 2011) However, the issue has failed to capture the proper attention and be given the urgency needed to address its far-reaching consequences. In July 2013, when the Ministry of Climate Change was demoted to a Climate Change Division, its budget was slashed by more than 60 percent of its annual spending. The Climate Change Division regained ministry status as of January 2015 but was not given a new budget or projects. After the 18th constitutional amendment, the Ministry's role was limited to coordination and facilitation in collaboration with the provinces and international forums.

The Ministry of Climate Change handles and supports both the Clean Development Mechanism (CDM) and Reducing Emissions from Deforestation and Forest Degradation (REDD+) initiatives in the country. Guided by the CDM Strategy (2006), the CDM cell inside the Ministry of Climate Change is the Designated National Authority on CDM projects in Pakistan. The strategy allows for unilateral, bilateral, and multilateral CDM projects, preferably in the area of energy, including renewable energy, energy efficiency, energy conservation, and fossil fuel cogeneration; land use, land-use change, and forestry (e.g., biodiversity protection, soil conservation, watershed maintenance, and sustainable forest and rangeland management); agricultural and livestock practices; waste management (e.g., landfills, solid waste management, recycling, and animal and livestock wastes); transportation (e.g., alternative fuel vehicles, mass transit systems, cleaner engines, and compressed natural gas); and industrial processes. Appendix 2 presents a full list of CDM projects.

Finally, other ministries, namely, power, energy, food security, and research, have some responsibility for climate change-related policies. The Ministry of Power is of particular interest, as it is responsible for the key area of mitigation with regard to power generation and adaptation for water resources. This role overlaps with that of the Ministry of Climate Change but transfer and delegation of oversight remains difficult and contested, due in part to the relative newness of the climate change institution, which has less political ownership or necessary indispensable resources.

4.6 Climate change linkages to key sectors

Climate change is a cross-sector issue, and this necessitates strong linkages with other key sectors of the economy that are particularly sensitive and vulnerable to the effects of climate change. The extent to which climate change is integrated in policy instruments across key sectors provides an indication of the extent of climate change mainstreaming. In this subsection, various key sector policies, and specifically the National Climate Change Policy (NCCP), are examined.

4.6.1 National climate change policy

The NCCP is the main document that informs the policy framework for climate change in Pakistan. In early 2011, the Ministry of Environment, in collaboration with UNDP Islamabad, initiated the process of developing the country's first climate change policy, which took around 1.5 years of extensive consultation to formulate. It was approved by the Federal Cabinet in September 2012, and subsequently launched by the newly formed Ministry of Climate Change in February 2013.

4.6.2 Policy analysis

The NCCP constitutes a mechanism in the overarching framework designed to address the challenges that Pakistan faces, or will face in the future, due to climate change. The policy outlines some major climate-induced threats, before laying out the policy measures for different sectors. The document adopts a sector-based approach and recognizes the importance of developing both adaptation and mitigation strategies for combating climate change-related threats.

The main objective in documenting this national policy is to address the issues that arise from climate change and determine how the country might continue to progress economically while negotiating these problems. Therefore, the ultimate goal of this policy is "to pursue sustained economic growth by appropriately addressing the challenges of climate change." This goal acknowledges that the challenges and opportunities presented by climate change cannot be separated from the country's broader development goals. However, thus far, the development policies have placed greater emphasis on economic and human development than on issues directly related to climate change. Short-term development goals, publicized in annual plans, focus on macro-economic stability and the achievement of high GDP growth rates, while medium-term development goals, as outlined in the Poverty Reduction Strategy Paper II and the Medium-Term Development Framework, focus on increasing human development by reducing poverty. Under Pillar IV of the Poverty Reduction Strategy Paper II, the Integrated Energy Development Program acknowledges the nexus of poverty reduction and environmental sustainability.

The subject of climate change only arises under the section on National Environmental Policy and is limited to "its potential to reverse progress in Millennium Development Goal achievements." Similarly, the Vision 2030 document only makes brief mention of climate change under "challenges - mitigating climate change," without offering any clear direction regarding what the vision is or where it is expected to take the country, with respect to addressing how climate change may affect the gains of other socio-economic policies, such as macro-economic policies and those related to social stability, poverty reduction, human development, and improved governance (GoP, 2007).

The National Climate Change Policy prioritizes adaptation techniques over mitigation measures, by stipulating a set of policy measures for adaptation in the water resources, agriculture and livestock, human health, forestry, biodiversity, and other vulnerable ecosystem sectors. Similarly, with regard to mitigation, a set of policy measures were recognized and prioritized in the energy, energy efficiency and conservation, transport, industries, agriculture and livestock, carbon sequestration, and forestry sectors. The policy acknowledges better socio-economic gains through tackling climate induced-poverty, mainstreaming gender, and improving town planning. Furthermore, appropriate measures relating to disaster preparedness, capacity building and institutional strengthening, technology transfer, and international cooperation for raising Pakistan's stance regarding climate change at various international forums have also been incorporated as important components of the policy. Pakistan's NCCP also incorporates an implementation plan, which emphasizes the development of "climate change action plans" by all relevant ministries, departments, and agencies at the federal, provincial, and local government levels. Furthermore, "implementation committees" at the national and provincial levels reporting to the Prime Minister Committee on Climate Change are considered a key institutional structure for moving forward with mainstreaming climate change and implementing policy.

4.6.3 Strengths of the national climate change policy

An extensive consultation process surrounded the formulation and development of the first NCCP. It involved all sectors' federal ministries, provincial governments, and all relevant stakeholders, including federal and provincial line departments, academia, nongovernment organizations, and civil society organizations. All provinces were also fully involved during its developmental phase; this was precisely the time when, under the 18th constitutional amendment, devolution was taking shape and all stakeholders were clear that the ultimate responsibility for its implementation would rest with the respective provinces. The federal government is required to fulfill national and international coordinator and facilitator roles, which entail providing the support required to access international climate-related financing.

The policy is comprehensive and inclusive. While it provides adequate cover for the adaptation and mitigation challenges that face different development sectors of the economy, it does not overlook the gendered aspects of climate change and the impact of climate change on poorer and marginalized groups within society. Furthermore, the policy was developed based on insights gleaned from the IPCC Fourth Assessment Report, but it also aligns with the findings and scenarios of the IPCC Fifth Assessment Report. The policy is indirectly informed and supported by a range of regulatory and policy documents, such as the National Disaster Risk Reduction Policy (2013), Renewable Energy Policy (2011), draft National Sustainable Development Strategy (2012), and the regulations establishing the Designated National Authority for the CDM.

4.6.4 Challenges of the national climate change policy

Under the 1973 Constitution of Pakistan, the subject of "environmental pollution and ecology" was included on the "Concurrent Legislative List," meaning that both Parliament and Provincial Assemblies were empowered to legislate in this area (Table 4-2). Following the 18th constitutional amendment, the subject of "environmental pollution and ecology" along with 46 other subjects, including health, education, food, agriculture, irrigation and population, livestock, forestry, biodiversity and conservation, and socio-economic and welfare responsibilities were devolved to the provinces. However, federal power and authority persisted, ensured through Clause 6 of Article 270 AA (Declaration and Continuance of Laws, etc.). Therefore, the federal government could continue to fulfill its role and responsibility in handling environmental issues and climate change. Federal and provincial bodies have neither challenged nor clarified this situation.

The efficacy of the NCCP is generally hampered by several challenges that are inherent in climate change. The time frame for the consequences of climate change impacts extends to decades and even centuries. The current planning structure of the government hinders its ability to deal with such long-term issues. Examples of these challenges are outlined as follows:

- Long time allotment for the effects of environmental change to unfurl and be felt is an imperative to viable strategy and arranging detailing and usage, while the improvement designs regularly cover a here and now of a substantial portion of 10 years.
- Cross-division and multidisciplinary approach is required to comprehend the ramifications of environmental change and react as needs be. It requires a scope of aptitudes and mastery inside the legislature, to address numerous measurements of climate change.
- Strong intrigue bunches with fewer washouts and many scattered victors and National and international jurisdiction.

Table 4-2: Summary of changes in responsibilities between the federal and provincial levels of government before and after the devolution of the 18th constitutional amendment in 2010

Responsibilities	Legislative Responsibilities: Changes Due to the 18th Constitutional Amendment of 2010	
	Before	After
Federal responsibility	Federal Legislative List	Revised Federal Legislative List Parts I and II. Federal Government has exclusive domain in Part 1. All policy decisions on subjects in Part II shall be decided by the Council of Common Interest.
Shared federal and provincial responsibility	Concurrent List	
Provincial responsibility	(Residual subjects not mentioned in either of the two lists)	All residual subjects not mentioned in the Federal Legislative List.

Source: United Nations Development Programme. Climate Public Expenditure and Institutional Review Study. Islamabad, 2015.

The most serious challenge facing climate change policy is its implementation. The NCCP renders the colossal task of policy implementation contingent on the development of an “action plan” at the federal, provincial, and local government levels. With a lack of certainty and limited understanding of the administrative and legal powers of the regulations, policies, and programs transferred to the provinces, it appears that there is less motivation in adopting a policy with nebulous directives. Furthermore, the government tends to prioritize other, more immediate challenges, such as terrorism and energy shortfalls. Most efforts and financial resources are used up by these problems, with limited time or financial resources remaining to deal with climate change aspects. Another challenge is the erosion of climate change-policy ownership by the provinces, due to potentially conflicting or overlapping objectives, duties, and preferences among provinces and federal agencies.

The mainstreaming of the NCCP into public sector discourse is impossible without effective vertical and horizontal coordination efforts with full involvement of all stakeholders from the government, civil society, technocrats, private businesses, and the public. In the past, formal institutionalized coordination efforts have largely been horizontal, involving mainly the government sector. An effective vertical coordination among federal, provincial, and local governments has not yet begun.

The Cabinet Committee on Climate Change, established in early 1995, marked the government's earliest coordination effort. It was later rebranded as the Prime Minister Committee on Climate Change in 2004. This committee is the uppermost political body directing climate efforts and is required to meet annually. It is headed by the Prime Minister of Pakistan, and includes the ministers for water and power, food and agriculture, science and technology, and the environment. The deputy chairman of the Planning Commission and the special advisor to the Prime Minister are also involved. The Committee's mandate is to provide the directive to policy formulation on climate change in the country; however, the body has suffered from a lack of sustainability and has been ineffective in building inter-ministerial linkages (Khan and Munawar, 2011).

The then-Ministry of Environment established the Core Group on Climate Change, with the aim of formulating Pakistan's approach and strategies to the negotiation underway at the UNFCCC, following the adoption of the Bali Plan of Action (2007). The group was composed of members of civil society, think tanks, and various ministries. The efficacy of this group was largely hampered by the other important ministries' apparent lack of interest in the issue, and it became inactive by the end of 2013.

The provision of climate change data and information is considered to be a primary motivational variable for mainstreaming the climate change issue that reduces uncertainty in decision-making processes (Field *et al.,* 2014). In the case of Pakistan, the lack of information and scaled-down data on the impact of climate change and its associated responses poses a major challenge in the implementation and mainstreaming of the NCCP.

Currently, proof of the direct impacts of climate change on growth is relatively scarce compared to evidence on natural disasters. At the federal level, each ministry has its own system for collecting and using data, mostly supported by the attached research institutions. For example, the Ministry of Water and Power generates water- and energy-related data through its organizations, including the Water and Power Development Authority (WAPDA), Alternative Energy Development Board (AEDB), and the National Energy Conservation Centre. Similarly, the Ministry of Food Security and Research generates and collects data from the Pakistan Agriculture Research Centre (PARC). Some agencies, such as the PMD and Global Change Impact Studies Centre (GCISC) under the Ministry of Climate Change, generate climate-related information. However, among the ministries and sectors, coordination, communication, and information-sharing remain poor.

At the provincial and local levels, this system of information generation and dissemination is fragmented and incoherent and is hampered by a lack of legitimacy and authenticity. Policy-makers are unable to make concrete decisions owing to the lack of specific information on adaptation and mitigation.

The following are some of the vital research institutions working on distinctive features of country-specific climate change issues and impact assessments. It is worth noting that scientific research related to climate change overlaps considerably across these institutions, since the country currently lacks a centralized coordinating system to track research programs and avoid overlapping efforts. For example, the WAPDA, GCISC, and the water wing of the PARC all focus on glaciers, mainly in isolation. These institutions are also hindered by the dearth of human and financial resources.

The PMD, established in 1947, recognizes itself as both a scientific and a service department, and functions under the Aviation Division of the Cabinet Secretariat. It researches, collects, and (re)broadcasts scientific information on a breadth of topics, ranging from early warnings of natural hazards (e.g., drought, flood, tropical cyclones, tsunamis, and seismic activity), weather data relevant to the agricultural community, global warming, and research for renewable energy resources. It also provides advisory services in the fields of planning and development, town planning, and infrastructure. The PMD is prominent as one of the primary organizations in the country that produces data that directly supports climate change efforts at the local level.

The PMD is divided into four divisions:

- National Centre for Drought Monitoring, Islamabad
- Research and Development Division, Islamabad (This division is working on GLOFs in Northern Pakistan in coordination with UNDP)
- Flood Forecasting Division, Lahore
- National Seismic Monitoring and Tsunami Warning Centre, Karachi

The meteorological services are extended on a regular basis to some of the purely scientific and hybrid organizations involved in both data production and decision-making at the higher level of governance. Among these are the Civil Aviation Authority, PARC, NDMA, Climate Change Division, Federal Flood Commission, Ministry of Religious Affairs and National Food Security, and water sector agencies. Likewise, the PMD is a member of the World Meteorological Organization and the South Asian Association for Regional Cooperation Meteorological Research Centre in Dhaka, Bangladesh.

The GCISC is an autonomous and dedicated institution for the impact of climate change on Pakistan and serves as the Secretariat to the Prime Minister Committee on Climate Change. Established in 2002, it functioned as a Public-Sector Development Project for 11 years. It attained the status of a national entity in 2013 through the GCISC Act 2013. Its function encompasses several areas of research, ability building, information dissemination, and aid to national planners and policy-makers from the water, energy, food, agriculture and livestock, forestry and biodiversity, health, ecology, and recent technology sectors. Among research initiatives, the GCISC is engaged in studying the effects of climate change on glaciers in the Himalayan region.

A board of governors chaired by the federal minister for climate change oversees the GCISC. Other members include scientists, technical experts from the provinces, private sector representatives, various federal and provincial ministries, the NDMA, the Pakistan Space and Upper Atmosphere Research Commission, and the PMD.

The PARC is an autonomous body with the mandate to provide science-based solutions to the agriculture sector and is administered by a board of governors headed by the Minister for National Food Security and Research. Other ministries represented in the board are finance, planning and development, food, agriculture and livestock, and science and technology; the PARC is a prime research and policy organization in the agriculture sector.

The Pakistan Council of Research in Water Resources (PCRWR) is an apex autonomous body established with the objective of conducting, organizing, coordinating, and promoting research in all aspects relating to water resources. Since its inception, the PCRWR has fulfilled its role as a national research organization by undertaking and promoting research, both fundamental and applied, across various disciplines pertaining to the water sector. More specifically, it oversees irrigation, drainage, surface and groundwater management, groundwater recharge, watershed management, desertification control, rainwater harvesting, water quality assessment and monitoring, and the development of innovative water resource management, conservation, and quality improvement technologies. However, it is important to note that the organization does not consider climate change to be among the primary challenges facing water management in Pakistan.

The overall decision-making body of the PCRWR is its Board of Governors. The Federal Minister (Scientific and Technological Division) of the Ministry of Science and Technology is the President of the Board of Governors, and its Secretary is the Vice President of the Board of Governors.

The WAPDA, established in 1958, is a semi-autonomous body with responsibility for the water and power sector. In 2007, it was bifurcated into two separate entities: WAPDA and the Pakistan Electric Power Company. The former is responsible for all aspects of water and hydropower development, including irrigation, drainage and water supply, flood management, prevention of water logging and salinity, and inland navigation, while the latter handles thermal power generation, transmission, distribution, and billing.

The WAPDA has two important wings: water and power. The power wing is responsible for hydropower generation, while the water wing is more active, since it deals with all water-related areas. In addition, the coordination and monitoring sub-wing oversees coordination among the various WAPDA formations with the Ministry of Water and Power and other national and international organizations and ministries. Finally, the WAPDA has its own research wing and produces science-based information related to issues and challenges surrounding water and power.

4.7 Other supporting policies and framework

4.7.1 Framework for implementation of climate change policy

The framework formulated in 2013 provides a guideline for the implementation of the NCCP by considering both the current and future anticipated climate change-related threats to the country. In line with the NCCP's policy measures, it establishes a comprehensive list of strategies for both adaptation and mitigation, as well as actions for each key sector primarily identified in the NCCP, while prioritizing adaptation efforts at the sector level.

The framework document aims to provide a fundamental building block for the development of a National Adaptation Plan, National Appropriate Mitigation Action, and the preparation of the Second National Communication to the UNFCCC.

The implementation time frame ranks action strategies into priority action (within 2 years), short term (5 years), medium term (10 years), and long term (20 years), and identifies the relevant organizations and ministries to play a role in each. However, the framework does not assign clear roles and responsibilities to these organizations and, most importantly, does not itemize how coordination among these organizations would be effective regarding institutional power and authority after the 18th constitutional amendment.

The framework lists the key factors for its success, including building high-level political support, in addition to cultivating interest from the donor community and attracting international climate financing. It pinpoints the donor community's lack of interest in climate change-related initiatives as a major implementation challenge for the mainstreaming of the NCCP. Similarly, it discusses the crucial role of the private sector in the successful implementation of climate change adaptation and mitigation programs in Pakistan.

4.7.2 National disaster risk reduction policy

The National Disaster Risk Reduction Policy (2013) aims to build the nation's resilience by reducing its exposure to several types of hazard, adopting principles to strengthen community resilience by improving vulnerability and risk assessments through a multi-hazard approach, and assigning a clear division of roles and responsibilities, interorganizational partnership, and accountability and transparency (National Disaster Risk Reduction Policy, 2013).

The policy objectives recognize climate change-related challenges in the context of national capacity building and development planning, as follows:

- Creating an integrated national capacity to identify and monitor vulnerability and hazard trends, including the potential impact of climate change.
- Promoting development planning that considers and addresses disaster risk alongside environmental and climate change-related concerns.

However, although the vision statement emphasizes the development of national resilience against natural and manmade hazards, it overlooks the strong connection between climate change and the increasing frequency and intensity of disasters with the potential to erode the resilience of communities. It envisions "a Pakistan that builds up its resilience to shocks from natural and man-made hazards with a sense of urgency, creating a solid base to address disaster risk reduction in vulnerable areas, while involving an increasingly wider range of stakeholders..."

It is crucial to highlight that the current policy document is not synchronous with the focus of the NCCP. The issue of disaster risk reduction is assigned a separate section in the NCCP, but in the National Disaster Risk Reduction Policy, which was formulated after the NCCP, the acknowledgement of climate change rarely exceeds one-liners that primarily acknowledge its role in the context of hydro-meteorological hazards, such as floods, droughts, and melting glaciers in northern Pakistan.

4.7.3 Provincial disaster management authority

Following the occurrence of a devastating earthquake in 2005, the central government decided to establish an organization to manage disaster at the provincial level. Since then, in Khyber Pakhtunkhwa, provincial disaster management has assisted people through rescue, relief, and rehabilitation efforts in disaster-affected areas throughout the province. To ease its workload and improve its response to disasters by helping those in need, disaster units have also been established at the district level and continue to function well.

There are also efforts to support coordination among other organizations, such as universities, disaster-related research organizations, nongovernment organizations, district governments, elected representatives at the district and union-council levels, to better respond to disasters by informing local communities in disaster-prone areas, provide relief items, and help with rescue efforts. Such work is primarily undertaken by the PDMA and DDMA through coordination with locals. The PDMA has contacts in disaster-prone districts and, as such, is the first port of call when an incident occurs. The PDMA also trains local people, particularly in disaster-prone areas, and elected representatives at the union-council level are in regular contact with the PDMA. In the event of a disaster, these are the people that the PDMA contacts to ensure that help is provided to those who need it by utilizing the district's resources before provincial teams reach the affected area. Additionally, they train volunteers who can help in the event of a disaster.

As part of the monsoon contingency-planning process each year, the PDMA asks district governments throughout the province to inform the provincial government of available resources and additional resources needed for disaster risk reduction during the planning phase. Later, the chief minister of the province approves these plans and all districts are provided with the required resources to combat disasters; these include not only tools needed for rescue or relief, but also money provided to the district governments to assist in the event of losses or casualties due to disasters (i.e., US$ 6,000 per death or

US$ 1,000–2,000 per injured person). In each district, the provincial government must ensure that the PDMA has a bank account in which 2–6 crore rupees must always be present for emergency response, and any money used from that amount is replenished by the provincial government. The PDMA warehouse of Khyber Pakhtunkhwa is in Nowshera, where it houses 10,000 tents, kitchen utensils, beds, futons, and other necessary supplies.

A provincial emergency operation center is always connected to a satellite, so that it can communicate easily with all disaster-concerned organizations at the national and district levels. In each department, including irrigation, planning and development, health, and education, there are also control rooms that can be contacted easily and swiftly, should the need arise. Pakistan’s army and air force, as well as environmental organizations (i.e., via weather reports), usually warn and alert civilians if a disaster seems likely. Currently, all disaster- or hazard-prone buildings (e.g., schools and hospitals) in the province are being identified, and a policy will subsequently be devised for their reconstructions, since safe buildings are instrumental in keeping people safe during disasters and ultimately reducing the human, social, and economic costs of disasters. The provincial government primarily assists local governments at the district level to reconstruct all schools damaged in any disaster, as occurred in Malakand division due to Army operations in 2009, when 181 schools were destroyed and rebuilt immediately.

The provincial government has been asked to incorporate disaster management into the educational curriculum, not only for primary school children, but also for students in second- and third-level education. Experts from the University of Peshawar are helping to draft this curriculum. Additionally, the Center for Excellence in Geology at the University of Peshawar is helping to identify earthquake- and landslide-prone areas. Such knowledge will be used to raise awareness of disaster-prone areas among local residents. Moreover, it is helpful in identifying suitable methods for mitigating or adapting to hazards and reducing their associated costs.

The greatest challenge faced by the department is a lack of financial resources. The majority of losses in Khyber Pakhtunkhwa province have been attributed to flooding. Although riverine flooding is manageable, it remains difficult to prepare adequately for urban flooding, due to the old and unsustainably managed sewage systems in Pakistan’s cities. In the coming years, among other tasks, the focus will be on how to protect cities from flooding.

To identify the areas of Pakistan that are vulnerable to different disasters, rainfall and precipitation, droughts, and flood data from each district are obtained from the PMD and subsequently analyzed. Vulnerable areas are then dealt with accordingly. However, this process is inefficient, and the early warning system largely fails to alert people in time. Another method of identifying vulnerable areas is to visit distinct regions within the province with the help of international and local nongovernment organizations, NDMA experts, and other environmental and disaster experts.

4.7.4 Role of environmental protection agencies in dealing with climate change

According to key informants from Environmental Protection Agency (EPA) in Peshawar, EPA began to address climate change and its disastrous consequences for each sector of life in Pakistan during 2016–2017. The first step was to ask the provincial land bureau of Khyber Pakhtunkhwa to provide them with all details of completed, uncompleted, and in-line projects targeting climate change, to understand where Khyber Pakhtunkhwa, specifically, and Pakistan, more generally, stand in addressing climate change. This also served to determine areas of weakness, so that they may begin communicating with the international community to inform them about the barriers Pakistan is facing in dealing with climate change. All project-funding information was also requested to clarify who exactly is helping Pakistan in addressing climate challenge. The aim is to communicate to the broader international community, including the United Nations, and to inform them which commitments have been achieved and which remain to be fulfilled. Based on the current status, the EPA climate change team will plan how to proceed.

According to the Paris Agreement, the provincial government of Khyber Pakhtunkhwa and the government of Pakistan are in dire need of assistance from international community and countries invested in combating climate change, with particular regard to three sectors:

a. Capacity building
b. Technology translation

c. Financial assistance

To cultivate support for the above three sectors, Pakistan must submit its intended nationally determined contributions; that is, Pakistan must submit their GHG emissions data, inform donors of the mitigation measures it has taken, and explain how these efforts have facilitated adaptation to climate change. Moreover, each year, all four provinces of Pakistan must submit their achievements in addressing climate change and the impacts on life to the Ministry of Climate Change, which subsequently communicates these reports to the United Nations.

In the future, the EPA will be more involved in climate change and presumably conduct monitoring activities regarding the best use of climate funds and efficient completion of projects. Khyber Pakhtunkhwa has spent 8 percent of its budget on adapting to climate change, which is a reasonable amount for a country like Pakistan, which has negligible carbon dioxide emissions but is an end-user of climate change-related resources.

Although slow and steadily, but Pakistan has been making progress in dealing with natural and human-induced disasters. In recent times, more accurately, Pakistani authorities has been paying great attention to combating natural disasters induced by climate change (Ullah, *et al.*, 2016). Different organizations related to environment, agriculture, energy management, disaster management, policies have been formulated to identify clear pathways of what to do and how to do. These policies and its focus areas are discussed in the sections below.

4.7.5 National environmental policy

The National Environment Policy of 2005 was formulated at a time when the country's climate change-related challenges were poorly understood by policy-makers (National Environmental Policy, 2005). The policy recognizes various issues, such as dwindling water resources and desertification, that may be linked to serious outcomes of climate change in Pakistan. In this policy document, climate change is emphasized as one of the key environmental issues.

4.7.6 Alternative and renewable energy policy

The Alternative and Renewable Energy (ARE) Policy (2011), developed by the Ministry of Water and Power, provides a road map for realizing the full potential of ARE in Pakistan (Government of Pakistan, Ministry of Water and Power, 2011). The AEDB, under the AEDB Act (2011), is empowered to develop a national strategy, policies, and plans for the utilization of ARE. The ARE Policy has an expanded scope, encompassing all ARE sources, including solar, wind, small-scale hydropower, biogas, biofuel, and energy from waste. Moreover, the ARE Policy sets out some enhanced financial mechanisms and addresses areas such as rural energy services and biofuels. It aims to establish the requisite infrastructure, so it can be fully mainstreamed and integrated within energy planning and economic and social development. Likewise, it has attempted to resolve policy conflicts and addresses stakeholders' concerns and includes the proposed establishment of an Alternative Energy Development Fund to promote this sector. When the ARE Policy was developed, stakeholder consultations were underway for the development of the NCCP. Furthermore, as a mitigatory measure, alternative energy indirectly improves the adaptive capacity of the community.

To attain funding for the initiatives within the ARE Policy, it focuses on achieving carbon credits using CDMs. In this context, the AEDB is authorized to provide technical expertise for the (former) Ministry of Environment as the Designated National Authority in its role under the CDM. The AEDB assists in the development of local CDM capacities, in addition to carrying out CDM promotion and raising awareness of ARE. Another key area of focus is the environmental and potential social impacts of alternative fuels, specifically biodiesel supply chains. Under the alternative fuel chapter, the ARE Policy identifies the EPA as the main agency for setting emissions standards for aldehyde and methanol production.

4.7.7 National power policy

The National Power Policy was formulated in 2013 under the support of the Ministry of Water and Power (Ministry of Water and Power Pakistan, 2013). The key objective of this National Power Policy is to attract local and foreign investment for the expansion of the country's power generation capacity, particularly in the production of inexpensive electricity. The National Power Policy strategy focuses on shifting Pakistan's energy mix toward low-cost sources, such as hydropower, gas, coal, nuclear, and biomass. Local and foreign investments will aggressively seek small- and medium-sized river hydel projects. Selected hydel projects under development will be positioned for privatization and multilateral agencies will be invited to partner with large infrastructure hydel projects. The National Power Policy estimated that 7,000 MW of electricity must be added to the system to regulate load shedding in Pakistan.

The National Power Policy document sets out clear targets in terms of efficiency, affordability, financial viability, the demand–supply gap, and system governance. However, the policy does not include a clear emission-reduction strategy. The energy sector is at the forefront in combating climate change worldwide, due to its high share of GHG emissions. In Pakistan, this sector contributes more than 50 percent of emissions; however, the policy does not consider how the initiation of cheap coal power could change the country's current low-emission status. Likewise, it fails to engage with any initiatives that would drive energy efficiency and promote clean energy by setting carbon pollution standards for high-emission subsectors.

4.7.8 National water policy

All four provinces of Pakistan have reached a consensus and signed the country's first ever National Water Policy (NWP). The new NWP is essential to the enhanced management of Pakistan's water resources and ensuring that future generations are not deprived of water as a result of global warming and climate change. The approved strategic policy follows the 2012 NCCP, and states that administrative bodies, such as the National Water Council and provincial water authorities, will be established at both provincial and federal levels for superior management of water supplies.

The approval of a water policy package, comprising a policy and a charter by Pakistan's Council of Common Interests on 23 April 2018, represents a historic milestone, considering the lingering, perennial disputes between Punjab and Sindh Provinces, which had hitherto impeded the formulation of the NWP. The 41-page NWP is unexceptionable. It addresses almost all relevant issues concerning the management of water resources, responds to the concerns of stakeholders, and reflects the inputs of Pakistani and external experts over the past 15 years. The shorter four-page charter is aimed at highlighting both the seriousness of "the looming shortage of water," which is "an existential threat…" that poses “a grave threat to (the country’s) food, energy and water security,” as well as “the commitment and intent” of the federal and provincial governments to make efforts “to avert the water crisis.”

Anchored in the paradigm of integrated water resource management, the NWP outlines a framework for intervention by federal- and provincial-level governments to address various issues that are exacerbating the declining supply and deteriorating the quality of water, threatening the prosperity and health of the rapidly growing population. The policy embraces the recommendations of the NCCP (2012) for countering the adverse effects of climate change, extreme weather events (e.g., floods, prolonged droughts, and heatwaves), and the rising sea level inundating coastal land and aquifers. The policy advocates the preparation for the augmentation of the country’s meagre water storage capacity via the construction of dams, both large and small, to cope with seasonal variations in water supply. It calls for the rehabilitation of the country’s water infrastructure, regulation and reduction of the current excessive abstraction of groundwater, reduction of the demands of water-user sectors (e.g., agriculture, which uses 95 percent of the available supply), and strengthening of the capacities of federal and provincial water resource development and management institutions.

The most remarkable provisions of the NWP are the proposed substantial increase in public sector investment for the water sector by the Federal Government from 3.7percent in 2017–2018 to at least 10percent in 2018–2019 and 20percent by 2030; the establishment of an apex body to approve legislation, policies, and strategies for water resource development and management, supported by a multi-sectoral steering committee of officials at the working level; and the establishment of a Groundwater Authority in Islamabad and provincial water authorities in the provinces. Considering Pakistan’s unenviable record in implementing most environmental policies, coupled with current crippling fiscal constraints, the increased allocations for the water sector in the new budget are admirable.

Critics may lament the exclusion of civil society representatives from the steering committee, an oversight that is apparently in disregard of their invaluable contributions to the promotion of policies and actions on equitable and sustainable water resource management. Moreover, the lack of commitment to advising gender mainstreaming in water-related initiatives is conspicuous and unjustifiable.

Regardless, the NWP recognizes Pakistan's critical dependence on transboundary rivers from across its borders with India and Kashmir, as well as Afghanistan, whence the Indus and its three tributaries transit to its territories. It specifically acknowledges the vast 21 MAF contributed by the Kabul River, representing 16 percent of the flow in the entire Indus River System. However, the NWP's references to transboundary rivers are more a reflection of Islamabad's worries about the impact of "existing and planned… developments (read Indian hydropower projects) on the western rivers" on "water availability to the disadvantage of Pakistan" than they are a vision linked to Article 7 of the Indus Waters Treaty on "Future Cooperation." Without any mention of India, the policy commits to four initiatives aimed at safeguarding the country's water-related interests. It states that "a mechanism shall be worked out for sharing of trans-boundary aquifers and joint watershed management, including sharing of composite real-time flow information especially relating to hydro-meteorological disasters/disaster-like situations endangering Pakistan's important infrastructure, communication network and economy." The 1960 Indus Waters Treaty provisions for the sharing of available information and data but discloses nothing about aquifers or the protection of the watersheds of the western rivers.

Second, the NWP recommends considering local and regional techniques to combat water crises and growing vulnerabilities to "hydro-meteorological disasters owing to trans-boundary releases and stoppages at critical times." The authors of the NWP appear unaware that there is, at present, no regional mechanism in South, West, and Central Asia that deals with transboundary rivers. Furthermore, Pakistan's fears concerning excessive water release, or flow stoppages, by India would need to be meticulously probed and substantiated.

Third, the NWP has planned to undertake a "study… to evaluate the impact of developments in the upper catchment of the Western Rivers" on Pakistan's environment, agriculture, and hydropower projects, which would also lead to the recommendation of measures to "minimize these impacts within the framework of the Indus Waters Treaty and international water laws." Similar suggestions were considered by Indian and

Pakistani experts and civil society representatives in several Track 2 dialogues concerning the Indus Basin, held during 2008–2010, whose implementation would depend on the decisions of the two governments.

Fourth, the NWP states its intention to explore measures "to preserve the environmental integrity of the (Indus Basin) system to reduce hazards faced by the population of areas of Eastern Rivers on the Pakistan Side keeping in view the rights of lower riparian." This evidently reflects a widespread global consensus on the importance of environmental flows in rivers. Significantly, the decision of the final award of the Permanent Court of Arbitration concerning the India–Pakistan dispute over the Kishanganga hydropower project, issued in December 2013, noted that the Court would have to give due regard to "the customary international law requirements of avoiding or mitigating transboundary harm and of reconciling economic development with the protection of the environment."

As in the case of the third suggestion, progress on this subject is predicated on the willingness and ability of the Indian and Pakistani governments to carry out a comprehensive dialogue aimed at promoting basin-wide cooperation concerning the Indus Basin, both within and beyond the provisions of the Indus Waters Treaty. Regrettably, the current state of relations between India and Pakistan would seem to rule out the prospects for such a dialogue any time soon.

4.8 Climate finance landscape in Pakistan

This section reviews the current architecture of government climate financing to better understand its capacities and constraints. It begins with a discussion of the domestic public finance flow process and allocation of climate change-related expenditures, and further elaborates on the roles of the various key institutions in this process. Finally, it examines the degree of Pakistan's success in accessing international climate-related finances.

The implications of climate change and its associated natural disasters represent real threats to Pakistan. This situation is evinced by several reports as well as few indexes, which mentions that Pakistan is among the most hard-hit countries and highly exposed to climate change associated natural disasters such as irregular precipitation, elevated temperatures and elongated summers, heatwaves, floods, drought, and other natural disasters. Such disasters hinder Pakistan's ability to achieve its economic goals. There, it is imperative for Pakistani authorities to urgently and smartly address climate change. To this end, Pakistan has been progressing slowly, but meaningfully, by establishing institutions, allocating budget funds, and improving collaborations and data flow within and among organizations. The Ministry of Climate Change is the highest authority to have been established thus far that has been allocated tasks to deal with climate change.

Addressing climate change requires resources. Considering that Pakistan lacks economic resources for climate change, access to international funding agencies is crucial. However, some international donor agencies help Pakistan in achieving its local and international promises. Such funding donors include the Green Climate Fund, Green Investment Fund, Forest Carbon Partnership Facility, Global Environment Facility, and Special Climate Change Fund. These funds are given for free but international donors make sure that Pakistan must use it transparent and efficiently.

Climate change has long-term consequences (Adger, 2006), therefore, it is vital that the relevant institutions develop policies and action plans designed to mainstream climate change considerations more effectively (Chaudry, 2017). Over time, Pakistan has made considerable efforts to incorporate climate change into its national economic and development agendas. As noted in Section 4.1, Pakistan has made progress regarding establishing institutions and assigning roles to them (Abid *et al.*, 2016). Nonetheless, there remains much for Pakistan to accomplish in terms of mainstreaming mitigation and adapting to climate change. This will require huge and sustained efforts at all governance levels, including legal and institutional policy changes, routine considerations of climate change in development expenditures, robust monitoring systems, and responsive budgets.

In October 2017, the Government of Pakistan published reports that addressed the issue of how best to integrate climate change into public, financial, and economic management (Chaudry, 2017). The first, known as the Climate Change Financing Framework (CCFF), outlines a reform agenda advancing new policies and processes to better align climate finance to existing climate policy objectives in Pakistan. The CCFF was elaborated in partnership with UNDP's Governance of Climate Change Finance Programme, which has supported the Government of Pakistan since 2012. The CCFF links policy and budgeting to ensure the transparency of allocations while improving the efficacy of existing public finance. Another report, anticipated since the release of a related version in 2015, was also released at the launch of the CCFF. Chaudry (2017) further mentioned in his paper that the so-called Climate Public Expenditure and Institutional Review provides an overview of the landscape of current climate policy and budget spending in the country, with the aim of improving future climate action.

Although climate finance and aid are continuously improving, they remain inadequate for requirements. Therefore, all available resources must be used more effectively if the effects of climate change are to be minimized. Climate Change Financing Framework have also been developed, with UNDP support and assistance from the United Kingdom and Sweden, in Indonesia, Cambodia, and Bangladesh, helping these countries to budget and plan so as to improve their adaptation to climate change. Pakistan's climate expenditure compares well with that of other countries, with the four provinces and the Federal Government spending a national average of around 8 percent of their total expenditure on activities related to climate change. The review also shows that most federal funds lean toward mitigation activities (with the aim of curbing GHG emissions), while most provincial funds are oriented toward adaptation (aimed at adapting to the effects of climate change). This exercise (institutionalizing climate finance) will prove useful in adapting to and mitigating the effects of climate change in Pakistan (Pakistan CCFF, 2017).

4.8.1 Planning processes and receptivity toward climate change

The Ministry of Planning, Development, and Reforms (Planning Commission) and the Ministry of Finance (MOF) are the two-apex planning and coordination bodies of the national government that exercise authoritative power in fiscal resource allocation, execution, and distribution to line ministries. The Medium-term Budgetary Allocation Framework, which serves as the central guiding approach, sets the process of budget allocation in motion by establishing a budget ceiling for each ministry. The budget is earmarked for both the development projects and the recurring expenses of each ministry in which recurring expenses receive a major share of the budget[5]. Once approved, the

[5] A budget analysis of the 2011–2014 period showed that current expenditures ranged from 80–84% of the total federal budget, while the development budget was only 16–20% (UNDP, 2015. Climate Public Expenditure and Institutional Review, Pakistan).

development budget is detailed in the Public-Sector Development Program, which lists all public-sector projects and programs, and the specific allocations made for each, in that fiscal year.

The Planning Commission and the MoF determine the development and recurring expenditures budget, which spans a seven-month preparation period. During the initial cycle of a project or program's preparation and approval, the line ministries set their own project lists with a proposed amount of funding. Individual projects with costs exceeding PKR 60 million (US$ 0.6 million), but less than PKR 500 million (US$ 5 million), require further review and approval from the Planning Commission through its Central Development Working Party committee. Similarly, projects that cost more than PKR 500 million (US$ 5 million) go through the National Economic Council, which sits in the MoF and is headed by the Prime Minister or the finance minister, for final approval.

During the next phase of project prioritization, the projects are reviewed again and discussed individually for funding allocation by the Priorities Committee and the Annual Plan Coordination Committee of the Planning Commission. Finally, the finance minister presents the Annual Federal Budget to the Cabinet and the Parliament for final approval.

Whereas climate change mainstreaming necessitates an integrated cross-sector approach, ministries and sectors normally focus on their own essential sector policies, appearing to pay limited attention to umbrella policies such as the NCCP, as the main driver for derivation of their investments; therefore, there is virtually no direct entry point for climate change in the preparation of the Medium-term Budgetary Allocation Framework's budget ceilings.

4.8.2 Domestic climate-relevant finance mechanisms and tools

At the domestic level in Pakistan, there has to date been no separate and dedicated funding for mitigation and adaptation activities. The national planning processes and budgetary framework lack a discrete standard coding system for the identification of climate-related projects and programs scattered across different sectors and departments. According to the recent Climate Public Expenditure and Institutional Review study for Pakistan (2015), the total federal climate-related expenditure (i.e., development + current budget) was estimated at around 6.52 percent during the previous

4 years (UNDP, 2015). The relative proportion of the climate-related budget spent on adaptation and mitigation varied significantly across the studied years. Similarly, the number of climate-related projects and proportion of projects within each government institution changed greatly during the study years, suggesting a defiance of directed and consistent resource allocation and policy delivery toward climate activities. The resource allocation processes, as they relate to prospective climate-related programs and projects at the national government level, are summarized in the ensuing sections of this chapter.

4.8.3 Climate-relevant expenditures in the federal budget

At the national level, the government appears keen to address the issue of climate change; however, its direction in this regard is debatable. For example, the process of budget allocation tends to reinforce core and "business-as-usual" activities. According to the Climate Public Expenditure and Institutional Review, "…Projects that solely focus on mitigation or adaptation to climate change rank low on the prioritization scale at all levels of decision-making in the government, barring the examples of the big investment and foreign-funded projects, e.g., hydro projects for increasing energy supplies and water availability rank high even if their externalities lead to mitigation of climate change emissions." Table 4-3 presents an estimated four-year statistical summary of federal expenditures in Pakistan.

The inclusion of projects in the development budget (i.e., the Public-Sector Development Program) is further affected by many other factors, such as the political influence of stakeholders and parliamentarians, political parties' manifestos, foreign funding, and, to a lesser extent, sector policies. Moreover, in the implementation and execution phase of the federal budget, the finance and planning divisions or departments have a centralized role in allocating fiscal resources among sectors and departments, expenditure heads, and activities and schemes. Centralized control of this nature discourages line ministries from saving on wages and diverting funds toward increased allocation for repair and maintenance expenditures. The climate-related budget analysis for the federal government (2010–2014) shows a very low ratio of climate-related expenditures in the federal budget, ranging between 5.8 percent and 7.6 percent of the annual total.

Table 4-3: Four-year summary analysis of climate expenditures in development, current, and total federal development budget

Federal Budget	2010–2011	2011–2012	2012–2013	2013–2014
Actual climate change-related development expenditures (PKR million)	133,427.98	129,494.76	133,544.91	187,485.67
Actual climate change-related current expenditures (PKR million)	58,620.28	69,835.31	63,188.51	55,914.82
Actual climate change-related expenditure (percent of federal budget)	7.57	6.52	5.78	6.22

PRs = Pakistan rupees.

Source: Climate Public Expenditure and Institutional Review Study. Islamabad. Pakistan. Data obtained from the United Nations Development Programme (2015).

The budgetary details regarding climate change are reviewed in Table 4-4, based on data obtained from a report published by the UNDP in 2015 (cited by Qamar, 2017). The table shows that all four provinces, as well as Gilgit Baltistan, Federally Administered Tribal Areas, Azad Jammu, and Kashmir, increased their annual climate expenditures. For instance, Khyber Pakhtunkhwa Province allocated from PKR 18.8 billion to PKR 38.6 billion during 2011–2015, equivalent to a total increase of 105 percent; in 2015, approximately 10 percent of the total provincial budget was allocated for climate-related expenditures. One example that evinces Khyber Pakhtunkhwa's commitment to addressing climate change-related issues may be observed in the internationally recognized and acclaimed Billion Tree Tsunami project, which was initiated in 2017. Similarly, Baluchistan allocated around 6–15 percent of its budget for climate change during 2012–2016. Since Punjab is Pakistan's largest province in terms of population, a substantial portion of the national budget is allocated to Punjab. The total climate-related expenses in Punjab increased from 6.2 percent (PKR 54.4 billion) to 13.7 percent (PKR 112.7 billion) between 2012 and 2016. Sindh has also demonstrated its commitment to combating climate change, dedicating substantial resources to social welfare, irrigation, and forest/mangrove management. During the investigated period, its climate-related spending ranged from 4.1 to 6.9 percent of the total provincial expenses.

Finally, Gilgit Baltistan is particularly rich in natural resources, and home to a large amount of wildlife conservation, forest management, and social welfare work; accordingly, its budgetary allocation ranged from 16 to 25.6 percent (UNDP, 2017).

For instance, Khyber Pakhtunkhwa province has allocated 18.8 billion PKR to 38.6 billion PKR during 2011-2015 with a total increase of 105 percent in this period. In 2015, approximately 10 percent of the total provincial budget was allocated for climate-relevant expenditures in Khyber Pakhtunkhwa. One of the examples that show how serious the Khyber Pakhtunkhwa province was in addressing the issue can be seen in the internationally recognized and appreciated programs called the Billion Tree Tsunami project, which was initiated in 2017. Baluchistan have also allocated around 6 to 15 percent of their budget for climate change in the period of 2012-2016.

Table 4-4: Details of climate-related provincial and federal expenditures (percentage) in Pakistan, as a percentage of the total budget

Administrative level	2011–2012	2012–2013	2013–2014	2014–2015	2015–2016
Federal	6.5	5.8	6.2	8.1	6.5
Khyber Pakhtunkhwa	7.2	5.3	7.1	9.7	8.9
Baluchistan	7.3	10.4	11.1	11.3	11.9
Punjab	6.2	7.1	8.2	9.3	13.7
Sindh	5.7	4.2	4.3	6.9	7.2
FATA	13.1	12.5	11.6	11.9	10.2
Gilgit Baltistan	16	19	20	28	25.6
Azad Jammu and Kashmir	9.2	14.0	12.5	16.9	14.3
National	6.7	6.12	6.7	8.5	8.4

Source: United Nations Development Program, 2017.

Punjab is the biggest province of Pakistan in terms of population. For this reason, a substantial portion of the national budget is also given to Punjab. The total climate-relevant expenses in Punjab increased from 6.2 percent (54.4 billion PKR) to 13.7 percent (112.7 billion PKR) during 2012 to 2016. Sindh has also showed seriousness in combating climate change and spent resources on social welfare, irrigation, forest/mangroves management. Its climate-relevant spending ranges between 4.1 and 6.9

percent of the total provincial expenses. Gilgit Baltistan is a nature rich part of Pakistan. Many wildlife conservations, forest management and social welfare work is done in that area and its budgetary allocation ranges from 16 to 25.6 percent (United Nations Development Program, 2017).

Similarly, on a sector basis, expenditure on mitigation measures in the energy sector represents over half of the total expenditure, dominating climate-related national expenditures (i.e., 57 percent). Other significant contributions come from transport (19 percent, predominantly mitigation), health and social services (9 percent, adaptation), and water resources (8 percent, adaptation) as shown in Fig. (4-2).

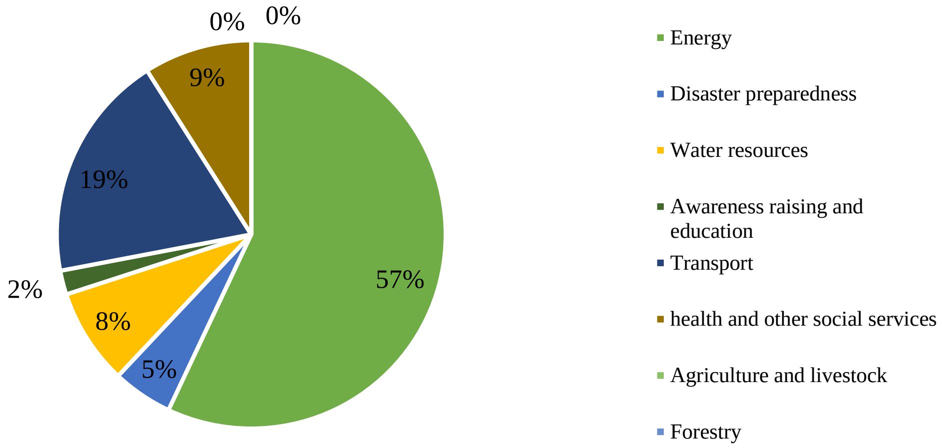

Figure 4-2: Sector-based allocation of climate-related expenditures in the Public-Sector Development Program of 2013–2014

Source: By author using data from Qamar, 2017.

Mitigation strategies are the primary priority of the government, dominating the federal climate-related budget profile, and accounting for 54 percent of the total expenditure. Meanwhile, adaptation activities account for 26 percent, while both adaptation and/or mitigation make up the remaining 18 percent. Supporting activities, such as raising awareness and capacity building, represent the lowest (around 2 percent) share of the budget (Figure 4-3).

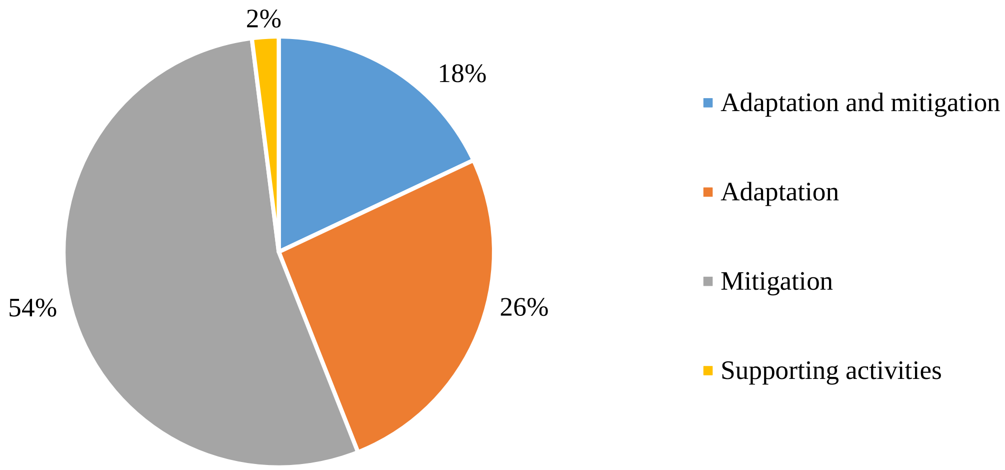

Figure 4-3: Allocation of expenditures to climate-relevant activities in the public-sector development program of 2013–2014

Source: Made by author using data from Qamar, 2017.

4.9 Conclusion

In recent years, Pakistan has suffered several severe, negative consequences of climate change, in the form of catastrophic floods, droughts, and cyclones, resulting in the deaths and displacement of thousands, loss of livelihoods, and damaged infrastructure. Climate change scientists warn that the frequency and intensity of such events will increase in the future. This trend is already evident in Pakistan, where floods have become an annual event, and the country is now listed among the countries most vulnerable to the effects of climate change. Pakistan is a new player in the international climate change field; therefore, the institutions tasked with combating climate change are still nascent, with limited technical, financial, or human power. However, considerable progress has been made over the last decade. The Government of Pakistan has begun to realize that beneficial institutional arrangements are necessary to negotiate the effects and consequences of climate change. As such, the Ministry of Climate Change was established in 2012 after the 18th amendment, tasked with formulating a comprehensive policy aimed at tackling climate change. The present study has explored how Pakistan has demonstrated progress in terms of strengthening initiatives to address climate change and its negative impacts, how those institutions access funding that allows them to function effectively, and finally, the evolution of disaster management systems in

Pakistan. The country has an annual budget allocation ranging from 6.1 percent to 8.5 percent for climate-related spending. At the federal level, most of this budget is spent on mitigation efforts (e.g., environmentally friendly energy projects), whereas provincial budgets tend to be consumed by adaptive measures (e.g., forestation, irrigation, and agriculture). However, Punjab and Sindh also direct substantial proportions of their economic resources toward mitigatory measures, such as improved transportation and communication due to its geography, topography and greater losses occurred from floods and other natural disasters in the past.

5 CHAPTER 5: CLIMATE CHANGE VULNERABILITY AND RISK PERCEPTIONS IN KHYBER PAKHTUNKHWA

5.1 Summary

This chapter provides evidence about farm-level vulnerability, and risk perceptions regarding dealing with natural disasters in Pakistan resulting from climate change. This chapter is aimed to enrich existing knowledge of climate change vulnerability and risk perceptions in a resource-limited country like Pakistan, so that effective measures can be taken to reduce vulnerability of farming communities and enhance their capability to adapt. For this, I examined local farmers' risk perceptions towards climate change phenomenon and identified factors of climate change which of the greatest concern to farmers' lives and livelihoods. The study utilized the household survey method to collect data in Charsadda district of Khyber Pakhtunkhwa province, involving 116 randomly selected respondents. Results showed that more than 80 percent of the local farmers acknowledge changes in climate. These changes are in the form of fluctuating rainfall and temperature pattern, increase in the frequency and intensity of annual monsoonal floods, elongated summers and shortened winters, increased pest attacks on crops resulting in reducing the actual potential of farming in the study area. Changes in summer and winter results in disturbing natural crop cycle which adversely affected crop productivity. Results further showed that, prevalent crop diseases, water scarcity, soil fertility loss and poor socio-economic conditions were main contributing factors to climate change vulnerability. The major limitation of this study was the exclusion of women from the survey due to religious and cultural barriers in Pashtun society, in which women and men do not mix. Reducing climate change vulnerability and developing more effective adaptation techniques requires assistance from government and collaboration at all levels i.e. national to local level. This help can be in the form of providing basic resources such as access to good-quality agricultural inputs, information and extension services on climate change adaptation, and modern technologies. Adaptation to climate change is one feasible option which can help reduce the negative impacts of climate change. However, it will need consultation with other key stakeholders required to create awareness and build the capacity of local farmers' towards reducing climate change vulnerability and facilitating timely and effective adaptation.

5.2 Introduction

Recent changes in climate have confronted people all over the world – for some, it is a matter of changes in weather and for others a matter of survival. The real injustice of climate change is that although developing countries have contributed less to the annual global carbon dioxide emissions they are suffering most from its effects (Daze, 2011; Van Aalst, 2006). It is expected that variability in climatic conditions is likely to increase the frequency and magnitude of some extreme weather events and disasters like flood, droughts, storms, and cyclones (Mirza, 2003; Greenough *et al.,* 2001; Field, 2012). This is due to geographical locations of some of the most vulnerable regions of the world, their high exposure, limited assets, rapid and unmanaged population growth, as well as the likelihood of mal-adaptation (Huq *et al.,* 2004; Hay and Mamura, 2010; Atta-ur-Rahman and Khan, 2011).

South Asian countries including Pakistan are among the countries most affected by the risks associated with climate change (Ali and Erenstein, 2016). Pakistan's vulnerability to the impacts of climate change has been increasing with time despite its contribution to global warming being negligible. In 2012, Pakistan was at the 12th position, 8th in 2015 and 7th place among top countries of the world exposed to the vagaries of climate change and global warming (Kreft and Eckstein, 2013; IUCN, 2009). Recently, disasters related to climate change such as floods, droughts, cyclones, and storms have hit Pakistan hard (Tingju *et al.,* 2014; Muller *et al.,* 2014; Atta-ur-Rahman and Khan, 2013). These disasters have not only become more frequent but have also caused more damage (Qasim *et al.,* 2015). Even after having been consistently affected by climate exigencies year after year, its response to solve the issue has remained lackluster. The burden of natural disasters in Pakistan is underlined by the fact that they have affected millions and killed thousands of people countrywide (Atta-ur-Rahman and Khan, 2013). Among others, rapid population growth, uncontrolled development and unmanaged expansion of infrastructure are the most common factors resulting in more people being vulnerable to natural hazards than ever before (Cardona *et al.,* 2003).

Studies suggest that poor people in rural areas of Pakistan are the most vulnerable to climate change (Ali and Erenstein, 2016; Deressa *et al.,* 2009; Füssel, 2007). These communities are struck hard by those changes in climate identified by many studies conducted throughout the country (Tingju *et al.,* 2014; Atta-ur-Rahman and Khan, 2013; Qasim *et al.,* 2015; Abid *et al.,* 2015). This is particularly because agriculture is climate sensitive and because of the huge number of rural populations predominantly dependent on agriculture as their mainstay of livelihood. Among others, the main challenges faced by farming communities in Pakistan include insufficient irrigation water; lack of technical knowledge, lack of education and limited number of extension facilities; widespread poverty among farmers and inadequate credit facilities; expensive farm inputs such as seeds, fertilizers and pesticides; lack of roads from field to market; low prices of agricultural output and the absence of agriculture-based industries (Abid *et al.,* 2015; Khan, 2013). Additionally, the inappropriate use of modern agricultural inputs such as fertilizers and pesticides has led to alarming environmental pollution (Khan *et al.,* 2013; Shahibzada *et al.,* 2012; Yousaf and Naveed, 2013; Saif-ur-rehman and Shaukat, 2013).

A consistent major problem for Pakistan's authorities is that natural disasters occur regularly at all scales. Unfortunately, the authorities responsible for disaster risk reduction in Pakistan have not made adequate use of recent developments in scientific methodologies, methods and tools for cost-effective and sustainable interventions (Atta-ur-Rahman and Khan, 2013; Qasim *et al.,* 2015). Research aimed at identifying the main drivers of climate change vulnerability, adaptation and risk perceptions at household level is urgently needed to reduce the negative impacts of climate change on agriculture (Abid *et al.,* 2016).

Studies report that farmers use several techniques to adapt agriculture to climate change vulnerability (Ali and Erenstein, 2016). Some of these techniques employed at farm level include diversification in crop practices and changing the timing of operations (Deressa *et al.,* 2009); changing farm management practices such as type and amount of agricultural inputs applied (Abid *et al.,* 2016); livelihood diversification (Hussain and Mudasser, 2007); institutional changes, mainly government responses, such as subsidies/taxes and improvement in agricultural markets (Mendelsohn, 2001); and technological developments such as growing new and heat-tolerant crop varieties and advances in irrigation and water management techniques (Deressa *et al.,* 2009; Hussain and Mudasser, 2007). Climate change is generally detrimental to agriculture but can partly be offset by deploying the various adaptation methods at farm level (Ali and

Erenstein, 2016; Abid *et al.,* 2015). However, the degree to which a certain agriculture sector is exposed and vulnerable to climate change depends on the adaptive capacity of community or area to withstand or react to those changes (Adger *et al.,* 2003; Ullah *et al.,* 2015). In addition, some adaptation methods are highly localized and cannot be directly adopted and implemented in other regions or agriculture settings.

Knowing the importance of agriculture for rural communities in Khyber Pakhtunkhwa province of Pakistan, the significance of identifying vulnerability towards climate and changes in climate, adaptation strategies and risk perceptions at farm level is crucial. Therefore, a growing number of agricultural experts have shifted their research interests towards the issue of climate change and its impacts on agriculture in Pakistan. The focus of these experts is on identifying perceptions of climate change related risks (Qasim *et al.,* 2015; Abid *et al.,* 2015; Khan *et al.,* 2013), vulnerability (Atta-ur-Rahman and Khan, 2013; Rasul *et al.,* 2012; Khan and Salman, 2012) and adaptations (Huq *et al.,* 2004; Abid *et al.,* 2016; Deressa *et al.,* 2009) particularly at farm level. Despite this, little research has addressed these issues in the case of Khyber Pakhtunkhwa province. Hence, this study provides an analysis of farmers' responses to farm risks, which has always been critical issue and particularly so under changing climatic conditions. The paper also provides detailed farm-level evidence and discussion to highlight the actual situation of farmers and their decision environment. The specific objectives of the study include; (1) to identify main factors of climate change vulnerability; and (2) to explore perceptions of rural farmers regarding their concerns on the impacts of climate change in the Khyber Pakhtunkhwa province.

5.3 Research methods

This section presents methods, describing the main characteristics of the scoping study and the applied techniques of data collection and data analysis.

5.3.1 Study area

To assess how communities' perceptions regarding changes in climatic conditions and factors that make them vulnerable to the vagaries of climate change, a comprehensive case study approach was chosen. Khyber Pakhtunkhwa province was selected as a sample site because it was previously identified as vulnerable to climate change (Saif-ur-rehman and Shaukat, 2013; Ullah *et al.,* 2015; Rasul *et al.,* 2012; Malik, 2012), and agriculture contributes approximately 38 percent to the provincial gross domestic product and provides employment for 44 percent of the total population (Atta-ur-Rahman and Khan, 2013; Khan, 2012; Khan, 1994). The Khyber Pakhtunkhwa province is divided into two parts for analysis purposes: northern and southern halves. The former is water sufficient and the latter is water deficient. In addition, floods have been a common phenomenon in the area due to monsoonal rains every year. The study area is the junction point situated along the bank of the Kabul River. This area faces two extreme conditions: drought and flood causing huge harm to humans, land and other property. Natural disasters, especially floods and droughts have severely affected agriculture in the Charsadda district of Khyber Pakhtunkhwa province. Two villages, Gulabad and Shabara, were selected from Charsadda district for this study (Figure 5-1). Gulabad lies on the main Peshawar–Charsadda road; Shabara is located 3 km to the east of the main Peshawar–Charsadda road and approximately 1 km to the east of the main Peshawar–Islamabad express motorway. Other facilities such as transportation, distance to district headquarters, access to internet and availability of mobile service and roads are equally available in both villages. However, access to water for irrigation is the main attribute differentiating the villages.

5.3.2 Data collection and sampling design

The study utilized the household survey (HHS) method for collecting data. A bottom-up approach was used to investigate actual farmers' experiences with climate and their responses to various climate conditions that might influence their decisions. Initially, a meeting was arranged with knowledgeable people such as village elders, experienced farmers, elected members of the village and school teachers in Gulabad to identify potential villages for the study. Prior to the meeting, the study objectives were explained to them and they were asked to provide best-fit case study villages based on their knowledge of the area. Seven potential villages were identified for the research team to visit using criteria of flood damage, access to transportation, distance to district headquarters, internet access, availability of roads and water availability for irrigation. Due to the time and financial constraints, sample selection was reduced to three villages based on distance from rivers and irrigation techniques used for farming. Out of these three villages, the research team randomly selected two: Gulabad and Shabara.

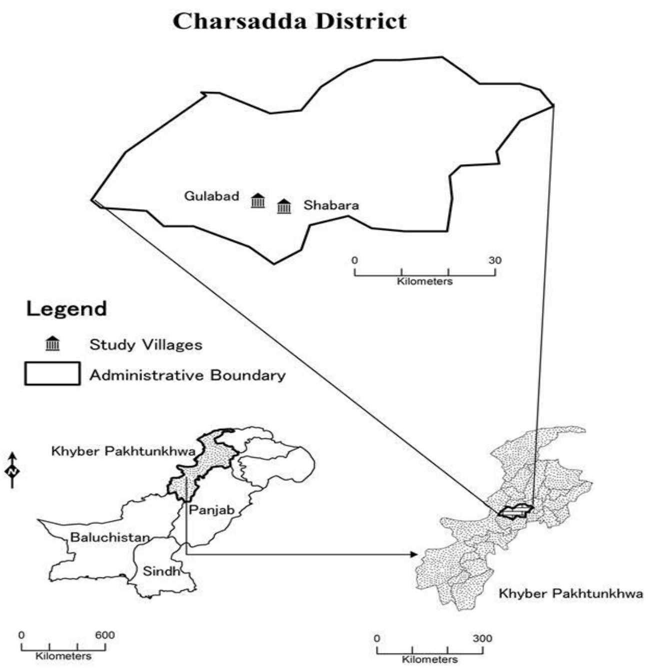

Figure 5-1: Study area

Source: Author's own illustration, 2016.

Using a structured questionnaire, the survey targeted representatives of households that in most cases were household heads. However, in cases of unavailability, other adult members of the household were interviewed. It is important to mention that this study was performed in a region where people with Pashtun ethnicity reside. In Pashtun societies, women are not allowed to mingle with male members (Qasim *et al.*, 2015). Hence, this study only covers perceptions of male respondents as it was impossible to capture women's perceptions for cultural and religious reasons. Two field assistants were hired to help the first author of this paper collect primary data from the study area. A one-day intensive workshop was arranged to train field assistants prior to visit study villages. All questionnaires were administered personally to the respondents by the research team. In total, 116 households (45 from Gulabad and 71 from Shabara) were randomly selected through lottery for interview. The sampling frame included residents of both villages, which were entirely male farmers. All interviews were conducted based on shared research principles and ethics (Bogner *et al.*, 2009).

Before starting the HHS, the purpose and objective of the study was clearly explained, and respondents were asked for informal verbal consent. During the field survey, the research team did not come across any household who refused to be interviewed. This might be because the study team and respondents shared the same language and other cultural attributes which made respondents less hesitant. Generally, the household survey lasted for approximately one hour. The survey included questions on household socio-economic characteristics – for example, age, gender, farming experience, occupation, education, assets for livelihood like transportation, electrical, mechanical assets, agricultural or farm equipment, climate-related vulnerability perceptions, knowledge on climate change and its impacts on agriculture, adaptation techniques employed to reduce adverse effects of climate change and constraints to adaptation. Perceptions on concerns from climate-related risks were also part of the survey. Perceptions on concerns from weather related changes were grouped into excess rainfall, temperature change and droughts from the answers given during the survey while concerns regarding agricultural production were grouped into severe weather condition, crop diseases, and lack of access to agricultural inputs. The reported concerns from changing climate (each measured on a five-point Likert scale) included decrease in income from agriculture (1), no compensation in case of human or agricultural losses (2), increased threats (3), no access to irrigation (4), and no access to alternative income (5).

5.4 Results and discussion

The findings of this chapter start with the analysis of social and demographic characteristics of the survey respondents and availability of assets for livelihood and farm characteristics at household level. Next, results on key factors contributing to the climate change vulnerability of farmers are presented in detail. The analysis then moves to explore concerns of surveyed respondents regarding climate-related risks in the region. Specific details about each section and sub-section are given below.

5.4.1 Demographic and farm characteristics

Agricultural studies have been exploring relationship between a variety of demographic and farm characteristics, for example, features such as age, education and gender can influence that might influence decision-making regarding type of land use, adoption of new technologies, intensity of production and so on (Burton, 2014).

Demographic and farm characteristics of sampled households are presented in Table 5-1. In both villages, respondents were all men, married and performing farming as a primary job. Farmers in Gulabad and Shabara, were in the age range of 23 to 70. Three categories were developed for the purpose of analysis i.e. 1) less than 31 years old; 2) 31-50 years old; and 3) more than 50 years old. Since all our sample consisted of farmers, it is important to categorize farmers' ages as it shows the experience in farming. Results revealed that in in both villages, only few percent of young farmers were involved in agriculture i.e. 4 percent in Gulabad and 17 percent in Shabara. However, most of the respondents were in the age range of 31–50 years (58 percent in Gulabad and 45 percent in Shabara). Moreover, farmers above 50 years of age were also in high proportion to other age groups. In both villages, 38 percent of respondents were above 50 years old.

In Gulabad, 44 percent of the sampled households had 6–10 years of education and in Shabara this proportion was 35 percent. Interestingly, 22 percent in Shabara and 42 percent in Gulabad had never been to school. The higher percentage in Shabara might be due to its remote location from the district center and main roads, and other facilities that are available in Gulabad and makes life easier for its inhabitants. A higher proportion of farmers i.e. 33 and 23 percent of surveyed households had 1-5 years of education.

The household size was large in both villages, i.e. 8–9 persons per household, providing a free or cheaper labor force for farming. The majority of farmers were experienced. Slightly more than half of the respondents in Gulabad had 20–35 years of farming experience, but in Shabara the ratios were evenly distributed with almost 25 percent, among the all categories (see in Table 5-1). Some respondents (20 percent and 25 percent in Gulabad and Shabara, respectively) could not provide their experience in years and explained that they have been involved in farming since childhood *(since the time when they were physically able to help family members in farmlands)*. In both villages, 76–89 percent of farmers used tractors for plowing land whereas the rest used tractors in both villages, however, it largely depended on their financial capability to afford using tractors, and on the availability of tractors during the peak sowing season in the study area. Most of the farmers in the study region grow sugarcane and wheat of which the former is for commercial purpose and later for personal consumption.

Table 5-1: Socio-economic and farm characteristics of sampled households

Indicators	Category type	Village name	
		Gulabad (percent)	Shabara (percent)
Household size (persons)		7	9
Gender	Male	100	100
Marital status	Married	100	100
Occupation	Farming	100	100
	Shop keeping	7	4
	Others	7	1
Age (years)	<31	4	17
	31–50	58	45
	>50	38	38
Education (years)	0	22	42
	1–5	33	23
	6–10	44	35
Farming experience (years)	Since childhood	20	25
	<20	11	24
	20–35	51	27
	>35	18	24
Land preparation	Use tractor	89	76
	Use both tractors and bullocks	11	24
Average production of major crops	Wheat	33.82	35.23
	Sugarcane	81.48	56.16
Land ownership status	Own land	71.11	83.10
	Rent land	28.89	16.90
Land size (average)		2.79	1.91
Income (average)		294,952.4	235,692.3
Frequency of plowing per year	Once	18	7
	Twice	53	65
	Three and more	29	27
Means of irrigation	Canal	100	--
	Tube-well	--	73
	Rain fed	--	21
	Both tube-well and rain fed	--	6
Frequency of irrigation	Nil	--	15
	Weekly	22	37
	Twice a month	51	27
	Three times a month	24	13
	Monthly	2	8
Source of information on climate change	Media	36	10
	Village elders	44	70
	Own view	9	1
	Friends	7	11
	Do not know	4	4
Farmer's unions		Does not exist	Does not exist

Source: Author's field survey, 2016. *"(--) means no responses were given"*

Approximately, 33.8 in Gulabad and 35.2 (mann) of the surveyed household in Shabara produces wheat while 81.48 and 56.16 sacks (one sacks consists of 50kg) produces sugarcane in both villages respectively. Average land holding size in Gulabad is 2.79 ha while in Shabara it is 1.91 ha. The smaller landholding and lack of water for irrigation makes yield lesser in Shabara compared to Gulabad. In both villages, majority of the farmers own land i.e. 71.1 and 83.1 percent of the farmers in Gulabad and Shabara while the rest usually rent land from other villagers who cannot work on their lands due to lack of labor or other possible reasons. Average income generated from selling sugarcane in Gulabad is approximately 294,952 PKR[6] whereas in Shabara the amount is 235,692 PKR. Again, the income in Shabara is lesser compared to Gulabad due to the more hardships' farmers face in farming. More than 60 percent of households in both villages ploughed their land at least twice per month. Lesser number of farmers responded that they irrigate land once in a month. Similarly, 29 and 27 percent of farmers irrigate land three times in a month in Gulabad and Shabara respectively. Inhabitants of Gulabad irrigated their agricultural land with canal water but in Shabara more than 73 percent of farmers used tube-wells for irrigation and the rest waited for rainfall. Land in Shabara is drier compared with Gulabad, hence it needs water more frequently to get desirable yields. Unfortunately, canal does passes in the middle of the village but there is no irrigation facility given to the villagers of Shabara yet. The canal was only used for fishing purpose during the time of survey.

Surveyed respondents mostly heard about climate change either from village elders (44 and 70 percent), through electronic media (36 and 10 percent), from friends (7 and 11 percent) or presented their own view based on their farming experience and how it has been changing due to increasing temperatures and shifts in rainfall pattern (9 and 1 percent). Another important question was asked form respondents about if farmers' unions existed to help farmers in the time of hardships or whenever they need help. It was surprising to know that in the villages where everybody depends mainly on farming for their life stay, no farmer's unions were present. Literature has consistently emphasized on the importance of such farmer's groups and its contribution in improving agricultural

[6] At the time of data collection in 2017-18, conversion rate of Rupee to Dollar was 105.

yield at farm level. Moreover, respondents further reported that they had never been invited by local government for training programs on agriculture which could build their capacity and teach them advanced farming techniques.

The literature has widely covered the importance of understanding farmers' socio-economic and demographic characteristics in the context of climate change vulnerability and adaptation concerning it (Abid *et al.,* 2016; Bryan *et al.,* 2009). The results have shown how policymakers can best support poor farmers, who are most vulnerable to climate impacts given limited resources to make changes in their farming practices. Providing support to the poorest farmers is critical because they are the least equipped and the most vulnerable (Bryan *et al.,* 2009). Addressing these issues requires strong leadership and government involvement in planning for adaptation and implementing measures to facilitate adaptation at the farm level (Bryan *et al.,* 2009; Adger *et al.,* 1999).

Around 24-million-hectare land is used for growing sugarcane annually across the globe producing approximately 1700 million tons of sugar (FAO, 2017). America leads the world in Sugarcane production whereas Pakistan is world's 5th largest sugarcane producer in the world. There are more than 8 million farms in Pakistan cultivating sugarcane (GoP, 2014). Mostly, cane is cultivated in Punjab, Sindh and Khyber Pakhtunkhwa provinces of the country (Qureshi and Afghan 2005). In Khyber Pakhtunkhwa, cane cultivation is shorter *(with average season length ranging from 8-10 months)* than in Sindh but almost same to Punjab. Cultivation is performed mostly in spring between February and March while harvest begins in November (Nazir et al., 2013). Concerning the average cane global cane yield versus yield in Pakistan, Malik and Arshad (2009) and Ali (2017) figured out that yield in Pakistan is much lower than its potential due to numerous reasons of which the prominent ones includes; lack of farmer education, low quality of available inputs, lack of water, unfavorable climatic conditions, cultivation related problems, over-using land resource etc. Moreover, they highlighted another critical issue with the farming in Pakistan i.e. lack coordination between mills and farmers.

Similar cases were also found in our study area where the absence of agricultural extension workers and no support form sugar mills (except for providing expensive loans to farmers) were among the serious concerns of farmers. Pakistan has the driest climate among the nations producing sugarcane which shows how difficult it is for farmers to provide enough water for cane plants during the season. On another hand, there has been limited initiatives taken by the government and the farmers to save water or at least use it efficiently. However, in 2018, the government of Pakistan has formulated water policy which gives some hope to the farmers if properly implemented. Moreover, the mills should also take the responsibility of water conservation in conjunction with the government to support poor farmers.

5.4.2 Assets for livelihood

Respondents of the HHS were asked about the assets they owned to support their livelihood. These assets included transportation, electrical, mechanical and agricultural or farm equipment (Table 5.2).

Table 5-2: Assets for livelihood in study area

Asset type	Gulabad (percent)		Shabara (percent)	
	Yes	No	Yes	No
Motorbike	38	62	32	68
Bicycle	27	73	28	72
Electric generator	31	69	10	90
Cellphone	76	24	69	31
Regular phone	7	93	--	100
Television	38	62	48	52
Radio	4	96	4	97
Camera	2	98	--	100
Washing machine	80	20	90	10
Other (e.g. sewing machine)	78	20	94	6
Tractor	2	98	--	100
Plow	80	20	90	10
Chemical spraying device	80	20	85	15
Water pump	73	27	73	27
Wooden cart	9	91	--	100
Grain/flourmill	4	96	--	100
Scale	82	18	83	17

Note: (--) means no responses were given.

Source: Author’s field survey, 2016.

In both villages, most respondents owned televisions, cellphones and other common agricultural farm equipment such as spraying device, water pump and scale. Few respondents owned a tractor or post-harvest facilities. Very few respondents had access to advanced techniques of farming due to their poor socio-economic situation. The majority of them faced poor economic conditions which expose them to the vagaries of climate change. Other researchers have consistently mentioned that having more agricultural assets and access to improved technology stimulates agricultural growth, expands food supply and so results in poverty alleviation (Ali and Erenstein, 2016; Abid *et al.,* 2016; Deressa *et al.,* 2009).

Previous studies suggest that analyzing vulnerability does not only involve identifying threats but also the resilience and recovery from the negative impacts of changing climatic conditions (Adger, 1999). This includes individual and household characteristics, socioeconomic status, farm characteristics, distance from markets, and access to extension and credit. As suggested, households that wish to reduce the risks associated with climate change and have the resources or access to resources needed to make the appropriate changes are generally more resilient and have greater capacity to adapt (Abid *et al.,* 2015; Deressa *et al.,* 2011). Knowledge of these assets helps in understanding how livelihoods work, and how people respond to climatic variability and adapt to change. Hence, livelihoods are built on these assets – individuals, households and groups depend on these assets for agricultural production (Jodha *et al.,* 2012). The general conception is that farmers with more capital better survive the negative results of climate change (Deressa *et al.,* 2011; Blaikie *et al.,* 2014). In the case of our study area in particular and Pakistan in general, the livelihoods of poor farmers are particularly at risk from the ever-increasing exposure to natural disasters like floods, droughts, heavy monsoons and heat waves (Qasim *et al.,* 2015; Abid *et al.,* 2015).

5.4.3 Major factors contributing to climate change vulnerability

This section addresses question about what perceived factors are the primary contributors to climate change vulnerability in the study area. After a detailed literature review, 16 variables were identified that are considered important in climate change vulnerability analysis (Abid *et al.,* 2016). The scores given for each indicator were measured and ranked on a five-point Likert-scale of very low (1), low (2), moderate (3), high (4) and very high (5), depending on how farmers perceived it in relation to the changing climatic conditions in the study area. Indicators that received a score 4 or 5 were considered as primary contributing indicators to climate change vulnerability whereas those receiving 1 or 2 were perceived as low contributing factors.

There were mixed responses among respondents concerning gauging indicators of climate change vulnerability. This might be due to the nature of different environmental risks people are exposed to in both Shabara and Gulabad. Consequently, the perceived threats from climate change vulnerability were also seen differently (Figures 5-2 and 5-3). Indicators whose impacts were less threatening were perceived as low contributors to CCV in Gulabad and Shabara. Those indicators included drinking water, forest degradation, transportation system, grazing area, land resource, landslides, irrigation facility, animal diseases and minimum extreme temperature (Figure 5-2). Whereas, soil problems (40 percent), crop pests (42 percent) and droughts (38 percent) were perceived as low contributing factors to climate change vulnerability. Flood was a major contributor to climate change vulnerability in Gulabad and 38 percent ranked it as a high and 47 percent as a very high contributor.

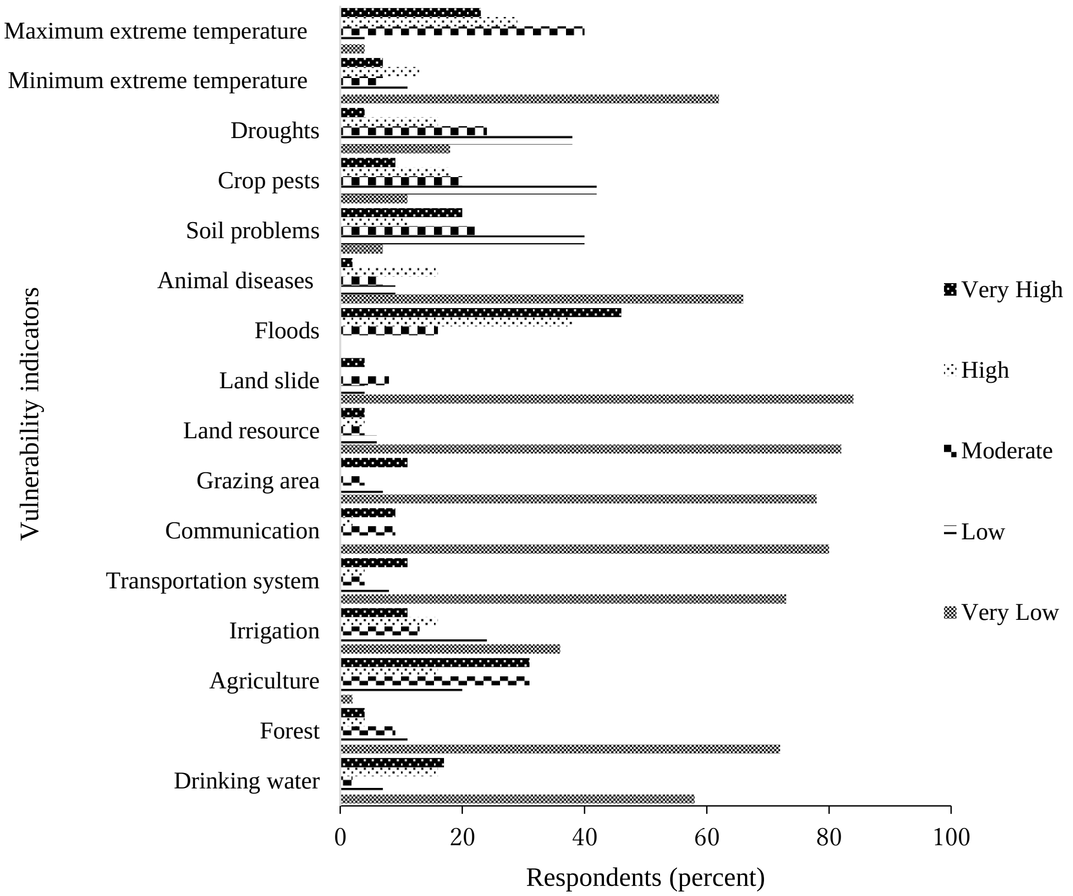

Figure 5-2: Perceptions on causes of climate change vulnerability in Gulabad

Source: Author's field survey, 2016.

In the case of Shabara, most of the indicators perceived as low, very low and moderately contributors to climate change vulnerability were ranked similarly to Gulabad. A mix of responses was observed in ranking drinking water, with almost equal numbers of respondents in the different rankings concerning changes in availability of drinking water (Figure 5-3). Unlike Gulabad, agricultural land in Shabara is either irrigated with tube-wells or rain fed. Therefore, more than 20 percent of respondents ranked irrigation in regard to climate change vulnerability as respectively very low, low, moderate and highly vulnerable to negative impacts of climate change. In the case of flood, 27 percent of respondents perceived that it was highly vulnerable to climate change vulnerability. Flood is a major threat of climate change vulnerability in both villages, possibly due to their proximity to the Kabul River that floods almost every year in the monsoon season of July–September, resulting in serious problems for the socio-economic and physical environment of the study area.

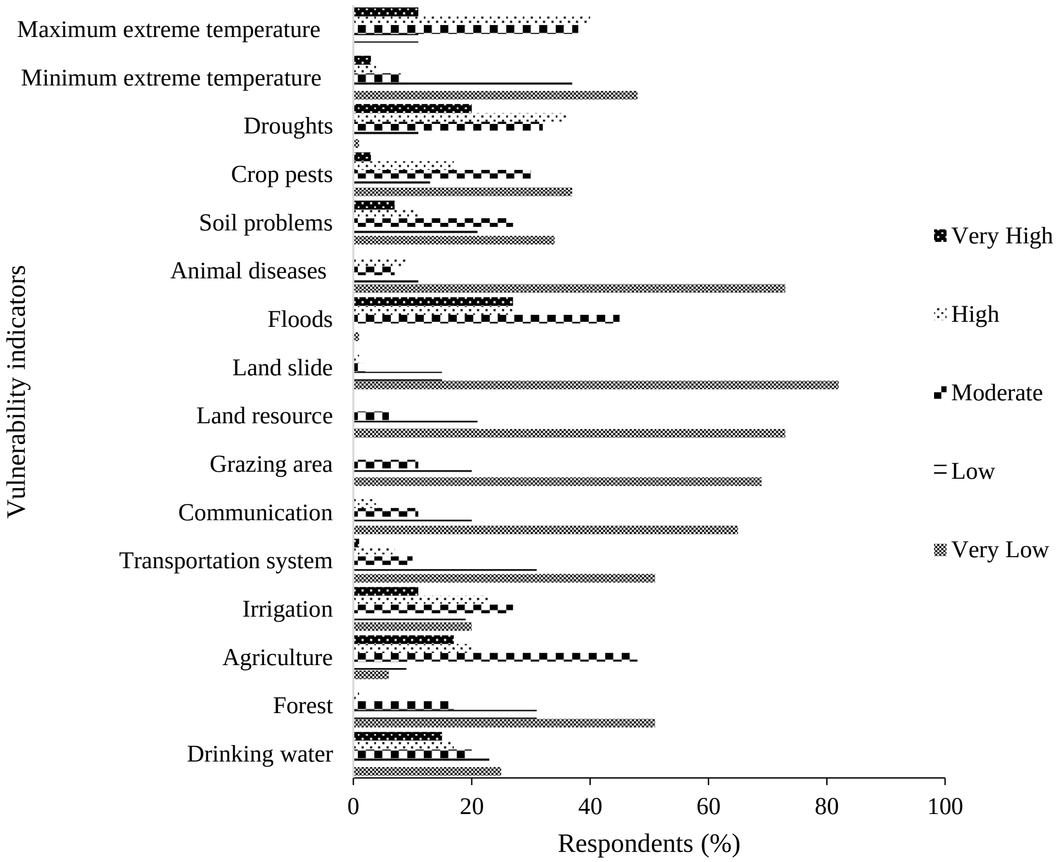

Figure 5-3: Perceptions on causes of climate change vulnerability in Shabara

Source: Author's field survey, 2016.

Comparing these results with other studies around the world, as well as some conducted in Pakistan, clearly indicates that many rural populations especially those involved in farming are severely affected by impacts of changes in climate (Mirza, 2003; Greenough *et al.*, 2001; Field, 2012; Ali and Erenstein, 2016). For instance, Abid *et al*. (2015) found similar conditions in Panjab province of Pakistan where longer summers, decrease in precipitation and changes in agricultural growing season were recorded by the farming communities. An increasing trend has been seen in the frequency and magnitude of natural disasters like extreme temperatures, floods and droughts (Maheen and Hoban, 2017). Temperatures are predicted to rise by 3 °C by 2040 and up to 5–6 °C by the end of the century. Monsoon rains will drastically reduce but have higher intensity. According to Abid *et al.* (2016), farmers' identification of various risks shows the importance of climate-related conditions for their farm-level operations. However, differences in how risk is perceived by farmers in different regions are common due to changes in the environmental setting, geographical location, availability of resources and economic status of an individual.

Disaster risk management experts believe that the main causes of vulnerability to hazards are not solely environmental but also result from ignorance of the people and destitution of the country (Adger *et al.,* 1999; Wisner *et al.,* 2012; Mustafa, 1998; Smit and Pilifosova, 2003). More than half of Pakistan's population lives in extreme poverty and many live-in disaster-prone areas. This specific social segment cannot be expected to make disaster risk reduction a priority although they suffer severely from disasters when they occur. One of the physical vulnerabilities of the people living in highly vulnerable areas might be attributed to this social issue (Mustafa, 2002). In the 2010 Pakistan flood, in many areas people ignored warnings about impending disasters for distinct reasons including lack of awareness, education and lack of trust between locals and government officials. Another example of social and economic vulnerability is seen in the irrigation system of the country, where high demand for water has led to inappropriate irrigation resulting in worsening the flood and drought conditions (Mustafa, 2002).

5.4.4 Farmers' perceptions about climate change risks

In Pakistan, many rural populations still heavily dependent on agriculture for their livelihoods. Despite the limited access to farm resources like fertilizer, pesticides, decent quality seed, water for irrigation, labor, land, and infrastructure, there are other environmental factors as well making farmers more vulnerable to climate change. Results elaborated perceptions of sampled respondents on primary risks to their agricultural production. In both villages, 70-71 percent of the respondents reported that weather is a primary production risk as shown in Table 5-3. In Shabara 59 percent and 44 percent of the respondents viewed crop pests and lack of access inputs as major perceived threats to agricultural production respectively. Surveyed respondents believed that risks associated with changes in climatic conditions in the region will not only decrease their incomes from farming (view of 33 and 35 percent of farmers in Gulabad and Shabara respectively) but will also expose them to other threats such as floods, droughts, and storms. The fear of exposure to other threats might be due to the already observed devastating impacts and damages caused by phenomenon associated with climate change.

Table 5-3: Perceived risks, and hopes from climate change among farm households in the study area

	Indicators	Gulabad (percent)	Shabara (percent)
Primary production risks	Weather	71	70
	Crop pests	18	59
	Lack of access to inputs	20	44
Climate change and its associated risks	No worry	0	1
	Decrease income	33	35
	Not compensate if losses	20	6
	Not provide alternative income	0	13
	Not reduce threats	42	25
	Not provide water for irrigation	0	14
	Others	7	0
Hopes from adaptation project	No hopes	4	0
	Improve income from agriculture	29	39
	Compensate if losses	31	6
	Provide alternative income	0	3
	Provide water for irrigation	7	42
	Reduce threats from climate change	31	11
Hopes from climate change	No hopes	76	82
	Improve income	4	3
	Compensate if losses	9	1
	Provide alternative income	2	3
	Reduce threats from climate change	4	6
	Others	7	6

Source: Author's field survey, 2016.

Project on adaptation was viewed as a source of access to loans, help improves soil fertility, provide good-quality agricultural inputs, compensate them in case of losses from disasters especially floods and more importantly help in reducing threats from climate change. In Shabara village, although a canal has been built for irrigating farming lands but absence of water channels from it makes it useless for time being. Hence, they rely either on tube wells or wait for the onset of rainfall to irrigate lands. While in Gulabad, all household has access to river water for irrigation. Furthermore, respondents also hope that the project on adaptation will provide access to water for irrigation. Their responses might be helpful for agriculture and climate change policymakers to effectively design it and be relevant to actual farm conditions. In addition, respondents were asked if they have any hopes from changes in climatic conditions occurring in their areas. Interestingly there were no hopes reported in both villages.

5.4.5 Farmer's perceptions of the most prevalent natural disasters affecting agriculture

Climate-induced natural disasters are considered as one of the greatest threats to farming globally as well as in Pakistan. Results show that, in Gulabad, 93 percent of the sampled respondents conceived floods and 56 percent conceived storms as the major consequence of climate change affecting farming (Figure 5-4). In Shabara, floods and droughts are the prime natural calamities that cause damages to agriculture productivity as reported by 62 percent and 77 percent of the respondents respectively. Unlike Shabara, in Gulabad, easy access to river water for irrigation was the main reason why drought did not affect farming. Crop diseases due to changing climate and variability was listed as less prevalent cause of damaging crops by most of the respondents in Gulabad. Farmers are particularly more vulnerable to the floods and droughts due to their poor economic situation and low adaptive capacity towards climate change and its associated risks (Ali and Erenstein, 2017; Rasul et al., 2012). These results are also in line with other studies performed across the globe such as a study performed by Arbuckle et al. (2014) and Kurukulasuriya and Rosenthal (2003). For instance, Deressa *et al.,* (2009) found that in Ethiopia, farmers are mainly faced with the consequences of climate change in the shape of changing rainfall patterns, severe droughts, and higher temperatures. The further also emphasized on the lack of availability of assists among poor rural farmers which exposes them to the devastating negative impacts of climate change.

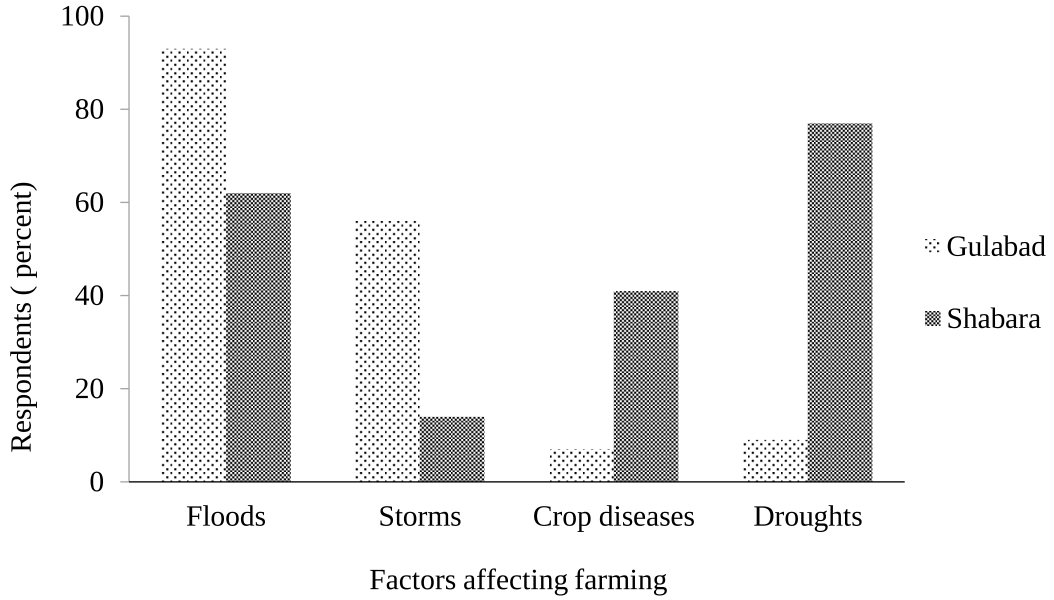

Figure 5-4: Major causes of reduction in agricultural production in Gulabad and Shabara

Source: Author’s field survey, 2016.

5.4.6 Perceptions about historical overview of production

In this study, farmers were asked to identify best, and worst years of production based on their perceptions. Interestingly, respondents could make a clear distinction of the flood year i.e. 2010, to mark best and worst years for production. In July 2010, all Pakistan in general and Khyber Pakhtunkhwa province, in particular, was hit hard by a countrywide deadliest flood. Charsadda was among other 25 districts greatly affected by the flood. It is important to mention here that the answers given to the question of best and worst year of production were completely based on respondents’ memory. Analysis performed for this study show that, 51 percent and 70 percent of respondents in Gulabad and Shabara perceived both best and worst years for production after the flood year of 2010. In addition, sampled respondents reported that in the year 2011, they received the highest yield probably due to the fertile silt brought by flood water with it. This fact was noted by Atta-ur-Rehman and Khan (2013) in their study performed in Charsadda district. All standing crops and majority of the land were flooded the countrywide flood in 2010. Hence, majority of the respondents perceived it as the worst year for agricultural production. Besides that, most of the respondents believe that since 2011, crop yield is continuously decreasing year by year primarily due to annual episodes of floods, yearly long dry situation, soil infertility, and unpredicted rain falls or even no rainfall except that of the monsoon season.

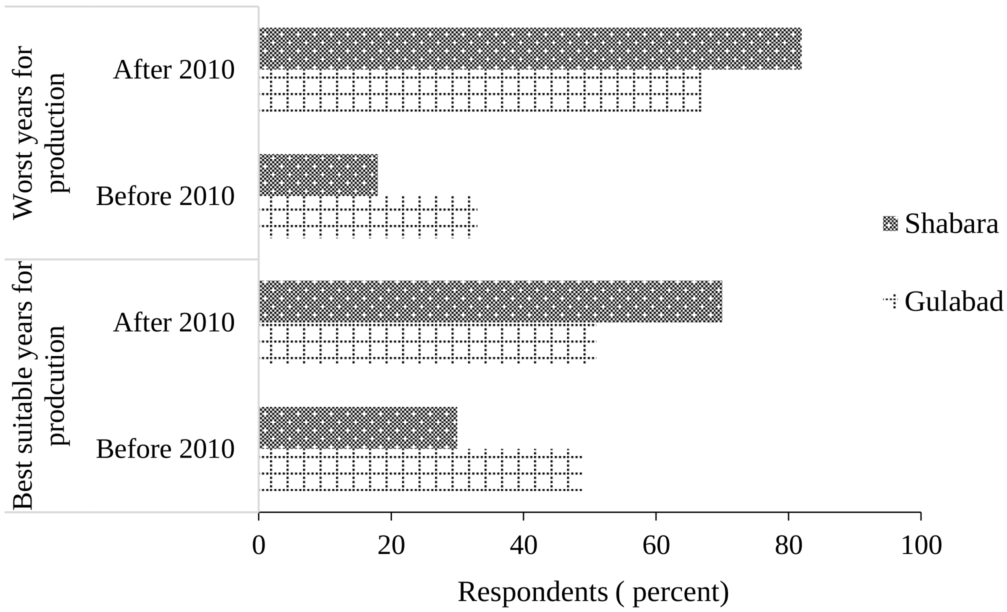

Figure 5-5: Farmers' perceptions on agricultural production in the study area

Source: Author's field survey, 2016.

Literature consistently focussed on the importance of understanding local knowledge in decision-making regarding climate risks (Harmeling, 2012; Roncoli *et al.* 2012). Farmers base their decision to adapt their farming practices to several other climate factors observed through personal experience such as extreme events; rainfall frequency, timing, and intensity; and early or late frosts (Deressa *et al.,* 2009). It is evident that in some cases, scientific climate knowledge is based on local knowledge constructed from everyday encounters with weather both felt and observed (Arbuckle *et al.,* 2014). Further, how farmers understand and perceive climate-related risks and uncertainties are important in identifying proper management practices and adaptation mechanisms as reported by Abid *et al.* (2015). Lebel *et al.* (2015) and Ullah *et al.* (2015) further argues that the assessment of farmers' perceptions of climate-related risks is important because it can help understand the decision-making attitude of farmers while facing uncertain climatic conditions. In addition, perceptions of farmers can help them make precise decisions about what crops to grow, when and with which inputs (Lucas and Pabuayon, 2011).

Another study conducted by Sultana et al. (2009) in the Punjab province of Pakistan shows that how wheat production has been affected by the changing climatic conditions, challenging food security situation in the country.

5.4.7 Damages occurred due to 2010 flood in the selected villages of Charsadda district

Results from our study reveal that in both villages, more than 70 percent of sampled respondents have lost both land and crops due to floods in 2010, whereas, almost 2 hectares of land was flooded costing approximately less than 300,000 PKR in Gulabad and slightly more than 200,000 PKR in Shabara (Table 5-4). Majority of the respondents in Shabara (69 percent), have lost livestock while a fewer number of households (31 percent) have lost livestock in Gulabad. Generally, locals keep goats, cows, and buffaloes in houses which they can sell in the time of hardships for example flood.

Table 5-4: Damage to properties (land, livestock, and houses) due to 2010 floods and storms in selected village of district Charsadda

Types of properties	Responses	Village Name	
		Gulabad (percent)	Shabara (percent)
Damage to land	No damage	29	24
	Only crops damaged	0	1
	Both land and crops damaged	71	75
	Average land size damaged (Ha)	1.84	1.95
	Estimated average cost of loss (PKR)	288,846	216,145
Loss of livestock			
	No loss	69	31
	Lost	31	69
	Average number of livestock loss per household	2	3.80
	Estimated average cost of loss (PKR)	154,643	206,122
Damage to houses			
	No damage	20	14
	Partially damage	24	28
	Full damage	56	58
	NGOs rebuild it	29	35
	Self-build	71	65
	Estimated average cost of loss (PKR)	332,742	286,222

Source: Author’s field survey, 2016.

Almost all households have lost their lands and crops. On average, standing crops of on 3.80 hectares of land in Shabara and 2 hectares in Gulabad were flooded. The estimated average cost of livestock loss was in the range of 154,643 to 206,122 PKR. Regarding house damage, 56-58 percent of the household reported that their houses fully damaged due to floods and 65-71 percent of the respondents rebuilt it by themselves. Some support was given by government and non-governmental organizations as well concerning rebuilding houses. The estimated average cost of damage was approximately 332,742 PKR in Gulabad and 286,222 PKR in Shabara.

5.4.8 Concerns regarding impacts of climate change on agriculture

This section explores perceptions of farm households regarding weather-related changes (Figure 5-6), primary risks to agricultural production (Figure 5-7) and finally their concerns from changes in climate in the region (Figure 5-8). The results showed that, in Gulabad, 69 percent of the respondents perceived excess rainfall as a major weather threat; whereas in Shabara, 83 percent of respondents perceived drought as the primary weather-related risk. The proximities of both villages to the Kabul River and the absence of any precautionary measures (e.g. high river boundary walls or effective early warning system) expose human lives, livestock, land, and infrastructure to flood risk in the monsoon season.

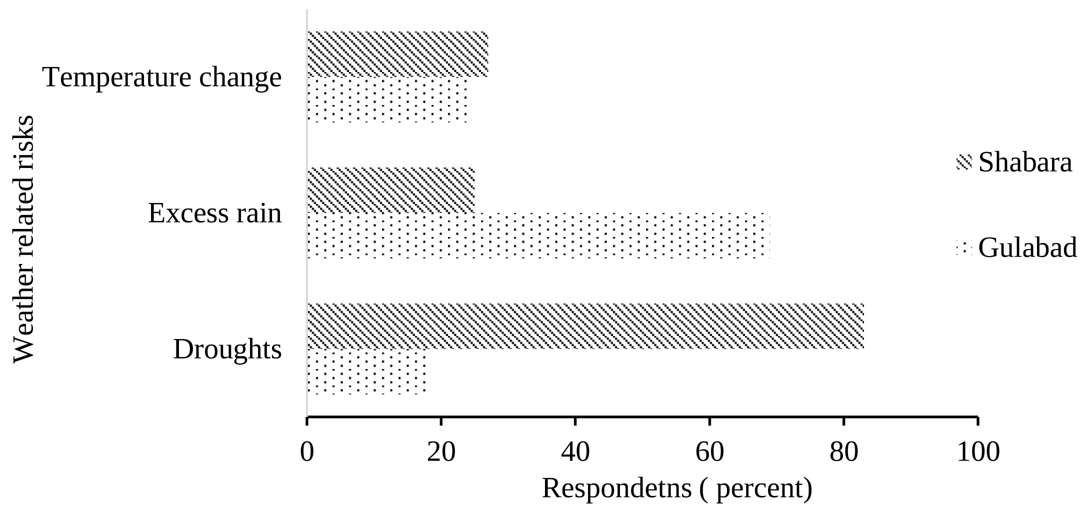

Figure 5-6: Perceptions on weather-related risks in Gulabad and Shabara
Source: Author's field survey, 2016.

Respondents were further asked about perceived primary risks for agricultural production. The majority of respondents, approximately 70 percent in both villages, reported changing weather conditions especially hotter summers as the primary risk. Furthermore, crop diseases and lack of access to superior quality agricultural inputs such as heat-tolerant seeds, fertilizers, and pesticides; to improved soil conservation techniques and to post-harvest facilities were among other factors significantly affecting agricultural production in the study area.

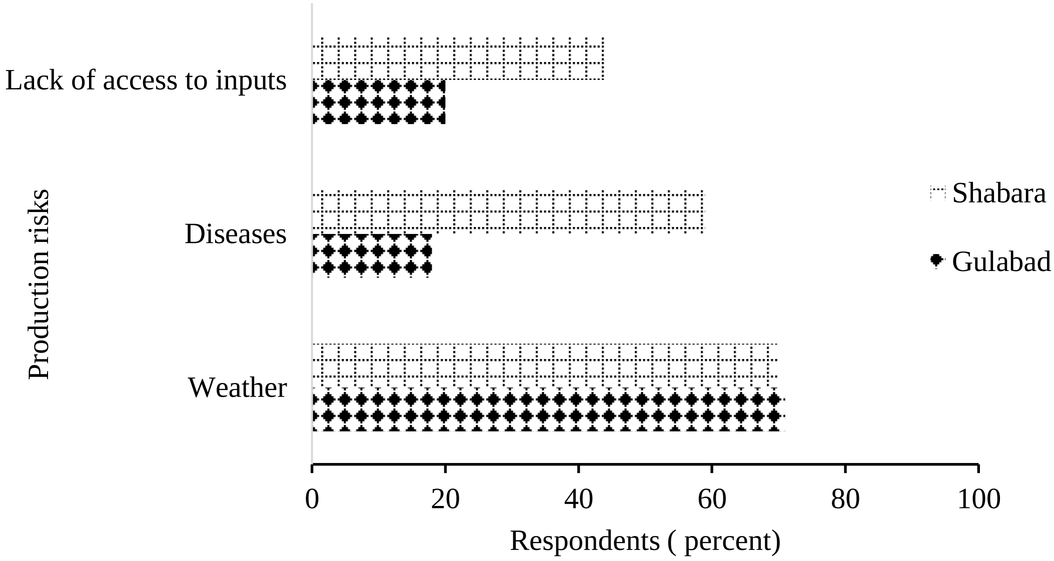

Figure 5-7: Perceived primary production risks in Gulabad and Shabara
Source: Author’s field survey, 2016.

Farmers were asked about their concerns regarding climate-related risks and the impacts on their household. Respondents in both villages acknowledged changes occurring in climate in the region (Figure 8). Respondents perceived that floods, droughts and warmer summers were due to climate change and were among the serious threats to their farming. As mentioned earlier, all surveyed households primarily depend on farming for subsistence. Respondents were of the view that these changes in climate would decrease farm income of their household. Some respondents (42 percent and 25 percent in Gulabad and Shabara, respectively) reported that changing climatic situations would increase threats to agriculture, such as low yields, less fertile soil and more crop diseases.

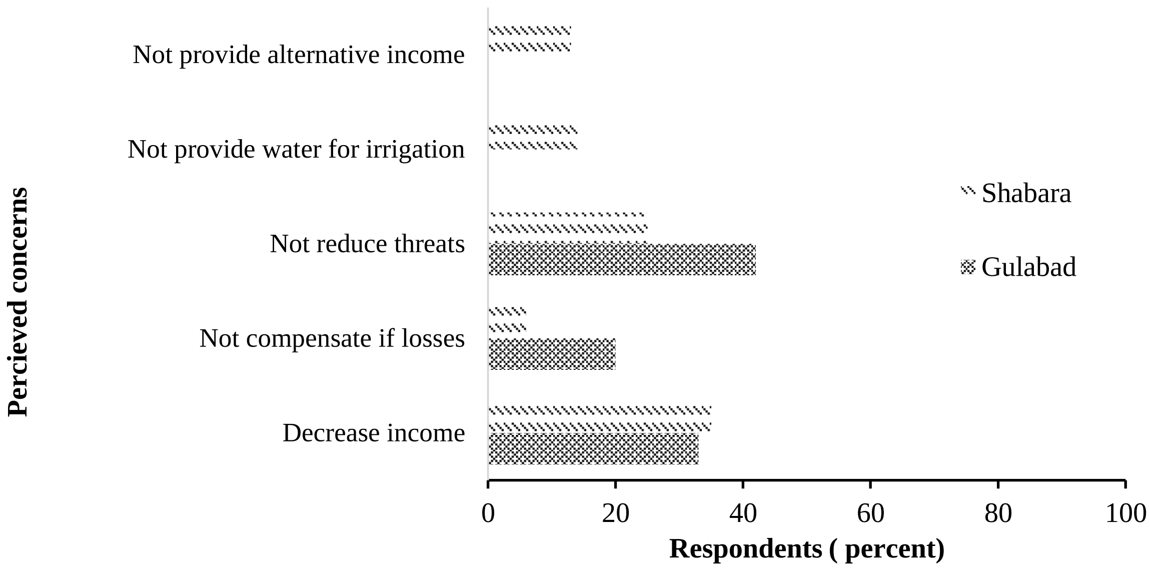

Figure 5-8: Perceived worries from changing climatic conditions in Gulabad and Shabara

Source: Author's field survey, 2016.

Perceptions and response of farmers towards uncertain conditions are important as they can describe the decision-making behavior of farmers (Rasul *et al.,* 2012). Hence, it is important to study risk perceptions of those farmers who live in a risky environment. In this regard, perceiving climate variability is the first step in the process of adapting agriculture to climate change, as discussed by Deressa *et al.* (2009) in Ethiopia and Abid *et al.* (2016) in Pakistan. In addition to the limited access to farm resources such as fertilizers, pesticides, good quality seed, water for irrigation, labor, land and infrastructure there are other environmental factors including floods, droughts and storms that increase climate change vulnerability of farmers (Rafiq and Blaschke, 2012; Ali, 2013; Asif, 2013; Bukhari and Siyal, 2011).

Furthermore, the literature consistently emphasizes the concerns arising from the impacts of climate change and its variability on agricultural production worldwide (Ullah *et al.,* 2015; Hay and Mamura, 2010; Ali and Erenstein, 2016). Continuous reduction and inconsistency in yield of major crops has been reported across Pakistan due to climate-related risks (Tingju *et al.,* 2014; Ahmad *et al.,* 2013). This suggests that in addition to analyzing risks to which people are exposed there is a need to investigate the quality of the options they have for coping and how they are ultimately managing risks. This understanding can facilitate identification of the most vulnerable groups and can also create opportunities to identify effective and sustainable adaptation strategies (Adger *et al.,* 1999; Rasul *et al.,* 2012; Ahmad *et al.*, 2013).

5.5 Conclusion

This study provides insights into the climate-related risk perceptions of farmers, including their vulnerability, and concerns regarding negative impacts of climate change on agriculture at farm level. Moreover, the chapter also explores farmers' perceptions on how they deal with climate change and its induced natural disasters. Identifying individual's risk perception is important as it determines their responses and helps in designing a context-specific policy. Farmers perceived that in the future climate change will be an even greater threat to agriculture.

The study identified that climate change is negatively affecting agriculture, which is in most cases is the only primary subsistence activity of rural farmers all over Pakistan, particularly in the Khyber Pakhtunkhwa province. This situation is consistent with other climate-related studies conducted throughout the country and in our study area. Recent changes in climatic conditions have exposed rural farming communities to numerous risks. For instance, farmers mentioned that disastrous floods, severe droughts, storms, extreme maximum temperatures, changes in rainfall pattern, crop diseases and loss of farmland due to floods, are among the worst situations negatively affecting agricultural production. Farmers in the study area had no access to agricultural extension or farmer training that could build their capacity. Government and other relevant stakeholders should provide easy access to those services so that farmers can learn advanced farming techniques and how to effectively adapt.

Therefore, building capacity of the locals towards reducing climate change vulnerability and facilitating effective adaptations are important. Future policies need to address barriers to the adoption of advanced adaptation techniques at the farm level. There is a dire need for research on identifying locally specific adaptation of agriculture to climate change so that farmers can decide the most suitable adaptation measure to apply. Support from agricultural extension bodies, research institutions, and policy makers is also needed to provide updated information on weather and access to quality inputs used for improving yields. Cooperation among farmers is also key in improving their adaptive capacity and resolving other problems at the community level. The study also recommends that other researchers, especially females, explore this issue with women as they are more vulnerable to climate-related risks, a topic that this study could not address due to cultural and religious barriers.

6 CHAPTER 6: FARM-LEVEL PERCEPTIONS AND ADAPTATION TOWARDS CLIMATE CHANGE IN KHYBER PAKHTUNKHWA

6.1 Summary

Agriculture is considered as the backbone for the economy of Pakistan but current changes in climate have been adversely affecting it. In this paper, perceived impacts of climate change on agriculture and adaptation towards it have been studied in Charsadda district *(lowlands)* of Khyber Pakhtunkhwa province of Pakistan through extensive field surveys, involving 116 farm households. Results show that the interviewed farmers are aware of variations in climatic conditions but are inclined to connect these to the natural climatic variability, rather than to human-induced climate change. Climate change factors including fluctuating temperature, evidence of droughty situations and a gradual shift in rainfall pattern have greatly pressured agriculture sector and livelihoods of the local peasants. The devastating floods of 2010 and 2011 in Pakistan have evidenced the severe climatic changes in Pakistan. These countrywide floods have washed the fertile soil that has directly contributed to agriculture productivity loss and increased vector-borne diseases in crops. The results further showed that changing crop type and cultivation pattern, improved seed varieties, planting shade trees and provision of fertilizers are measures to adapt and improve agricultural productivity that may reduce the climate change vulnerability at household level. Lack of access to financial services and to information on agricultural training, and lack of support from provincial and local government were among the major constraints to adaptation. Therefore, the study suggests that improved understanding of the climate change impacts and knowledge on adapting adequately as well as providing better access to financial services, improved technology, and up to date knowledge on modern farming techniques will help protect farmer's lives and livelihoods and boost their resilience towards changing climatic conditions.

6.2 Introduction

Climate change is considered as one of the most complex challenges for societies and economies around the globe. The impacts of climate change are observed differently across the world (Anita et al., 2010). Households in developing world are particularly vulnerable because they are poor, lack basic resources to adopt to climate change, institutions working in the field of reducing climate induced disasters are lacking technical skills, and early warning systems are absent (Hoffman, 2013). Moreover, the frequency of climate induced disasters has also increased, i.e. 100 per year from the 1970s to 400 per year in 2000s (EM-DAT, 2016). Among others, due to its high climate sensitivity, agriculture is greatly affected by changes in climatic conditions. It is expected that future climate change will likely affect crop production in poor developing countries mostly in Africa and Asia due to decreased water availability, rapid population growth, urban expansion, new or changed insect pest incidence etc. (Javed, 2016; Porter *et al.*, 2014). Some of the prevailing impacts of climate change includes, changing rainfall patterns, frequent floods, severe droughts, intense heat waves, melting of glaciers, increase in sea level are some of the major consequences we can expect to see because of human induced greenhouse gas emission (IPCC, 2007; Adger *et al.,* 2003).

Pakistan is frequently cited as one of the most affected countries from climate change where among other sectors, agriculture is highly at-risk due to climate change (Javed, 2016; Khan *et al.,* 2016; MoE, 2009), though it contributes little to global greenhouse emissions. Currently, global vulnerability index places Pakistan at 7th position amongst the countries that is going to be hurt worst by climate change (Javed, 2016). Rising temperatures, intense rains, droughts and production losses in agricultural sector are expected in Pakistan due to climate change (Shakoor *et al.,* 2011). Agricultural scientists claim that the temperature increases in Pakistan are expected to be higher than the global average, resulting in reduced national agricultural productivity (Sultana and Ali, 2006). While the temperatures have risen, the summer season has become prolonged and winter has become shorter (Salik *et al.,* 2015). The heat wave period has also increased by 31 days during the years 1980 to 2007 (Yu *et al.,* 2013; Sultana *et al.,* 2009).

The recent annual episodes of floods in Pakistan are the classic examples of how dangerous climate change can be for lives, livelihoods and other properties of people. These floods are due to the heavy and irregular monsoonal rains occur mostly in July – September every year (Eid *et al.,* 2007). Substantial losses are reported in crop yields, land, houses, and other properties, leaving majority of the locals highly vulnerable to its impacts (Atta-ur-Rahman and Khan, 2013). Dry lands of Pakistan are also affected by the changing climate due to high degree of dependence on natural climatic conditions (Khan *et al.,* 2016; Sultana and Ali, 2006). Increase in temperature and reduction in rainfall has exposed farmers to great agricultural losses resulting in remarkable differences in expected yields (Shakoor *et al.*, 2011; Sultana *et al.*, 2009; Hussain and Mudasser, 2007).

At that situation, farmers are trying to adjust their practices to the changing climatic conditions by various coping strategies (Abid *et al.*, 2016). According to IPCC (2001), adaptation to climate change refers to the adjustments in natural or human systems in response to actual or expected effects of changing climatic conditions. Deressa *et al.* (2009) explained that among others, common adaptation techniques in agriculture include; use of new crop varieties that suits local environmental conditions, crop diversification, irrigation, changing the types and quality of agricultural inputs, like seeds, pesticides and fertilizers, or in the worst case migrating to other places. Abid *et al*. (2016) further argue that while farm households are exposed to numerous climate related risks, the degree of their vulnerability depends on whether or not they can adapt. Timely adaptation to those risks may reduce vulnerability. However, adaptation to climate change depends on the socio-economic, environmental, and political environment of the region. The current level of knowledge about the process of adaptation and vulnerability of agricultural farms to climate change is still limited due to lack of research and identification of local risk perceptions which could help design effective policies (Deressa *et al.,* 2009). This is evident in Pakistan because the current literature on climate change and agriculture mainly cover economic and biophysical aspects across the country (Abid *et al.,* 2015).

The importance of agriculture sector can be seen from its contribution (23.3 percent) towards the total GDP (Gross Domestic Product) of Pakistan, accounting for 42.1 percent of the total labor force in the country (Economic Survey, 2003-04). However, several climatic factors have already been threatening agricultural productivity of the farms both economically and physically. These factors include change in rainfall pattern, temperature hike, changes in sowing and harvesting dates, water availability and land suitability (Sultana and Ali, 2006). Poor farmers suffer most from the effects of climatic events like floods and droughts which directly affect their lives and daily livelihood patterns (Ekpoh, 2010). Hence, such climatic events not only cause the agricultural losses but also reduces farm income of farmers (Sultana *et al.*, 2009), reduces job opportunities in farming and inputs and investment in the agricultural sector.

There is an increasing trend among agriculture and climate change researchers in Pakistan in exploring the causes and impacts of climate change on agriculture among poor rural inhabitants (Abid *et al.,* 2016; Ali and Erenstein, 2016; Rasul *et al.,* 2012). However, more efforts are needed to explore impacts of climate change on agriculture to ensure less agricultural losses, securing livelihoods of farmers, and meeting increasing food demands. Hence, the analysis made in this paper aimed to strengthen understanding of farmers about climate change and their decision making while living with climate change and its variability. It is argued that a better understanding of farmer perceptions regarding climate change, current strategies for managing climate change and their determinants will be important to form policy and planning for the future successful adaptation of the agricultural sector. In this perspective, this study intends to explore how farmers in the region conceive climate change and its impacts on agriculture, factors contributing to it and adaptation techniques deployed to avoid the odd impacts of climate change and its associated risks.

Climate change is considered as one of the most complex challenges for societies and economies around the globe. The impacts of climate change are varying across the world (Anita et al., 2010) where most of its severe impacts are observed in the developing world because of the poor economic conditions, lack of basic resources, weak institutional capacity and adaptive measures (Hoffman, 2013). Moreover, the frequency of climate-induced disasters and hazards has also increased from the last few decades (EM-DAT, 2016). Some of the prevailing impacts of climate change observed in different regions are included changing rainfall patterns, frequent floods, severe droughts, intense heat waves, melting of glaciers, increase in sea level. (IPCC, 2007; Adger *et al.,* 2003)

Pakistan is one of the most vulnerable countries to climate change where different sectors of the livelihoods are exposed to climate change induced risks (Chaudhry, 2017; Ullah *et al.,* 2017; Javed, 2016; Khan *et al.,* 2016; MoE, 2009). Particularly these climatic changes have prolonged the summer seasons and shortened the winter in different areas of Pakistan. (Salik *et al.,* 2015). Furthermore, the heat wave period has also increased by 31 days during the years 1980 to 2007 (Yu *et al.,* 2013; Sultana *et al.,* 2009). Climatic changes and its induced disasters are expected to have wide-ranging impacts on every sector of life in Pakistan (Chaudhry, 2017). For instance, the recent annual episodes of floods in Pakistan or heat waves in Karachi are the classic examples of how dangerous climate change can be for lives, livelihoods and other properties of people (Chaudhry, 2017). These floods are due to the heavy and irregular monsoonal rains occur mostly in July – September every year (Eid *et al.*, 2007). Substantial losses are reported in crop yields, land, houses, and other properties, leaving majority of the locals highly vulnerable to its impacts (Atta-ur-Rahman and Khan, 2013). Drylands of Pakistan are also affected by the changing climate due to a high degree of dependence on natural climatic conditions (Khan *et al.*, 2016; Sultana and Ali, 2006). Increase in temperature and reduction in rainfall has exposed farmers to great agricultural losses resulting in remarkable differences in expected yields (Shakoor *et al.*, 2011; Sultana *et al.*, 2009; Hussain and Mudasser, 2007).

Considering agriculture is a vulnerable sector to climate change, it has made policymakers, researchers and development experts in Pakistan to revisit its policies and adjust it to the demands of the present time. Moreover, it has been increasingly recognized in Pakistan that agriculture sector significantly contributes to the country's GDP and play a key role in sustainable livelihoods of farmers. However, several climatic factors have already been threatening agricultural productivity of the farms both economically and physically. These factors include; change in rainfall pattern, temperature hike, changes in sowing and harvesting dates, water availability and land suitability (Sultana and Ali, 2006). Farming community is often most suffered from the effects of those climatic events, causing threats not only to their farming but also reduces job opportunities in farming and investment in the agricultural sector. (Sultana *et al.*, 2009). In this perspective, this study is aimed to explore perceptions of farm household regarding climate change and in response adaptive measure of the locals towards climate change in the lowlands (*District Charsadda*) of Khyber Pakhtunkhwa (KP) province of Pakistan.

6.3 Methods and materials

6.3.1 Study area

Khyber Pakhtunkhwa (KP) is located in the north-west of Pakistan and is the third largest provincial economy in the country. Agriculture is the mainstay for many inhabitants of the province. However, not all lands are suitable for farming due to uneven topography of the area. Mostly, areas near three main rivers namely; Indus, Kabul and

Swat rivers are fertile and suitable for agriculture. The Kabul River enters at a point near the south-west of the Charsadda district and is bounded by Malakand District on the north, Mardan district on the east, Nowshera and Peshawar districts on the south and Mohmand Agency on the west. District Charsadda is one of the areas hit hard by floods in the province. Poor rural farmers in the district are at high risk of the annual floods mainly occurs in the monsoon season i.e. July – September. Moreover, severe droughts, heavy storms are also of the greatest concern to those farmers. The study area was purposively selected as a sample site because it had previously been identified as vulnerable to the odd impacts of climate change and its induced natural disasters by many researchers like Rasul *et al.,* (2012); Ullah *et al.,* (2015); Saifurehman and Shaukat, (2013) and Malik, (2012). Natural disasters, especially floods and droughts have severely affected agriculture, lives, livelihoods and other properties of the locals in the Charsadda district (Ullah *et al.,* 2017). For this study, two villages namely; Gulabad and Shabara were selected from Charsadda district as shown in Figure 6.1.

6.3.2 Sampling and data collection

Extensive Household survey (HHS) was carried out in two selected villages (Gulabad and Shabara) of District Charsadda. During the HHS 116 households were randomly selected for detail interviews i.e. 45 from Gulabad and 71 from Shabara. The survey mostly targeted households head using a structured questionnaire to explore research objectives, however, if unavailable, other adult members of the household were interviewed. This study was performed in Pashtun tribe of Pakistan where both men and women do not mix. Therefore, the study did not include responses from women due to cultural and religious reasons. The sampled households were selected through multi-stage stratified sampling. In the first stage purposively Khyber Pakhtunkhwa was selected among the four provinces of Pakistan. In the second stage, among 24 flood-hit districts, Charasadda was purposively selected. In the third stage, the affected area was divided into two categories urban and rural areas. The urban area was excluded from the survey as per the objectives of the study only the farmer’s risk management strategies to be studied and farming is not practiced in urban areas. Later, in the last stage, 116 respondents were randomly selected from the total population of two villages in the district keeping in view the homogeneity and heterogeneity such as climatic conditions, farming practices, irrigation facilities and distance from river. The sample size was relatively smaller due to budget constraints.

Two field assistants were hired to help the first author of this paper in collecting primary data from the study area. A one-day intensive workshop was arranged to train field assistants prior to visit stud villages. The study team administered all questionnaires personally. Before starting the HHS, purpose, and objective of this study were clearly explained and respondents were asked for an informal verbal consent. Generally, the household survey lasted for approximately an hour. The survey was conducted in September and October 2016. The survey includes questions on awareness among villagers regarding climate change and its key factors affecting agricultural production, locally perceived best and worst years for agricultural production, and damages associated climate change induced natural disasters. Adaptation techniques employed to reduce negative impacts of climate change were also part of the survey.

6.4 Results and discussion

This section starts with exploring seasonal calendar of the study area. Then, the chapter describe farmer's perception and awareness towards climate change. Then the paper reports perceptions of surveyed respondents on the most prevalent natural disasters in the study area, a brief history of agricultural production (*best suitable and worst year)* for agricultural production and damages caused by climate-induced natural disasters. The analysis then moves to identify the key factors of climate change affecting farming and then explore adaptation practices deployed to reduce negative impacts of climate change on agriculture in the study area.

6.4.1 Seasonal calendar

A seasonal calendar is a visual method of showing the distribution of seasonally varying phenomena such as economic activities, resources, production activities, problems, illness/disease, migration, and natural events/ phenomena over time. It can be used for understanding seasonal differences during livelihoods analysis and vulnerability analysis; illustrating dynamic dimensions of well-being, which are often poorly illustrated through conventional forms of poverty assessment; identifying cause-and-effect relationships between seasonally varying phenomena; understanding the time of the year when different social groups are more or less vulnerable; identifying some of the reducing, mitigating, and coping strategies people use to manage risk; identifying periods when specific groups of people usually suffer particular hardship so that appropriate "safety nets" can be set in place or other remedial actions taken (Brocklesby, 2002; Sontheimer, *et al.* 1999). In this study we use it for showing annual agricultural activities in Charsadda district. In addition, the calendar also present vulnerability towards natural disasters induced by climate change in the study area.

Table 6-1: Agricultural seasonal calendar of Charsadda district

	W	M											
Months			1	2	3	4	5	6	7	8	9	10	11	12
Agricultural activities														
Wheat		■	Growing	Growing	Growing	Growing	Harvesting	Harvesting				Planting	Planting	Growing
Sugarcane		■	Harvesting	Harvesting	Planting	Planting	Growing	Growing	Growing	Growing	Growing	Growing	Harvesting	Harvesting
Eucalyptus *(harvest every four to five years)*		■	Growing	Planting	Planting	Growing	Growing	Growing	Growing	Growing	Growing	Growing	Growing	Growing
Maize		■						Planting	Planting	Growing	Growing	Growing	Harvesting	
Tomato		■		Planting	Planting	Growing	Growing	Harvesting	Harvesting	Harvesting	Harvesting	Harvesting		
Potato (summer crop)		■		Planting	Planting	Growing	Growing	Growing	Growing	Harvesting	Harvesting	Harvesting		
Potato (Winter crop)		■	Growing	Growing	Harvesting	Harvesting	Harvesting	Harvesting	Harvesting	Harvesting	Planting	Planting	Growing	Growing
Onion (summer crop)		■		Planting	Planting	Growing	Growing	Growing	Growing	Harvesting	Harvesting	Harvesting		
Onion (Winter crop)		■	Growing	Growing	Harvesting	Harvesting	Harvesting	Harvesting	Harvesting	Harvesting	Planting	Planting	Growing	Growing
Okra		■		Planting	Planting	Growing	Growing	Harvesting	Harvesting	Harvesting	Harvesting	Harvesting		
Cucumber		■		Planting	Growing	Growing	Growing	Growing	Harvesting	Harvesting	Harvesting	Harvesting		
Chilli		■	Harvesting	Harvesting							Planting	Planting	Growing	Harvesting
Bottle Gourd		■		Planting	Planting	Growing	Growing	Harvesting	Harvesting	Harvesting	Harvesting	Harvesting		
Bitter Gourd		■		Planting	Planting	Growing	Growing	Harvesting	Harvesting	Harvesting	Harvesting	Harvesting		
Brinjal		■		Planting	Planting	Growing	Growing	Harvesting	Harvesting	Harvesting	Harvesting	Harvesting		
Peas		■	Harvesting	Harvesting							Planting	Planting	Planting	Growing
Disasters														
Flood/ Heavy rainfall								■	■	■	■			
Storms									■	■	■			
Droughts (doesn't happen every year)			■	■	■	■	■	■				■	■	■

Planting ■ Growing ■ Harvesting ■

Source: Author's field survey, 2017.

Note: W stands for women and M for Male. As explained in Chapter 5 & 6, agriculture in the study area is manily performed by males, hence, females are only involved in household works.

Sugarcane is the commonly grown in the study area and hence I also focused this group discussion to identify how farmers prepare land, sow, harvest, irrigate, apply fertilizer, pesticide, sell and so on during the season. Moreover, this discussion also covers what other crops farmers grow and types and seasonality of vegetables is also explained in detail.

Participants of the focused group discussion explained the process of sowing-harvesting sugarcane, making jaggery, and selling it to the sugar mills. Jaggery making (Ganrhi), is a traditional small industry for Jaggery (hereafter called Gurr, a local name for jaggery) production. This method of production is practiced across all the agriculture rich district of Khyber Pakhtunkhwa province, including Charsadda. All gurr-makers usually wake up early in the morning and head towards ganrhi and work till late evening. This work starts in November and ends in late February till mid-March. Main task of the peasants is to juice the ripen sugarcane and convert it to yellow slices of Gurr.

Sugarcane is sown in January, then ripe up and harvested after a hard work of farmers who makes it into bunches ready to be taken to ganrhi. In my study area, these bunches are carried by using bulls-carts, donkeys-carts or by using tractors depending on the financial condition of the peasant. In the past, ganrhi used to be run by peasants using hands but now most of them have installed Chinese machine which have extension of heavy iron gears that circulates around each other. Sugarcane bunches are placed inside it and it extracts juice from it. This machine has not only reduced the labor work but also save time of the farmers that they can utilize in other household activities.

Later, baking soda is thrown into the big pan where sugarcane juice is accumulated. This increases the boiling of sugarcane juice and the smaller particles goes up in the corner are then separated and taken out through a long stick with a filter. This process goes until two to three hours and stops when gurr gives its orange color. Next, large ceramics pot is used for cooling down the hot and here the final stag come, where labor working in ganrhi using water to cool their hands and speed up the gurr ball making. Afterword’s gurr is placed in sacks and ready to be brought to the market for selling.

Participants further explained that after doing all this hard work (sowing, harvesting, making gurr), they then expect reasonable prices in return. However, this is not always the case. Prices are set by the government and usually peasants sell it to the mills according to their promised made to mills. Peasants in our study area are poor and cannot afford growing sugarcane by themselves. Sugar mills lend money, fertilizers, or any other thing farmers need and in return ask them to sell their produce to them. In this case, prices are set by the respective mills, with no intervention from local farmers. This is where farmers bear the biggest losses. Few participants mentioned that, when we set for calculation after selling gurr, sometimes we end up with no gain and no loss or in some cases, we (the farmers) get small benefit. Farmers must pay the prices of ingredients to plough the land, seeds, urea and the daily or monthly wages of their working peasants. They, then asked the research team to decide if this is fair or unfair, because after doing all this hard work, the return is negligible. Undoubtedly, having no control or in the worst case, information regarding price fluctuation in the market, have shocked local peasants, especially those whose livelihood mainly depends on farming.

Not only prices, but market for selling gurr is also squeezing. Participants explained that, in the past, they have more options to choose regarding where to sell. They further mentioned that, Gurr from Khyber Pakhtunkhwa was famous in Afghanistan and other central Asian countries due to its unique taste and color. However, due to worse bilateral relations and bad political situation in the country, we have lost that market. It is now occupied by Indian sugarcane growing farmers. By inquiring their views on the future of sugarcane and agriculture in general in the study area, participants reported that the increasing number of farmers are now thinking of switching land from agriculture to other means of income generation. However, this fact is not in line with the household data I analyzed. This might be because farmers in the area are un-happy and unsatisfied with the government support in the form of subsidies, access to good agricultural inputs, easy access to market information, weather related information and so on. This will no doubt be affecting the labors and peasants' who are not skilled to find another job.

Growing sugarcane requires large labor force at all growth stages starting from preparing land to harvesting and then taking gurr to the sugar mills in the nearby areas. Participants explained that in the peak times, people help each other in harvesting. Sometimes, labor from neighboring villages are requested for help. This type of mutual help is common in Pashtun society, explained by the participants and supported by astudy performed in the same district by Hussain and Khattak (2011). However, not all labor is free of cost, instead hiring people from villages require huge investment. By asking about the exact number of labors hired, it was difficult to provide an exact number because labor demand changes according to the financial situation, already available labor in the household, and on the type of growth stage. For example, the maximum number of labors is required during harvesting, but for sowing, irrigating, applying fertilizer, only few people are required. Proper attention is given to the people hired based on their farming experience. Moreover, during harvesting proper care is taken to maintain high quality standards. Sugarcane is harvested by labour which gets cash and in-kind benefits in return. The labour gets the sugarcane straw and harvests the sugarcane. In some cases, when there is a lot of grass and other food available for the animals, they can take it home either for free or by paying small money.

Besides that, farmers also grow maize, wheat and different types of vegetables as supporting crops. These crops are mainly for household's own consumption and if they have large land, of which huge parcels are allocated for maize or wheat production, then it can also be sold.

During discussion, I also inquired about the best suitable time for sowing, and months of year when usually flood, brought or storm destroy their crops. Participants in both villages believed that recent annual episodes of flood are the main culprit for destroying standing crops. These floods, as discussed in other parts of the dissertation, usually occur in monsoon season i.e. July-September. Sometimes, when flood is not so strong, it is good for sugarcane crop because peasants does not need to irrigate land due to flood water inundation in the fields. On the other hand, drought is perceived as more serious threat especially in Shabara. In Pakistan, annual rainfall is quite low during most of the year. Lower rainfall increase demand for irrigation water during crop growing stages. Farmers in Gulabad have access to water so they can irrigate land two or three times per month. However, in Shabara, it is the opposite. During discussion, participants in Shabara, considered drought as the biggest threat than flood. This is due to the fact that they do not have access to river water. Although, government has built canal, but it is non-functional. During most of the year, it is dry or near to dry (less water) but in monsoon season, due to heavy rainfalls, this same canal gets flooded and because a biggest threat. Participants in Shabara, demanded from government to take care of this canal. By taking care they meant that government should either close it or provide us access to use it whenever there is enough water to be used for irrigation.

a. Summer vegetables

Vegetables, despite of their type and seasonality, it is grown for self-consumption in the study area. Tomato, Hot pepper, sweet pepper, Brinjal, Cucumber, Okra, Bottle Gourd, Sponge Gourd, Bitter Gourd, Tinda Gourd, Pumpkin, Arum, Potato, Mint, Turmeric, Ginger, Musk Melon, Water Melon, Sweet Potato & Groundnut are summer crops. The best time of sowing is spring (Feb, March) and they will produce till September, October.

b. Winter vegetables

The best sowing time of winter vegetables is September, October and they will produce till February and March. Winter Vegetable includes Cabbage, Cauliflower, Broccoli, Carrot, Potato, Onion, Lettuce leaf, Radish, Turnip, Peas, Spinach, Fenugreek, Beets, Mustard, Coriander, Mint & Garlic. The above-mentioned seasons are generally suited for most areas, but there are certain exceptions varying from crop to crop. For example, tomato can be grown year around in Karachi or similar areas, but you cannot grow it in those parts of country where frost is certain also there are different varieties for different seasons, for example, summer Radish variety is different from winter variety. Early and late sowing can also be beneficial, prepare seedling of spring planting in winter underneath plastic sheets and fall planting in summers underneath shades these crops will provide you off-season vegetables which are otherwise very costly in market.

6.4.2 Farmer’s awareness and perception of key factors of climate change

Climate change is perceived differently because its impacts are seen differently across the study area. It is crucial to know how farmers perceive climate change to be able to design effective policies for supporting sustainable agriculture. Survey results presented in (Table 6-2) revealed that 87 percent and 92 percent of the respondents understood climate change *(changes in the short and long-term weather)* in Gulabad and Shabara respectively. Most of the sampled households in Gulabad heard of climate change either from village elders (42 percent) or through electronic media mainly through radio (36 percent) while in Shabara, village elders were the main source of information on climate change (83 percent).

Table 6-2: Perception about key factors of climate change among sampled respondents in Gulabad and Shabara

Indicator	Response	Gulabad (percent)	Shabara (percent)
Do you know climate change?	Yes	87	92
	No	13	8
Source of information on climate change	Personal observation	7	4
	Village elders	42	83
	Media	36	11
	Do not know	15	4
Factor of climate change that has changed	Temperature change	33	68
	Rainfall pattern change	56	34
	Frequency of extreme events has changed	16	7
	Others	4	4

Source: Author's field survey, 2016.

Village elders share their experiences with other farmers and discuss how environmental situations have changed over time. Moreover, 33 percent of the respondents in Gulabad and 68 percent in Shabara perceived that the common factors changed due to climate change includes an increase in temperature and unpredicted rain falls (54 percent in Gulabad and 36 percent in Shabara). Changes in these conditions have made farming difficult and have also significantly reduced agricultural production in study area. Few number of households perceived an increase in the frequency of extreme events such as floods, droughts etc. but they reported that natural hazards especially floods have also become more disastrous in recent past years.

Literature shows that if farmers are aware of the changes occurring in climate, or to the risks associated with it, they can better prepare for it (Qasim *et al.,* 2015). People highly exposed to those risks are obliged to take actions against it to minimize its devastating impacts. In this study, most of the farmers acknowledged changes in climate and perceived that the increasing temperature, extreme drought situation and changing rainfall pattern are among the major threats to farming in the study area. Similar findings have been reported by Khan *et al.* (2016); Abid *et al.* (2015 and 2016) by mentioning that climate-induced disasters especially floods have become more disastrous in recent past years. Moreover, the results are also in line with the data shown by Centre for Research on the Epidemiology of Disasters (CRED – EM-DAT) for Pakistan. Recent studies show that this increase in the frequency of natural disasters can be linked to climate change (Atta-ur-Rehman and Khan, 2013; Epkoh, 2010; Adger, 2003; and Ministry of Environment, 2009). The consequences of such changes are devastating for lives and livelihoods of poor rural farmers. Researchers from Pakistan have reported that the absence of early warning system in disaster-prone areas like Charsadda exposes communities to negative impacts of climate change. Although, institutions like Pakistan Metrological Department and National and Provincial Disaster Management Authorities regularly update their websites by posting daily weather reports and other relevant information that can be helpful for rural farmers, but their ignorance towards using modern technologies, and using internet makes the information less significant in protecting farmers from the negative impacts of climate change. Instead, farmers in our study area mostly rely on traditional knowledge of village elders *(involved in farming)* regarding what changes they have observed in short and long-term weather.

6.4.3 Perceptions on impacts of climate change on agriculture in the study area

Figure 6-1 and 6-2 summarizes the rating of main consequences of climate change and its effect on farming in the study area. These perceptions were measured on a four-point scale i.e. no extent, little extent, some extent and great extent. A total of 19 indicators of climate change were pre-identified from the literature that could potentially affect agriculture, of which seven were perceived as having no to minor impact on farming and were excluded from analysis. These seven indicators include; deforestation, long duration of winter, lack of vegetation/pasture, post-harvest losses, and shortening of crop life cycle. Results indicate that 60 percent of the sampled respondents in Gulabad and 54 percent in Shabara conceived annual episodes of severe floods as a major threat to farming. Among other variables listed as having a higher impact on agriculture in both villages includes; loss of farmland due to floods i.e. 53 percent in Gulabad and 68 percent of respondents in Shabara. In Shabara, 63 percent and 42 percent of all the sampled respondents perceived drought and shifts in the pattern of temperature and rainfall respectively, as major contributing factors to the negative impacts of climate change on agriculture in the region. Results also revealed that decrease in soil fertility (36 percent and 63 percent) and high-temperature (40 percent and 52 percent in Gulabad and Shabara) respectively contribute to some extent to disturb farming in the study area. Whilst, other indicators included in the analysis such as long duration of winter, lack of vegetation, post-harvest losses, shortening of crops life cycle etc. were conceived as having little to no impact on farming the study area. Although, both villages are closely located to the river, but only farmers in Gulabad uses river water for irrigation. As explained earlier, due to the absence of water channels from canal to farming lands, majority of the respondents in Shabara rely either on Tube-wells or rain-fed irrigation. In Shabara, among all, 44 percent of the respondents reported that availability of water for irrigation is one of their major concern in getting desired yield.

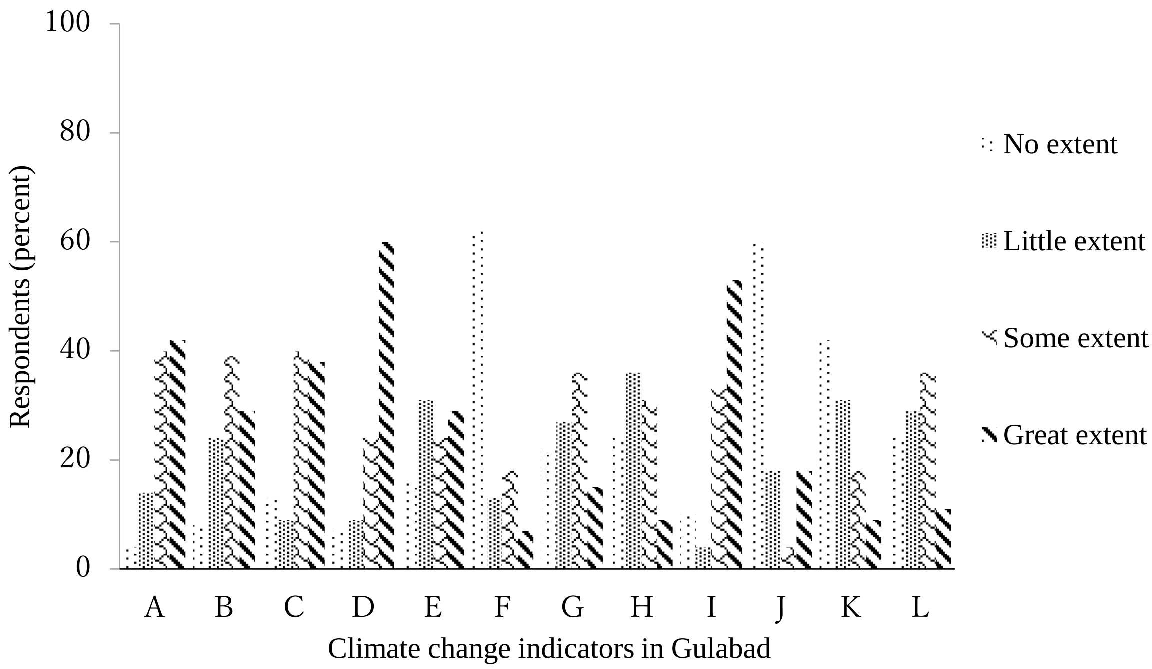

Figure 6-1: Rating impacts of climate change on agriculture in Gulabad

Source: Author’s field survey, 2016.

Note: A: High temperature; B: High rate of precipitation; C: Pattern of rainfall and temperature; D: Floods; E: Attack of pests and diseases; F: Lack of water supply; G: Decrease in soil fertility; H: Droughts; I: Loss of farmland due to floods; J: Soil erosion; K: Long duration of summer; L: Crop destruction by high speed wind

In different regions of Pakistan, for the most part, farmers’ perceptions of climate change and experience of extreme events appear to be in line with actual climate data and matches closely with the results drawn from scientists’ data analysis. Results from other studies have shown that the steady increase in mean maximum temperature, unpredicted rain falls, a decrease in precipitation on most of part of Pakistan has resulted in agricultural losses and increasing risks of crop pests and disease outbreaks (Sultana and Ali, 2006; Abbas, 2009; Farooqi *et al.*, 2005). In the case of this study, majority of the farmers understood climate change and the major perceived consequences identified were increased in the length of summer and increase in the temperature, unpredicted rainfall, disastrous floods, severe droughts, and storms. All these factors have resulted in great agricultural losses which were observed as the only major livelihood for subsistence. Like our findings, studies performed in other parts of the country showed that floods and droughts were also the major consequences of climate change (Sultana *et al.*, 2009; Abid *et al.*, 2016). For instance, monsoon floods in 2010, 2011, and 2014 caused huge damages to agriculture crops, livestock, and primary infrastructures like water channels, tube wells, houses, seed stocks, fertilizers and agricultural equipment (Atta-ur-Rehman and Khan, 2013).

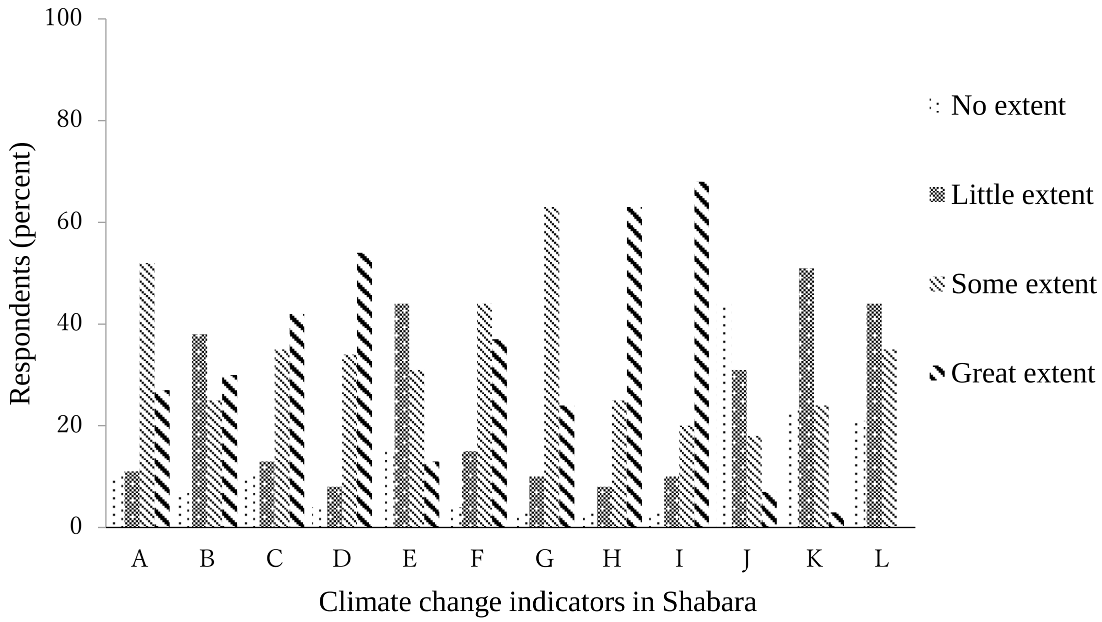

Figure 6-2: Rating impacts of climate change on agriculture in Shabara

Source: Author's field survey, 2016.

Note: A: High temperature; B: High rate of precipitation; C: Pattern of rainfall and temperature; D: Floods; E: Attack of pests and diseases; F: Lack of water supply; G: Decrease in soil fertility; H: Droughts; I: Loss of farmland due to floods; J: Soil erosion; K: Long duration of summer; L: Crop destruction by high speed wind.

6.4.4 Crops growing stages and its sensitivity towards rainfall for a successful harvest

Rain is important to agriculture because all plants need water while regular rain pattern is vital to successful harvest. Too much or too little rainfall can be harmful, even devastating to crops. Hence, this section decribes crop responses at different stages to rainfall for a successful harvest. Wheat and Sugarcane were the commonly grown crops in the study area. The responses given are only applied to those two crops. A four point Likert scale (not important, somewhat important, very important and critical) was used to capture responses of farming household during household survey. Crop growth stages included in the analysis were; planting, germinantion, vegetative, flowering, maturation and post harvest.

Results presented in Figure 6.3 reveal that, none of the respondents reported that rainfall is not important ant any growth stage of cropping. Few respondents believed that rainfall is somewhat important in both villages for a successful harvest. However, sampled households in both villages believed that despite of what growth stage a crop is at, timely rainfall is always critical for a successful harvest and getting desired yield. Majority of the respondents were of the view that rainfall is very important or even critical for a successful harvest at any crop growth stage. Results further show that, sampled households in a range of 45 percent to 70 percent, specifically mentioned that rainfall is much needed during germination, vegetative and maturation stage. Others reported that at planting stage rainfall is critical for a successful harvest.

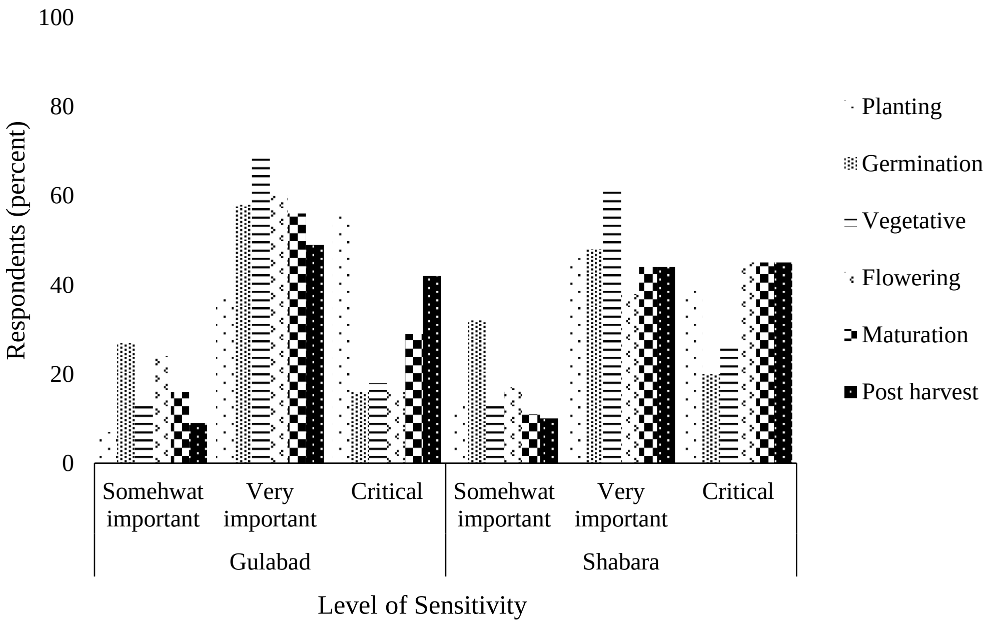

Figure 6-3: Perceptions of farmers on sensitivity of crop stages towards changing rainfall pattern for a successful harvest

Source: Author's field survey, 2016.

6.4.5 Adaptation strategies and sources of climate-related risks

This section borrows previous methodology used to identify how farmers adapt to climate-related risks at farm level in Panjab province of Pakistan (Deressa *et al.,* 2011; Abid *et al.,* 2016). Adaptation strategies included in this study were grouped into four major categories: (1) changing cropping practices, e.g. crop type and variety or planting date; (2) changing farm management techniques such as fertilizer, pesticide, seed quality or irrigation; (3) advanced land use management measures, i.e. changing farm management techniques such as sowing and harvesting, planting shade trees, stopping cutting trees, using less water, storing water and soil conservation; and (4) livelihood options, including shifting from single to multiple crops, shifting from farming to livestock keeping, migration and renting more crop land. A total of Fifteen adaptation strategies were identified in the study area, practiced by the sampled respondents' due to the consequences of changing climatic conditions. All the adaptations were based on local knowledge. Local people mostly depend primarily on farming and are facing poor economic condition. The study area is among one of the highly-exposed districts of the country. Hence, adaptation agriculture to the vagaries of climate change is considered as the most appropriate method to reduce the negative impacts of climate change. Percentage statistics of respondents who were practicing a mix of adaptation strategies to adapt with the climate change induced natural disasters are given in (Table 6-3).

During the field visit, it was found that among all listed adaptation methods, farmers in both villages were using a mix of strategies to cope the vagaries of climate change. The most prominent and widely used methods in both villages include; changing crop type, changing seed quality, change fertilizer, plant shaded trees and stop cutting trees due to the increased threats from floods, droughts, soil erosion and pest attacks on crops. The reasons for adaptation to climate changes were mostly similar in both villages. Few sampled respondents deploy adaptation methods like change crop type, variety or change planting dates to ensure desired production while facing changing climate. Farmers in Gulabad changed crop variety, type, and quality of fertilizer, pesticide and seed quality; plant shade trees; and shift from single to multiple crops to cope with climate change (Table 6-3). The prominent methods of adaptation to reduce the negative impacts of climate change in Shabara included changing crop type, changing seed quality, plant shade trees and stopping cutting trees. The methods of adaptation to climate change were mostly similar in both villages. Changes in cropping practices implemented by respondents were dependent on the nature of problem. A change in crop type or variety was mostly adopted due to pest and insect attacks on crops that negatively affected agricultural production. To overcome this problem, households reported that they had tried new fertilizers and pesticides to ensure desired production. Farmers try different combinations of pesticides but mostly buy the cheapest available, partly due to availability in the village market – it is easier to buy it within their vicinity. The case of fertilizers is similar to that for pesticides. In response to loss of fertile soil layers by floods in 2005 and 2010, farmers used more fertilizers to balance nutrients in the soil and increase crop productivity. All farmers thought that their production had decreased in the last decade or so, and they try to add more fertilizer to their soil than before. It was also mentioned that these adaptation strategies did not help improve their yields. Farmers have started buying heat-tolerant wheat varieties to cope with extreme hot weather events, following farmers in Punjab province who usually get higher yields compared with farmers in the study area and in Khyber Pakhtunkhwa province generally. It was reported that wheat and sugarcane production had reduced by more than half compared to 10 years ago. Most farmers believed that this was due to changes in climatic conditions, poverty and lack of support from local government. Changing farm management practices include changing fertilizer, pesticide, seed quality and frequency of irrigation were implemented by sampled households. For instance, in Shabara, during dry years (which happen often), farmers changed their irrigation frequency to ensure the desired production. Crops are exposed to pest attacks in cases of more rainfall.

Table 6-3: Types of adaptation methods employed to manage negative impacts of climate change on agriculture identified by farm households

Adaptation strategies	Village Name		Source of risk
	Gulabad (percent)	Shabara (percent)	
Changing cropping practices			
Change crop type	13	41	Flood, drought
Change crop variety	33	2	Flood, drought, soil fertility, maximum extreme temperature
Change planting dates/season	--	7	Flood, drought
Change farm management techniques			
Change fertilizer	82	55	Drought, soil fertility, crop pests
Change pesticide	36	18	Drought, crop pests
Change irrigation	4	17	Drought, soil problems
Change seed quality	58	79	Drought, crop pests
Advance land use management measures			
Plant shaded trees	58	61	Flood, soil erosion
Stop cutting trees	16	13	Flood, soil erosion
Store water	2	3	Drought, water scarcity
Farm diversification	24	11	Soil fertility, drought
Change farm management techniques	7	--	Flood, crop pests, drought
Livelihood options			
Shift from crop to livestock	9	--	Flood, drought
Migration	9	--	Flood
Rent out cropland	9	--	Soil fertility, flood, drought

Source: Author’s field survey, 2016.

Due to loss of fertile soil layer by a countrywide flood occurred in 2010, 80 percent of the respondents in Gulabad and 55 percent in Shabara reported that they apply more fertilizers to balance nutrients in the soil and increase crop productivity. More than half of the respondents in Gulabad and approximately 61 percent in Shabara have started planting Eucalyptus around lands near the river to reduce soil erosion from flood in monsoon season i.e. July to September.

Although sampled respondents understand the importance of water for agriculture, none of them store water to help them during drought situation. In Gulabad, availability of water for irrigation is considered as a less critical issue because of having good access to river water. In Shabara, although canal has been built but due to unavailability of water channels to lands, farmers cannot get benefit of it. Due to this situation, farmers in Shabara, mostly rely on tube-well irrigation or wait for the onset of rainfall. Pakistan is currently facing serious electricity shortage. Hence, farmers rely on buying diesel to run tube-wells for irrigating agricultural lands. Moreover, sampled farmers mentioned that unaffordable prices of diesel make farming more expensive and unaffordable for them. To reduce high expenses of using diesel, farmers usually reduces the frequency of irrigating land. This situation resulted in compromising on receiving lower yields due to untimely irrigation.

Livelihood diversification is considered as an important strategy in dealing with risks. It is defined as “a process through which new ways of raising income and reduction of environmental risks, is identified”. Diversifying livelihoods includes both on and off farm activities in the context of agriculture. In the study area, most of the sampled respondents were exclusively farmers. Hence, other alternative livelihood options were not largely adopted by them particularly in Shabara. This is partly because of the inherited farming as an occupation and because of not knowing what else to do. Due to lack of access to good agricultural inputs, higher threats from annual episodes of floods, long dry conditions, and infertile soils, a few farmers tend to rent out more land for farming. Similar environmental situation exists in the neighboring districts or even worse, hence not many farmers tend to migrate to other areas, instead stay in Gulabad and Shabara. It should be noted that all these strategies, however, are mostly followed in combination with other strategies and not alone. Sampled respondents were also asked about the source of risk due to which they need to adapt to the vagaries of climate change. Prevalent annual floods, extreme droughts, soil infertility, increased crop diseases and water scarcity were listed as the most important consequences of climate change in the study region.

To maintain productivity while facing climate challenges, farmers must respond with effective adaptation measures. Agricultural adaptation to climate change includes adjustments made to the agricultural system in response to current or future climate changes, which enhances resilience towards climate change (Abit *et al.,* 2015). In our case, farmers mostly utilize changing fertilizers, seed quality, plant shaded trees and changing crop variety as the most commonly and frequently adaptation methods. However, none of the households noted improvement in agricultural yield due to such adaptation. This could be due to farmers' inability to determine which adaptations are most effective at increasing farmers' resilience as identified by Deressa *et al.* (2009) in Ethopia and Abid *et al.* (2016) in Punjab province of Pakistan. This is one of the reasons why despite adequate measures taken for reducing the negative impacts of climate change and its induced disasters, the proportion of success in achieving desired outcomes is conspicuous from one community to another even with the same set of warnings and awareness generation mechanisms at place or having same set of resources to utilized in the time of hardship. Technical solutions alone often fail to enhance resilience of population unless there is a good understanding of perception and social setup that constructs this perception, the technical solutions alone often fail to build up resilience of the population.

As explained earlier, information sharing on climate change were mostly through village elders who had the experience of farming since long time. This experience enabled farmers to identify the changing weather conditions on a longer period. On the other hand, farmers rarely applied that knowledge on the field to improve agricultural production. This is evidenced by considering the adaptation strategies deployed by farm household at the study area. Sampled respondents, in most cases, look for economically feasible adaptations instead of environmentally feasible. By doing so, farmers face situations in which they struggle to improve agricultural production. This is probably due to the ignorance towards impacts of climate change on agriculture in the region. For most of these adaptations, farmers generally followed their co-workers. Interestingly, both the experienced farmers and their followers were not sure how will those adaptations help improve agricultural yields. For instance, only 2 percent of the farmers in Shabara have tried changing crop varieties compare to 33 percent in Gulabad. Due to the high exposure towards floods risk, more than half of the farmers have already planted trees for protecting their land, lives, and properties. However, not many of the sampled respondents stopped cutting trees as they need it for fuelwood consumption. Similarly, not many of the households have tried diversifying farm management techniques and look for other alternative livelihoods that could help in time of hardship. Lessons learned from this study on how farmers perceive climate change, ongoing adaptation measures, are important for crafting policies and programs aimed at promoting successful adaptation of the agricultural at farm level. However, in the case of Pakistan, the current level of support for the agriculture sector in terms of climate change adaptation is fairly limited due to weak implementation of climate policy and the very low technological and financial capacity of the country in adapting towards climate change (Ullah *et al.,* 2015; Ullah *et al.,* 2017). Hence, vulnerability to climate-related risks may be reduced if farmers effectively adapt to the changing conditions to reduce losses in crop yields. To achieve this goal, farmers will need support from multiple stakeholders such as local government agencies, agricultural extensions, researchers and from local community.

Advanced land use management techniques were also adopted to protect livelihoods against negative impacts of climate-related risks. Although respondents understood the importance of water for agriculture, no one used water or stored it for winter (the season when there is insufficient water for irrigation). In Gulabad, availability of water for irrigation was considered a less prominent issue because they had good access to river water. Although a canal was built in Shabara, farmers get no benefit due to a lack of water channels to land. More than half of the respondents in Gulabad, and approximately 60 percent in Shabara have started planting Eucalyptus around their land especially near the river to reduce soil erosion from floods during July–September. However, farmers were unaware that Eucalyptus have a high-water demand (Forrester *et al.,* 2012). Farmers in Shabara showed more concern after learning this fact because they already face water scarcity for irrigation.

All sampled respondents were primarily farmers and their whole household depended on it. Other livelihood options were currently rare. Farmers have tried shifting from single to multiple crops, planting Eucalyptus or replacing wheat with maize in some parcels of land. Due to unavailability of grazing areas, few respondents were willing to depend on livestock for subsistence. One household migrated from a neighboring village to Shabara in response to loss of agricultural land due to floods in 2010 but was not satisfied with soil fertility in Shabara. Small numbers of farmers rented extra land within the village to increase their overall agricultural production and meet household food demand, which had been affected by infertile soil, lack of access to good agricultural inputs and high exposure to droughts and floods.

Due to the high exposure of agricultural communities to vagaries of climate change across Pakistan, many farmers tend to minimize these impacts by trying different adaptation methods. However, the impact of climate-related events strongly depends on the capacity to adapt to the risks. Although adaptation practices are potentially important, not all farmers use such practices due to lack of knowledge on what techniques are appropriate (Baig and Amjad, 2014; Ahmad *et al.,* 2013). This situation particularly applies to Pakistan where knowledge about the current process of adaptation and vulnerability aspects at farm level is still very limited due to lack of research on environmental vulnerability and local-level risk perceptions (Hussain and Mudasser, 2007). Abid *et al.* (2016) and Adger *et al.* (1999) reported that those who adapt in a timely manner may not only reduce the negative impacts of climate change but also profit compared with those who adapt late or not at all. However, the approaches to adaptation assume that people have access to the resources needed to put these strategies in place. For the most vulnerable people in many communities, this is simply not the case. When people do not have secure access to these resources, their options are limited, and they are less able to act on adaptation (Daze, 2011; Mertz *et al.,* 2009).

6.4.6 Adaptation to climate variability across different categories of farmers based on education level and farming experience

From the results presented in previous section in Table (6.3), adaptation techniques that were deployed by the majority of the households were further cross-checked with farmers education level and farm experience by assuming that adaptation to climate change differs in terms of extent to choose certain adaptation technique. The most prominent adaptation methods included in this analysis are; changing fertilizers, pesticides, seed quality and plant shaded trees to deal with the vagaries of climate change. For this purpose, we categorized education level of farm households into three categories: illiterate farmers with no formal education; those with 1 to 5 years of schooling; farmers with more than 5 years of schooling (Figure 6.3). Results indicate that illiterate farmer tends to adopt less compare to those with relatively higher education level. In Gulabad, 36 percent farmers with more than five years of schooling employed changing fertilizers as an adaptation strategy for improving agricultural yields whereas interestingly 37 percent of the farmers having no formal education in with Shabara, have focused on changing seed quality. As discussed earlier, although, farmers did try to shift from one strategy to another year by year, they always emphasized on looking of the cheapest (in economic perspective) available options. For example, farmers did change seed quality, but it does not mean that they have bought a better-quality seed or heat-resistant seed that can survive in harsh environments. Instead, they looked for seed type that they have not grown in the past few years and hope that it could help improve agricultural yield. Moreover, in both villages, fewer number of respondents, although with slight variation, tempted to adapt to changing climatic conditions by applying new and improved crop varieties despite any relevance to their education level (Figure 6-3). This may be due to the poor economic condition of locals and because of their ignorance that by applying heat-resistant crop varieties, agricultural production can be improved. Here, it is important to mention that the absence of agricultural extension workers has worsened the situation. Those officials could educate farmers on the importance of using heat-resistant crops and seeds and could provide support in accessing where to buy it.

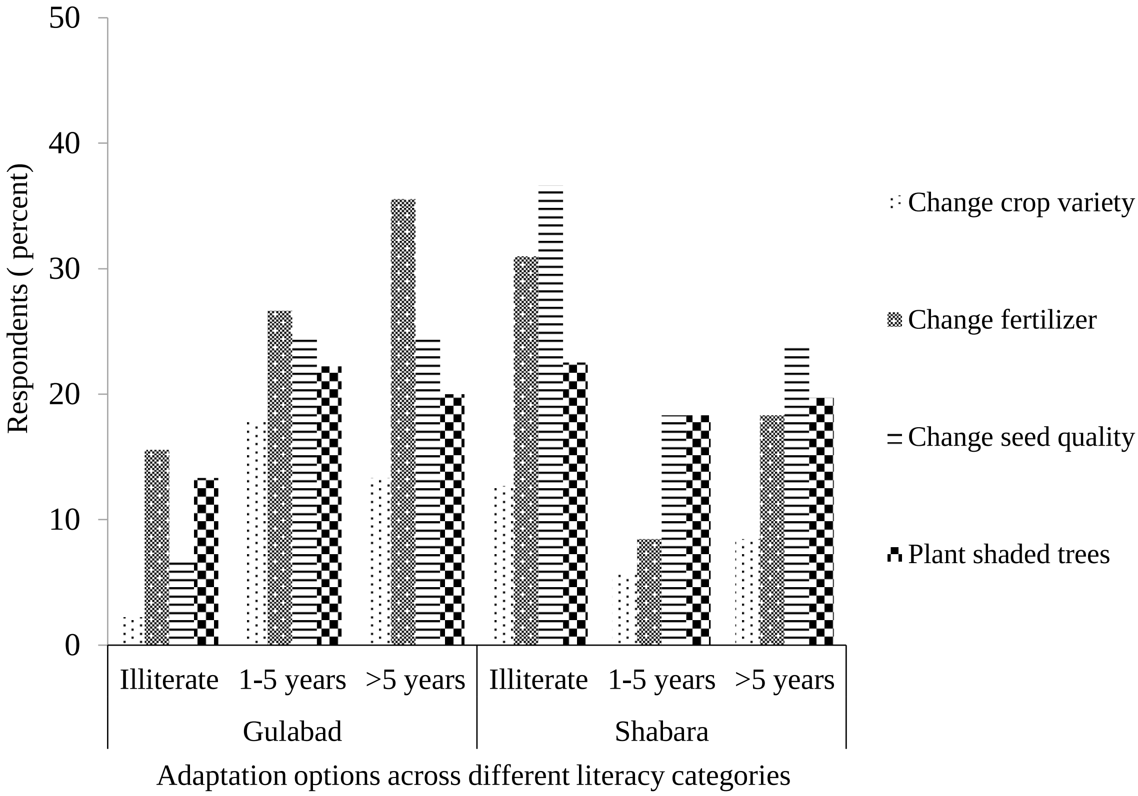

Figure 6-4: Adaptation to climate change across different groups of farm household based on their education level

Source: Author's field survey, 2016.

The analysis of adaptation measures across distinct categories of farmers based on farm experience is described in Figure 6-4. Categories generated for farm experience were grouped into three types i.e. 1 to 10; 11 to 20 and more than 20 years of experience. Farmers who have less experience were less likely to adapt a single or a combination of measures taken to reduce the negative impacts of changing climatic conditions on farming. In both villages, fewer number of farmers with less farm experience (1 to 10 years) have tried to adapt any adaptation option to the changing climate. On the other hand, those with greater experiences (11 to 20 years and more than 2- years) have tried almost all options to adapt i.e. change fertilizers, changing crop type, seed quality, and plant shaded trees.

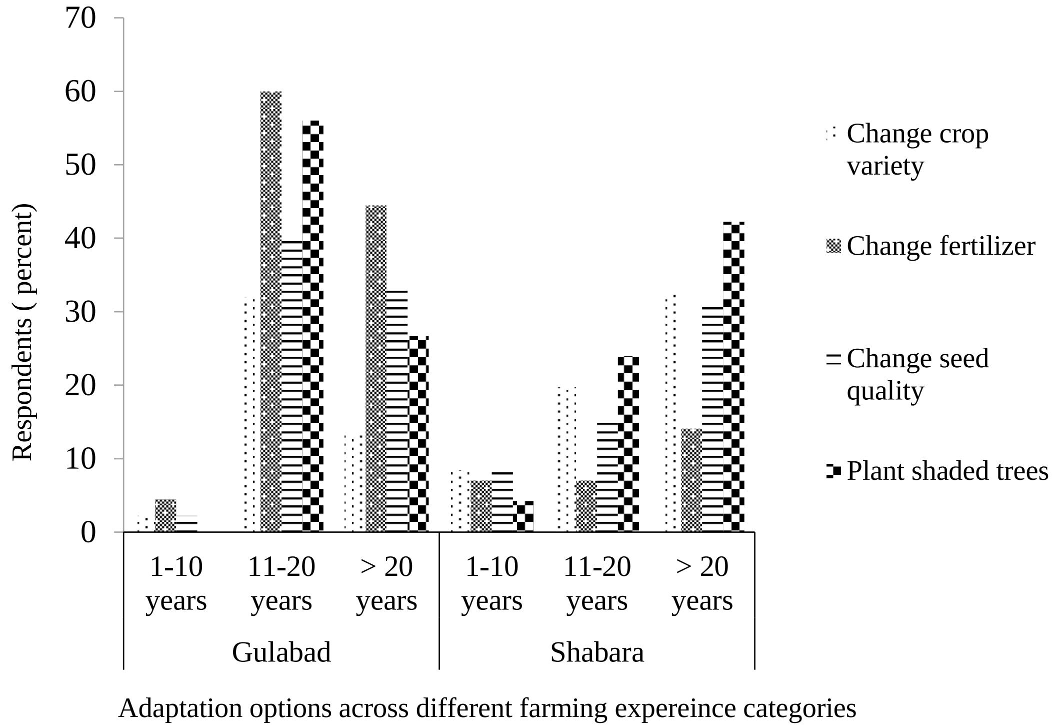

Figure 6-5: Adaptation to climate change across different groups of farm household based on their farm experience

Source: Author’s field survey, 2016.

Adapting or coping is a community's or an individual's way of using existing resources within a specific boundary and with some expectations to achieve goals. For this, all available or relevant resources are being used. It can be said that adaptation depends on how much an individual is resourceful i.e. the more resources available, the higher are the chances to adapt. However, this does not ensure whether this adaptation will be effective or not unless the awareness level of a community or an individual towards the issue that needs adjustments. For this, in our case, education and farm experience were studied to see how it affects adaptation measures taken for improving agricultural yield. These two indicators (education and farm experience) are among the many other socioeconomic attributes of the farm households’, considered as key factors in deciding how effectively farmers can or cannot adapt to climate change (Ali and Erenstein, 2017). Education can help in accessing updated information on modern agricultural techniques used widely in farming for improving productivity. Moreover, farmers with farming experience tend to be more aware of past weather and climate events and can better decide how to adapt their farming in response to extreme events (Adger, *et* *al.*, 2003). Our results are in accordance with those from Ali and Erenstein (2017); Elahi *et al.* (2015) and Abid et al. (2015 and 2016), who performed their studies in various parts of Pakistan. By concluding, it can be said that the higher the education level and farming experience, the higher are the chances of an individual household to adapt to the changing climatic conditions.

6.4.7 Constraints to adaptation

During the HHS, farmers were asked to identify constraints that they perceived to be the most important barriers to changing their farming practices (Figure 6-5). Although farmers referred to several barriers to adaptation, the most important in both Gulabad and Shabara included poverty, lack of support from government and lack of assets. In Shabara, lack of water for irrigation, lack of information and knowledge on climate change weather and rainfall pattern, of an effective and timely early warning system, and of market and price information were also among the dominant constraints to adaptation.

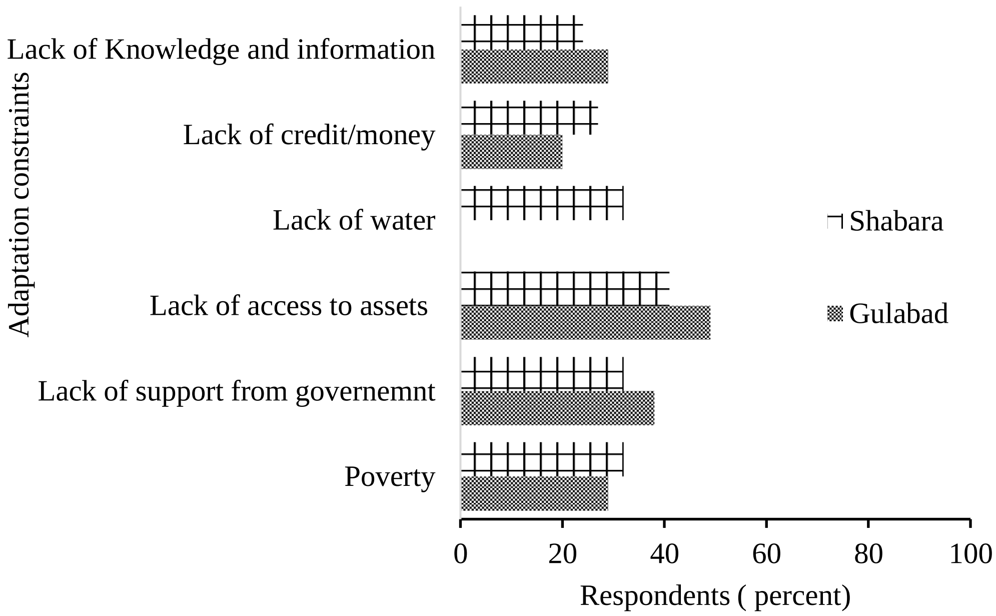

Figure 6-6: Perceived constraints to climate change adaptation at farm level in Gulabad and Shabara.

Source: Author’s field survey, 2016

The capacity of a household to cope with climate risks depends to some degree on the enabling environment of the community and is reflective of the resources and processes of the region (Smit and Pilifosova, 2003). At the local level, the ability to undertake adaptations can be influenced by such factors as managerial ability; access to financial, technological and information resources; infrastructure; the institutional environment within which adaptations occur; political influence; kinship networks and the socio-economic status of the household (Blaikie *et al.*, 2014; Watts and Bohle, 1993; Kelly and Adger, 2000; Roncoli *et al.*, 2002; Eakin, 2003). However, to understand the importance of factors shaping farmers' decisions and responses to adapt, it is necessary to explore their perceptions regarding the barriers they face (Bryan *et al.*, 2009). Hence, in the next chapter, farmers' concerns about risks associated with climate change are described in detail.

6.5 Conclusion

This study examined farmers' perceptions of climate change associated risks, its impacts on agriculture, and adaptation measures taken, based on household surveys conducted in Khyber Pakhtunkhwa province of Pakistan. The surveyed farmers were asked if they have observed any change in long-term weather (climate) over the years, of which majority acknowledged the changes in both short and long-term weather. Those who observed changes were further asked if they can identify and rank the key factors of climate change affecting farming. Fluctuating weather and climate variability have led to devastating consequences in the study area resulting in losses to their lives, livelihoods, and other properties. These mainly include flooding, drought, heat stress and erratic rainfall patterns. By asking if they have responded to such devastating consequences, farmers reported that they mostly tend to change crop variety, change fertilizers and plant shade trees. Farmers with higher education and greater farm experience intensively used those measures in response to climatic changes. However, those adaptation measures were mainly based on personal choice without having proper knowledge and information on when to employ, how to adapt and which strategy help improving yield. Because agricultural production remains the main source of income for most rural communities in the study area, an effective adaptation of the agricultural sector to the adverse effects of climate change will be imperative to protect their lives and livelihoods. Hence, the study suggests that farmers should use more advanced farming techniques to cope with climate change and variability. Other proper adaptation techniques such as application of heat-resistant crops, water, and soil conservation, use of better-adapted crop varieties, altering planting dates etc. must also be used to ensure getting desired yield. This aim could not be achieved with the greater involvement of multiple stakeholders such as policymakers, extension agents, researchers, and farmers to effectively minimize impacts of climate change on agriculture in the region and to strengthen local adaptation capacities.

7 CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

The impacts of climate change are felt most severely in developing countries of Asia like Pakistan because of its geography, resource and infrastructure constraints. In other parts of the world, climate change is also among the most critical issues. However, for some people and regions, it is a matter of change in long-term weather but, for others it is a matter of survival. Pakistan is among the countries where it is a matter of survival as it is affecting different sectors of life including Agriculture. Agriculture itself is weather and climate sensitive. Thus, it needs careful attention in the context of Pakistan as the country is predominantly dependent on agriculture. In the recent decades, like many other institutions of the country, agriculture is facing serious issues due to lack of proper attention being given by the government. In this scenario, farmers face huge losses in the form of reduction in the yield per hectare and total agricultural produce comparing to other neighboring nations. The lack of human capital in terms of technical and managerial skills at community and district level constitutes to be a key constraint to deal with these issues in agriculture sector. However, on the other hand, agriculture and climate experts repeatedly emphasize on dealing with the reduction in agriculture yield by providing meaningful and scientific solutions. A growing body of literature is now available on how rural farmers can adjust their farming to the changes in climate but implementing those findings of the scientific studies are yet to be seen. In this study, rural farmer’s perceptions, vulnerability and adaptation attempt to minimize the negative impacts of climate change in the context of Khyber Pakhtunkhwa province of Pakistan, are thoroughly discussed. The study contributes to the growing concept of how rural farmers can adjust their farming practices to the changing climatic condition who in most cases are among the poorest of the poor.

It is well-known fact that in Khyber Pakhtunkhwa, agriculture is a dominant economic activity contributing approximately 38 percent to the provincial Gross Domestic Product (GDP) while at the same time provides huge employment opportunities (44 percent) to the inhabitants of the province. Out of its total reported area of 10 million hectares, mere 18 percent is cultivated. There are two cropping seasons, namely Kharif (winter cropping season) and Rabi (summer cropping season). Rice, sugarcane, cotton, maize, sorghum and pulses are important winter crops, while wheat, barley, gram, tobacco and mustard are summer crops. Similarly, in the province, livestock is the major source of livelihood earnings especially in the arid and semi-arid areas and the sector is experiencing a gradual increase in number of livestock in the province. Almost every year during the monsoon season with the rise in the water level in these rivers, the area gets flooded causing damage to house, crops, livestock. Inundated water and poor sanitation system cause water borne diseases during flooding season. Although, Pakistan has district disaster management authorities on paper across the country but, until now, communities mostly rely on their own coping strategies for survival but have not yet developed disaster preparedness, mitigation, prevention and response strategies to any significant level. It has been observed that communities in the study area are more frequently affected due to the frequent flooding in these rivers nowadays. Climate change and global warming are among the serious concerns which makes this area threaten to flood. Although hardly any rain in the upper Khyber Pakhtunkhwa and Peshawar basin observed during April, but huge surge of water observed frequently during this time due to glacier melting starts at the mountainous areas of Gilgit Baltistan, Chitral and other areas of Khyber Pakhtunkhwa. This speedy glacier melting is seen as huge problem for near future because it is the main source of river water.

Rural farming in our study area is highly exposed to the vagaries of climate change and its associated risks in the shape of floods, droughts, and heavy storms. Farmers in the study villages acknowledge changes in both short and long-term climate by relying on their personal observations. In the time of hardships, they seek support from other important stakeholders like government agencies working in agriculture sector, non-governmental organizations and other experienced farmers in the area for advices. Farmers to adapt to the changing climate but their adaption strategies are most relying what they already know and what they can afford. For example, farmers know few types fertilizers that are available in the nearby markets. Hence, they tend to buy one of those for one year. If the produce is satisfactory, then they will continue buying the same, otherwise, will change to another one and same applies to seed type and quality and pesticides. In terms of advanced adaptation methods like water conservation, soil management, using heat resistant crops, post-harvest methods, farmers seriously lack information on how to use. Scientists not only emphasize on the *"how"* of adapting but also on the "*what and when*" to adapt which in our case, farmers were not aware of. Therefore, it is important to identify adaptation strategies that are location specific but have the potential for wider application for adaptation, especially by vulnerable rural farmers who face more significant climate change challenges.

Interestingly, our respondents knew where the agriculture extension offices were located but were hesitant to visit it in the need due to lack of trust. In the 2010 floods, police and other government officials repeatedly announced about the danger of the flood, but the locals did not believe and explained that information from government agencies are not reliable. This distrust was shocking for me and I explained to them the importance of seeking guidance from agricultural extensions, other research centers or any individual who works in agriculture like university graduates, professors. Irrigation was another big issue faced by farmers in Shabara. Government has built a canal, but locals do not have access to the water for irrigation purpose. Hence, farmers either used tube-wells or waited for the onset of rainfall whereas, in Gulabad, farmers had direct access to river water for irrigation.

7.2 Recommendations

As a long-term plan, Pakistan must adjust farming practices with the changing environmental conditions by adaptation advanced technologies, and know-how to match it with the local needs to cope with climate change. These may include heat and or drought or even flood tolerant varieties, short term early maturing crop varieties, etc. Such technology development must be taking a lead from the vulnerability analysis, prioritization and mapping, so that the local adaptation capacities are strengthened.

As it stands now, use of climate information is weakly shared with farmers. In most cases, it is uploaded on their websites which are out of farmers reach. Either they cannot use computer, internet or do not have access because of living in remote rural villages. Hence, readily available and improved use of climate information to farmers for decision making related to livelihoods must be ensured. This may require increasing the density of weather observatories; establishing rain gauges at village level; enabling access and efficient management of weather-related information. Therefore, new techniques for confident projection of regional climate change and its variability, including extreme events must be applied. Coordination of climate change adaptation activities in the area may be enhanced and non-governmental organization (NGO), community and the public must be kept aware of developments on risks of climate change and involve them in planning, adaptation, and mitigation strategies.

Optimize the use of farmers' traditional, indigenous knowledge on resource conservation, coping strategies, etc, by evaluating, assessing its scales, integrating with modern technologies such improved seed varieties, crop management techniques, water and soil conservation, community resource conservation, rainwater harvesting and storage to maximize the outcome of knowledge management. Moreover, encourage the adoption of location specific conservation techniques (cover cropping, in-situ moisture conservation, rainwater harvesting, groundwater recharge techniques, locally adapted cropping mixture, etc) for water efficient agriculture and demonstration of these available technologies in the farmers' fields. Strengthen the weather based agro-advisory services to enable farmers manage climate risks effectively and develop equally accessible weather insurance products.

Multidisciplinary dialogues and programs to enable scientists, policy makers, development practitioners and farmers to discuss and share research findings and experiential knowledge is necessary. Additionally, provide incentives to farmers to adopt natural resource conservation measures that enhance forest cover, replenish groundwater and use renewable energy, and provide support to improve the existing indigenous technologies that are eco-friendly and sustainable, through research, documentation and up-scaling.

During climate induced natural disasters, infrastructure plays a key role. Shabara is connected to the rest of the district by a bridge which in the time of hardship such as flood *(most common natural disaster in the area)* is the only source of evacuation. However, it gets flooded and people face difficulties in evacuation. Similarly, transportation to the village is weakly managed even during normal days. During floods or other tough times, transport owners blackmail locals by asking for unreasonable prices which locals hardly can bear to pay. Therefore, improve infrastructure in vulnerable regions is key in disaster risk reduction which needs improvement and the can only be solved with the help of government support. The impact of changing trends and consistent unpredictability of climate parameters on agriculture productivity, food production and storage, rural incomes and its distribution, migration, natural and common property, collective action must be considered in agricultural planning. Different programs implemented at the village level to enable farmers adapt to climate change should be coordinated to eliminate duplication and improve effectiveness.

This is encouraging that farmers understand and acknowledge changes in local climate. However, it is now responsibility of the government agencies like agriculture extension offices, agriculture and climate change ministries, universities who graduates are studying agriculture to send their students to the field and educate farmers about how to effectively adapt to the negative impacts of climate change. Effective adaptation means when, and how to adapt. For instance, in this case study, because farmers are poor, lack assets to buy good quality agricultural inputs, hence they end up with adaptation measures that are not helpful at all. It is our collective responsibility to educate rural farmers and help them in increasing yield and over all agricultural production. In Pakistan, nearly half of the country's population is females, and most of Pakistan's population live in rural area where agriculture is the predominant livelihood source. Now, in the situation, if we have areas where females do not participate in income generation activities, it exerts extra pressure on the family and pushes them into extreme poverty. This situation is exacerbated by large household size (8-9 persons per household in my study area). However, large household size can be seen positively if they participate in income generation activities especially females. Therefore, I strongly suggest female's participation in farming. Throughout the world, researchers have proved that when females participate in farming, the family income increases as there is extra income generated but it also encourages other to do so. At the same, I appreciate local customs which does not allow females to work outside of their house. It should not stop females from not gardening inside the house. Still, they can grow vegetables for household consumption. However, all this can be done through proper education, teaching local farmers that females must do income generation work as well.

It all starts with training. Local policy makers and farmers alike need new skills, tools and technologies to better respond to climate change. These ingredients go beyond solar-powered irrigation pumps and drought-resistant seeds; they include eco-friendly farming practices, better linkages to markets, and policies and plans to support farmers in building productive food systems to feed our growing population. In order to protect the future of our rural farmers, decision makers will need to look beyond farming and consider the inter-locking drivers that impact food production, such as soil degradation, water scarcity, heat resistant crops, improved post-harvest techniques, and changing markets.

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Appendix A: Research tools

Household survey questionnaire

Explain to respondents: (1) purpose of survey; gathering data on climate change vulnerability of local community especially focusing on agriculture sector. This data will be only used for educational purposes i.e. completing doctoral studies. Data needed includes; *demographic data, household's assets and sources of income, Agricultural production and marketing, perception and rating impacts of climate change, adaptation strategies towards climate change, matrix of climate related vulnerability perceptions.* Explain that names will be written in this form to facilitate conducting the interview and for finding the household again during the 2nd field work if needed, but will be kept completely confidential; (2) that 'livelihood' is defined by the most time spent on an activity and not amount of money; and (3) that 'the last 12 months' is the 12-month period prior to the date of the interview.

A. Demographic information, human resources and educational knowledge

Basic biodata (Table 1)

Interviewer name	Respondent name
Vilage Name	Phone number
Age	Marital Status
Main occupation	Other occupation
Religion	Education
No. of family members	Gender

Households' Livelihood Assets (Table 2)

Type of asset	Number owned	Value per unit (average)	Total value
Transportation			
Truck/van			
Motorcycle			
Bicycle			
Boat			
Boat engine			
Saddle			
Other			
Electrical/mechanical goods			

Continued...

Type of asset	Number owned	Value per unit (average)	Total value
Electric generator			
Cell phone			
Regular telephone (land line)			
Television			
Radio			
Cassette/CD/ DVD player			
Computer			
Camera			
Washing machine			
Sewing machine			
Agricultural/farm equipment			
Tractor			
Plow			
Chemical spraying device			
Water pump			
Wooden cart or wheelbarrow			
Grain/flour mill			
Scale			
Other			

Agricultural Production and Land Tenure (Table 3)

Crop type (5 major crops)	Land occupied (ha)	Production (ton) (last year)	Sell or consume?	Income (if sell)	Cropping season	Ownership status

Sources of Income (Table 4)

3.1 What is your primary, secondary and tertiary household dependency?		
Primary source of income	Secondary source of income	Tertiary source of income

(*Examples: farming, livestock, laboring, business, government service, remittances earning, donation, government aid etc.)*

Part B: Livelihood dependency and climate change knowledge

(FARMERS oNLY)

Since how long are you growing the crops mentioned in Table 3?

Have you changed the type of crop in the past that you used to grow?

Yes/No

What did you change to?

Why did you do so?

Has your yield increased or decreased over the passage of time?

- Increased
- Decreased
- Same
- Don’t know

Do you think it can be further improved? If Yes, how?

How do you prepare your land for crops?

- Tractors
- Bullocks
- Wooden ploughs
- Others

How many times a year do you plough your land?

- Once a year
- Twice a year
- Three times a year
- More (exact number)

How and where do you store your production?

Do you sell it?

Yes/No

How much do you sell out of the total production?

Where do you sell it?

- To individuals
- In village market
- Local market
- Regional market
- Whole sale
- Others

How far is the market from your home?

- <5 km
- >5 kms

How do you transport your produce from the cropping land to market?

- Own source of transportation
- Rent a vehicle
- Other

What is the total cost of transportation?

How much income do you get from selling per season/annually?

How do you irrigate your land?

- Rain fed

- Tube well
- River
- Canal
- Pressure pumps
- Others

What is the frequency of irrigation?

- Daily
- Weekly
- Monthly
- Other

If your source of income is agriculture, then

For how long you are doing agriculture?

Your involvement in agriculture increased or decreased in last 10 years?

- Increased
- Decreased
- Same
- Don't know

If it increased why?

If it decreased why?

How much is your agriculture dependent on rain water?

How much is agriculture dependent on irrigation water?

Do farmers in the area practice dry planting or do they wait for onset of rainfall?

How do farmers judge when rain is sufficient for planting?

What do they do if rains are insufficient for planting?

- Plant anyway
- Do not plant
- Wait for rain
- other

Do you know the exact growing seasons of your crops?

You researched about the growing seasons by yourself or your elders told you?

Which periods in the growing season are the most critical to have rainfall for a successful harvest? (Table 5)

Phases of production	Not Important	Somewhat Important	Very important	Critical
Planting				
Germination/leaf development				
Vegetative				
Flowering				
Maturation				
Post harvesting				

In the excess rainfall years, at which growth stage(s) was the crop most affected? (Table 6)

Phases of production	Year	Year	Year	Year
Planting				
Germination (leaf development)				
Vegetative				
Flowering				
Maturation				

In the drought years, at which growth stage(s) was the crop most affected?

(Table 7)

Phases of production	Year	Year	Year	Year
Planting				
Germination (leaf development)				
Vegetative				
Flowering				
Maturation				

Can you mention natural calamities and disasters that has affected your produce? *(For example, floods, droughts, storms, earthquakes, epidemics or crop diseases)*

In Table 3 you've mentioned major crops that grow, can you please tell us which crops involves more human effort and which involves less human effort?

Do you think so that the crops that involve less human effort are more prone to natural calamities? *(ask for explanation)*

Do you know Weather, Season or Climate (Long term Weather)?

What has been your main source of information on climate change prior to this interview?
1=proponent; 2=village leaders; 3=hearsay in village; 4=government; 5=extension agent; 6=NGO; 7=media; 9=other (specify) _________________; -8=does not apply

In past (last 20-30 years) do you recall having the most favorable weather for production?

In past (last 20-30 years) do you recall having the worst weather for production?

Have you noticed any change in long term weather (climate) in the last 20-30 years?
Yes/No
If yes, then which factor of the climate you think has changed more? *(For Example, temperature rise, Rainfall pattern changed, frequency of extreme events has increased, summer are longer, and winter are shorter etc.)*

Did your crop growing seasons changed in the past due to this change in the climate?

Yes/No

If yes, for which crop?

Did your growing season for a particular crop shortened or lengthened?

If it lengthened, then for which crops and for how many days?

Did this adaptation strategy worked/Are you getting the same produce?

Adaptation strategies

Types of adaptation methods employed to manage climate related risks (Table 8)

Adaptation strategy	Yes/No	Source of risk
Changing cropping practices		
Change crop type		
Change crop variety		
Change planting dates/season		
Changing farm management practices		
Change fertilizer		
Change pesticide		
Change irrigation		
Change seed quality		
Advance land-use management measures		
Changing farming technique *(sowing, harvesting etc.)*		
Planting shaded trees		
Stop cutting trees		
Store water		
Soil conservation		
Use less water		
Livelihood options		
Shift from crop to livestock		
Shift from single to multiple crops/farm diversification		
Migration		
Rent out crop land		

What are the major constraints to adaptation to climate change vulnerability?

- Limited farm resource (water, technology, agricultural inputs etc.)
- Lack of financial means
- Lack of Knowledge and Information *(adequate knowledge on adaptation such as soil and water conservation, crop diversification and alike)*
- Lack of support from local or private institutions

If farmers are exposed to weather risks, how do they currently manage them?

Have you experienced any other change? (e.g. more crop diseases such as pest attacks etc.)

Rating impacts of climate change on agriculture (Table 9)

No.	Variable	No extent (1)	Little extent (2)	Some extent (3)	Great extent (4)
	High-temperature				
	High rate of precipitation				
	Pattern of rainfall and temperature				
	Deforestation				
	Floods				
	Attack of pests and diseases				
	Long duration of winter				
	Long duration of summer				
	Lack of vegetation/pastures				
	Post-harvest losses due to climatic variability				
	Shortening of crops life cycle				
	Heavy weed growth				
	Crop destruction by high speed winds				
	Lack of water supply				
	Decrease in soil fertility				
	Destruction of wild life ecosystem				
	Drought				
	Loss of farmland due to floods				
	Soil erosion				

What are the primary production risks?

- Pests
- Diseases
- Weather
- Lack of access to agricultural inputs

- Others

What are the specific weather risks that production faces?

- Droughts
- Excess rain
- Temperature change
- Others

How often you have discussed the climate variability in your community?

Do you think that your knowledge about climate is sufficient and you can adopt to changing climate?

Yes/No

If yes, then what strategies would you select to adapt to climate change?

If not, what information would you need to be given to you during your work/growing crops?

Who is your preferred information source and what is the preferred way for you to receive information about how to make your household and home safer from natural disasters?

Are there any other issues regarding the reduction of risk and loss associated with natural disasters that you feel are important?

What factors affect sensitivity of agricultural farms to climate change?

- Water Scarcity and Quality
- Poverty
- Good Storage Facility
- Access to Assets
- Support from Government

Have you/your crops been damaged by any natural calamity that you can associate with the climate in the past?

Yes/No

If yes, can you tell us what in detail about damages occurred? (ask for other damages such as human loss, livestock loss, house damaged and if possibly ask for economic value of the loss)

Disaster type	Damage to houses (fully/partially damaged)	Estimated cost	Area under crops damaged (ha)	Estimated cost	Livestock	Estimated cost	land, house, crops, livestock and others	Estimated cost

Do you think you could have avoided this loss?

Yes/No

If yes, how?

Was your home, fields located on a wrong (disaster prone) place?

Yes/No

If no, then do you think it was all natural and there is no way to escape or to manage?

If you don't have any way to escape, then do you think it might happen in future?

Yes/No

If yes, then what are your preparations?

What are your hopes about how climate change will benefit/effect your household?

- Respondents do not have any hopes to express
- I hope it will improve the income of my household
- I hope it will adequately compensate me in case of losses
- I hope it will provide me with alternative or supplementary income
- I hope it will reduce the threats from climate change

= Other (specify)____

Did you receive a warning about the flood/cyclone/drought before it happened?

Yes/No

Who gave you this warning?

Do you think institutional and government support can help you avoid damage?

Yes/No

If yes, then how? *(for example, early warning system etc.)*

If there were to be a project on adaptation towards climate change in this area, how would you hope that it would benefit your village?

- Respondents do not have any hopes to express
- We hope it would improve our incomes from agriculture by improving our yield
- We hope it would adequately compensate us in case of losses
- We hope it would provide (sufficient) alternative/supplementary income
- We will have continuous supply of water for irrigation
- We hope it would help reduce the threats from climate change
- Other (specify)____

What are your worries about how climate change will affect your household?

- Respondents do not have any worries to express
- I worry it will decrease the income of my household
- I worry it will not adequately compensate me in case of losses
- I worry it will not provide me with alternative/supplementary income
- I worry it will not reduce the threats from climate change
- Other (specify)____

Matrix of climate related vulnerability perceptions (Table 10)

Village Name	Drinking water	forest	agriculture	irrigation	Transportation system	electricity	Other energy resources	communication	Grazing area	Land resource	Land Slide	Floods	Animal diseases	Soil problems	Crop pests	Droughts	Minimum extreme	Maximum extreme

Very low, 2-Low, 3-Moderate, 4-High, 5-Very high

What kind of agricultural support has the Government provided you so for?

- Agricultural inputs
- Access to knowledge and information
- Irrigation facility
- Trainings
- Financial support
- Access to technology
- Others (Specify)

Are you satisfied with it?

Yes/No

Currently what kind of support the Government is providing you?

- Agricultural inputs
- Access to knowledge and information
- Irrigation facility
- Trainings
- Financial support
- Access to technology
- Others (Specify)

Do you think it is helping you in improving your yield or total production? How?

Cost of agricultural production in the 12 months prior to interview

We would like to calculate the cost of your agricultural production during the last 12 months.

These should be purchased inputs only. If it is easiest just to list the total cost, do so.

Table 11. season from ___________ (month /year) to ___________ (month/year)

No.	Item	Quantity	Total cost (in year)
	Seed		
	Fertilizer		
	Manure		
	Pesticide		

Hired labor

Hired machinery

Transportation/marketing

Payment for land area

Other, please specify___________

Access to Finance, Co-operatives and Conflicts

Are there any farmers' unions in your village?

Yes/No

Do you participate in farmers' union/groups?

Yes/No

What benefit do you get from those unions?

- Exchange of inputs
- Exchange of information
- Exchange experiences
- Others

Do you think it is good to be a member of those unions, why do you think so, please explain? (get aid, training, share problems, access to information, get advice etc.)

How do farmers normally finance input costs?

- Do not buy inputs
- Own finances
- Loan from banks
- Money lenders
- Interested in finance but no access
- Other sources

What type of financing? What are the terms?

What time of year is the financing received? What time of year is financing needed?

What month are they expected to pay back loans?

Would having access to some form of insurance improve farmers' access to credit?

Are there any conflicts between/among farmers?

Yes/No

What type of conflicts are They?

- Water
- Land
- Inputs
- Outputs
- Others

How do you solve those conflicts

Table 12: Trends in Agriculture and Demographics

No.	Questions	Agree	Disagree	Don't know	Explanation
Natural resources					
1	Number of people involved in agriculture has increased compared to10 years ago				
2	Soil fertility of cropland is better now than 10 years ago.				
3	Fresh water is easily available now compare to 10 years ago				
4	Disasters (floods, cyclones, droughts, earthquakes etc.) happen more frequently now compare to 10 years ago				
5	Temperature is more extreme now than 10 years ago				
6	Current agricultural production from land is less than 10 years ago				
7	People have more agricultural knowledge now than 10 years ago				
8	People involved in agriculture now are less than 10 years ago.				
9	Has you household change crop that you grow in the past				
10	Has your household's income over the past years been sufficient to cover the needs of the household?				
11	Government provide more agricultural aid now than 10 years ago				
12	Irrigating land is easier now than 10 years ago.				
13	Access to agricultural inputs is easier now compare to 10 years ago				

Continued…

Demographics	
14	The population of the village is larger today than 10 years ago
15	More people are working inside the village today than 10 years ago
16	More children in the village go to school than 10 years ago
17	Transportation is easier now than 10 years ago

Checklist for bringing the interview to an end:

- State that you have asked the last question and the interview has come to an end
- Remind the respondents that this is an academic research. We do not finance or implement climate change adaptation projects.
- Ask the respondents if they have any questions about the interview or climate change.
- Remind the respondents that we will interview them again in 2nd field visit if needed.
- Remind the respondents of the guarantee of anonymity and confidentiality
- Express that you are thankful to the respondents for their willingness to participate in the research and for sharing their valuable time.

Key informant interview: General information

Writer
Interviewer
Checked by
Respondent/Gender

Participants: Village leaders, village elders, villagers known for historical knowledge (number of respondents: 4-6 people)

Village governmental structure, History and People's Livelihoods

1) Can you describe how your village is politically organized today? (Positions in structure, what positions do, how positions are filled)? [ask village head about gender representation]

2) What notable events would you say have occurred in the village since its founding (natural events: earth quake, flood; political events: reformation, village expansion, special autonomy)?

3) To your knowledge, has there been any change in village governance since its creation? If yes, how so? (Different boundaries? Expansion of area, or new housing, etc.?)

4) If changes happened, what was the cause of this expansion or development in the village? (Is there new regulations) And how expansion/development impact the village?

5) How do people in this village make their livelihood? *(Did they hunt? Keep animals? Plant? Farm? Fish? Government servants?*

6) How would you say peoples' livelihoods have changed since you were a kid?

7) How have livelihoods been affected by natural hazards?

8) How did local village bodies affect things in the village?

No.	Infrastructure [type and quantity]	Affected by natural hazards?	Loss (estimate)	Who has responsibility to maintain infrastructure?

B) Goals and desires for future

9) How would you like to see your village develop in the future? What do you feel could help promote this future?

10) You previously mentioned activities and livelihoods regarding natural hazards (What changes could happen to your livelihoods (fishing, farming, labor etc.) in the future because of those hazards?

11) How would you see *the following factors* in your village in the future (increasing, decreasing, remains same, according to the activities that you mentioned above)? Do you predict any change? If yes, how? If not, why not?

Indicator	Response	Explanation
Agricultural Production		
Land utilized for agriculture		

Conflicts
Co-operations
Irrigation facilities
Access to market
Access to Information
Access to water
Access to land
Natural hazards

Opinion survey of perceptions and politics of climate change

Date:

Name of Informant: Phone Number:

Gender: Education level:

Name of Organization: Type of organization:

Role of organization in disaster management

Put in place organization and coordination to understand and reduce disaster risk, based on participation of citizen groups and civil society. Build local alliances. Ensure that all departments understand their role to disaster risk reduction and preparedness.

1. What is the focus of work of this organization?
2. What is your position or role in organization?

3. How well are local organizations (including local government) equipped with capacities (knowledge, experience, official mandate) for disaster risk reduction and climate change adaptation?

- Poorly equipped
- Average
- Well equipped

4. To what extent do partnerships exist between communities and local authorities to reduce risk?

- Poor consultation between both
- Not so good and not so bad
- Good consultation

5. How much does the local government support vulnerable local communities (particularly women, elderly, infirmed, children) to actively participate in risk reduction decision-making, policy making, planning and implementation processes?
6. To what extent does the local government including your organization participate in the national DRR planning?

Financing for Disaster risk reduction

7. Assign a budget for disaster risk reduction and provide incentives for homeowners, low-income families, communities.
8. How far does the local government have access to adequate financial resources to carry out risk reduction activities?
9. What is the method for identifying vulnerable communities?
10. What is the scope of financial services (e.g. saving and credit schemes, macro and micro-insurance) available to vulnerable and marginalized households for pre- disaster times?

Disaster Risk Assessments and decision making

11. Availability of up-to-date data on hazards and vulnerabilities, risk assessments and use these as the basis for urban development plans and decisions. Ensure that this information and the plans are fully discussed with local people.
12. To what degree does the local government conduct thorough disaster risk assessments for key vulnerable development sectors in your local authority?
13. To what extent are these risk assessments regularly updated, e.g. annually or on a bi-annual basis?
14. How regularly does the local government communicate to the community, information on local hazard trends and risk reduction measures (e.g. using a Risk Communications Plan) including early warnings of likely hazard impact?
15. To what extent those assessments help in preventing local communities from disasters?

Safety and Infrastructure Improvement

16. How adequate are measures that are being undertaken to protect infrastructure during disasters?
17. How safe are all main schools, hospitals and health facilities from disasters so that they have the ability to remain operational during emergencies?
18. To what degree do local government or other levels of government have special programs in place to regularly assess schools, hospitals and health facilities for maintenance, compliance with building codes, general safety, weather-related risks etc.?
19. How strong are existing regulations (e.g. land use plans, building codes etc.) to support disaster risk reduction in your local authority?
20. Are people aware about such codes?

Education, Training and Awareness Programs

21. How regularly does the local government conduct awareness build or education programs on DRR and disaster preparedness for local communities?

22. To what extent does the local government provide training in risk reduction for local officials and community leaders?
23. To what degree do local schools and colleges include courses, education or training in disaster risk reduction (including climate related risks) as part of the education curriculum?
24. How much do the local community participate in the restoration, protection and sustainable management of ecosystem services?

Institutional capacity to deal with disasters

25. Do you think that your organization have enough resources to effectively help people during disasters and recovery? (resources: emergency supplies, emergency shelters, relief supplies, identified evacuation routes and contingency plans etc.)?
26. If no, what you need and how will you get it?
27. To what extent are early warning systems established in your area?
28. To what extent does the local government have an emergency operations center (EOC) and/or an emergency communication system?
29. How regularly are training drills and rehearsals carried out with the participation of relevant government, Non-Governmental Organizations, local leaders and/or volunteers?

Perceptions about changes in climate

30. In the past 10 years, have you observed any of the following changes in climate in this region?

- Reduced rainfall
- Increased rainfall
- Changes in seasonal patterns (when rainy and dry seasons occur)
- Drought
- Flooding/landslides
- Other (specify):

31. In the past 10 years, have you observed any of the following changes in the region that you think are due to change in climate?

- Increase/decrease in water availability
- Increase/Decline in crop productivity
- More health-related problems
- Changes in seasons of flowering or fruiting
- other (specify):

32. What are your concerns about the potential negative impacts of the climate change in this region?

- Threaten biodiversity conservation? Yes/No/Don't know
- Degrade watersheds or disrupt hydrology Yes/No/Don't know
- Exacerbate poverty? Yes/No/Don't know

33. Threaten or undermine the existing rights of villagers over the land and resources they use?

    Increase conflict over distribution of resources or revenues? Yes/No/Don't know

    Decrease employment? Yes/No/Don't know

    Relocation (migration) of people? Yes/No/Don't know

34. What sectors of the local economy (in this district or municipality) do you consider most important for the future economic development of this area? (If needed, explain that we are looking for answers like "agriculture," or "timber," or "tourism".

35. Who do you consider to be the most disadvantaged or poor populations in this region? We would like to know who are the most disadvantaged, whether or not they will be affected by the adverse impacts of climate change? Please specify

- People living in remote areas of this district
- Farmers or others (occupation)
- Men/women/children/old people

- Others. Please specify

36. What groups should we pay particular attention to?

- The poorest
- Most discriminated against
- Most often forgotten
- Farmers
- Men/women/children/old people
- Others. Please specify

37. As you know, we are studying farmers' adaptation towards climate change in this region. However, first, I would like to ask you about the concept of climate change and adaptation, in general. {If necessary, clarify climate change and adaptation} For each question, please tell me your answer on a 1 to 5 scale, where 1 means very little, and 5 means very much or almost all. Or just say no if you don't know the answer.

Questions	Very little (1)	Little (2)	Moderate (3)	Very much (4)	D/K (5)
. How familiar are you with climate change?					
. Do you think that people in your organization understand the concept of climate change?					
. What proportion of (or how many) people in your organization are strongly against climate change?					
. Do you think that the state/provincial government supports climate change policies?					

. Do you think that state/provicial government is raising awareness about climate change and its impacts?	

Note: Record any spontaneous comments about level of government support for climate change:

45. Whom would you say are the 3 actors who have done much work about climate change? These could be individuals or organizations, working at the local, national, or international scale.

<table>
<tr><th colspan="7">Focus group discussion: Seasonal calendar</th></tr>
<tr><td rowspan="4">Writer</td><td rowspan="2">Facilitator</td><td rowspan="2"></td><td colspan="2">Entered by</td><td colspan="2"></td></tr>
<tr><td colspan="2">Checked by</td><td colspan="2"></td></tr>
<tr><td colspan="6">File name:</td></tr>
<tr><td colspan="2">Wrote on back of the paper</td><td>Y</td><td>T</td><td>Copied?</td><td></td></tr>
</table>

No.	Name	Occupation	Address	Group
1				
2				
3				Women
4				
5				
6				
7				
8				Men
9				
10				

Focus Group Discussion: Seasonal Calendar

Materials: Color markers, flip card papers, voice recorder

Participants: 6 (minimum)

Duration: about 1

Facilitator: 1 persons

Note-taker: 1 person

Objective: *To gain understanding of livelihood activities, their seasonality, deadly seasons (disaster) in the village.*

Step by step:

Introduction

The facilitator begins with introducing she/himself. Explain about informed consent and ask if the participants understand/agree with it. Ask if we could proceed.

Explain carefully and clearly the objective of this discussion and how long it might take.

Ask the participants what the main seasons of the year in the village. Reference to weather patterns (such as rainy season, dry season) or local events (such as harvest festivals or religious celebrations Eid/Ramadhan) can be used. Write these along the top of a flip chart paper. Symbols or different colors can also be used to indicate these seasons (*look at the following seasonal calendar table)*.

If participant's familiar with the months of the years, the facilitator can write or number the months below the seasons (*look at the following seasonal calendar table)*.

Ensure that there are enough spaces on the left side of the paper to list the activities or events in the village that participants feel important (*look at the following seasonal calendar table)*.

Give each subgroup a flip chart (s) and color markers and ask a representative from each subgroup to draw the same table.

Explain to participants that we would like to know about the agriculture activities in this village, what crops they grow (staple crop such as wheat, sugarcane, rice and other vegetables), what the activities are (starting from preparing field until harvesting and selling), and in which months in a year they conduct these activities. Ask also about other activities relate to livestock (such as rearing cattle, goat, chicken, and pig). Ask them to write, draw a picture or symbolize these activities on the table:

Preparing field for planting (cutting trees, build shelter, etc.)

Growing crops…

Weeding

Harvesting

Selling/bartering harvested crops

Rearing livestock (cattle, goat, pig, chicken, etc)

Etc.

After participants finished agricultural activities, ask about cultural, social, customary or religious events: what cultural, social, religious events celebrated by the villagers and in which months in a year these events happened. Ask them to write, draw a picture or symbolize these activities on the table.

Celebrating the Independence Day

Celebrating religious events (Eid day, Christmas)

Celebrating harvest

Mass circumcision

Etc.

After participants finished with domestic-related activities, ask if there are other activities commonly take place in the village (such as making basket/handicrafts) besides the ones already mentioned before. Ask them to write, draw a picture or symbolize these activities on the table.

Ask participants if there is seasonal employment outside the village that people might follow. (For instance, fruit-picking or construction job that requires man labor outside the village). Ask how many people are following those seasonal employments and when during the year does it occur but also where people are doing those work. If it is not a regular period every year, then the facilitator should not on the side the fluctuating dates and where they could do such seasonal jobs.

Ask if there any event such as diseases (such as malaria, dengue fever, diarrhea, etc.) or disasters (such as flood, drought, etc.) that commonly occurred every year in the village. If yes, ask them to write, draw a picture or symbolize these activities on the table.

Who helps villagers during those events? Is there any support from Government?

Explain or ask participants what they think they can use this calendar for. *Linkage to PMRV can be drew from at least two points of views: 1) the availability of people throughout the year in possibly conducting additional activities related to PMRV, and 2) the possibility of integrating PMRV activities with the community activities that are related to forest*

Wrapping up

Make sure you have a key explaining the different activities and symbols used on the calendars.

Conclude the activity with reviewing the discussion results. Thank participants for their participation and time.

Seasonal Calendar Table

Season	W	M												
Months			1	2	3	4	5	6	7	8	9	10	11	12
Activities/Disasters/Diseases/Holidays (the order is flexible)														

3.
4.
5.
6.
7.
8.
9.

Appendix B: List of basic terminologies

Climate change

The climate of a place or region is changed if over an extended period (typically decades or longer)

Risk

The chances of losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between hazards and vulnerable social conditions. Risk is expressed as Risk = Hazards x Vulnerability. Some experts also include the concept of exposure to refer to the physical aspects of vulnerability.

Vulnerability

The inability (of a system or a unit) to withstand the effects of a hostile environment.

Adaptation

Adjustment made when dealing with systems behavior and characteristics intending to enhance its ability for better managing external stress

Capacity

A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster. Capacity may include physical, institutional, social or economic means as well as skilled personnel or collective attributes such as leadership and management. Capacity may also be described as capability.

Adaptive capacity

The capacity of a system to adapt if the environment where the system exists is changing.

of the society.

Coping capacity

The means by which people or organizations use available resources and abilities to face a disaster. In general, this involves managing resources, both in normal times as well as during crises or adverse conditions.

Disaster

A serious disruption of the functioning of a community or society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources. It results from the combination of hazards, conditions of vulnerability and insufficient capacity to reduce the potential negative consequences of risk.

Hazard

potentially damaging physical event or phenomenon that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Hazards can include natural (geological, hydro meteorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity, frequency and probability.

Natural hazards

Natural processes or phenomena occurring on the earth that may constitute a damaging event. Natural hazards can be classified by origin namely: geological, hydro meteorological or biological. Hazardous events can vary in magnitude or intensity, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing.

Disaster risk management (DRM)

The comprehensive approach to reduce the adverse impacts of a disaster. DRM encompasses all actions taken before, during, and after the disasters. It includes activities on mitigation, preparedness, emergency response, recovery, rehabilitation, and reconstruction.

Disaster risk reduction

The measures aimed to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development.

Mitigation

Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.

Preparedness

Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.

Public awareness

The processes of informing the general population, increasing levels of consciousness about risks and how people can reduce their exposure to hazards. This is particularly important for public officials in fulfilling their responsibilities to save lives and property in the event of a disaster.

Recovery

Decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk.

Relief / response

The provision of assistance during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration.

Resilience / resilient

The capacity of a community, society or organization potentially exposed to hazards to adapt, by resisting or changing in order to maintain an acceptable level of functioning. Resilience can be increased by learning from past disasters for better future protection and to improve risk reduction measures.

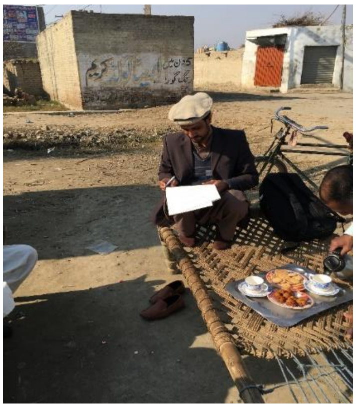
What is community-based disaster risk management (CBDRM)?

The most quoted definition of CBDRM is "Community-based disaster risk management. CBDRM is a process in which at-risk communities are actively engaged in the identification, analysis, treatment, monitoring and evaluation of disaster risks in order to reduce their vulnerabilities and enhance their capacities. This means that people are at the heart of decision-making and implementation of disaster risk management activities. The involvement of the most vulnerable social groups is considered as paramount in this process, while the support of the least vulnerable groups is necessary for successful implementation." (Abarquez and Murshed, 2004).

Appendix C: Pictures taken during field survey

	
Picture 1: During household survey with a local farmer in Gulabad (Date: 13/9/2016) Source: Author’s own picture	Picture 2: Traditional house of a farmer in Shabara (Date: 15/9/2016) Source: Author’s own picture
	
Picture 3: Donkey cart used carrying sugarcane and its busges as fooder for animals in Shabara (Date: 19/9/2016) Source: Author’s own picture	Picture 4: Interview with a lecturer in Center for Disaster Planning and Management, University of Peshawar (Date: 4/10/2016) Source: Author’s own picture

	
Picture 5: A visit to farm land in Gulabad with a local farmer (Date: 28/9/2016) Source: Author’s own picture	Picture 6: Packaging of tomatoes for selling (Date: 1/10/2016) Source: Author’s own picture
	
Picture 7: Farmer carrying fodder for livestock (Date: 8/1/2018) Source: Author’s own picture	Picture 8: Visit to sugarcane fields in the study area (Date: 8/1/2018) Source: Author’s own picture

	
Picture 9: Canal in Shabara which is the main source for flooding study area in the monsoon rainy season (Date: 9/1/2018) Source: Author’s own picture	Picture 10: Poplar trees (locally called as Sufedar) planted for reducing land erosion, flood protection and business purpose. Source: Author’s own picture
	
Picture 11: Interview with farmers regarding impacts of climate change on rural livelihoods (Date: 8 /1/2018) Source: Author’s own picture	Picture 12: Interview with farmers regarding climate change trends and farmer adaptation towards it (Date: 8 /1/2018) Source: Author’s own picture

	
Picture 13: A farmer carrying destroyed sugarcane stems to feed animals Date: 25/9/2016 Source: Author’s own picture	Picture 14: Kabul river passing through both study villages and is a major cause of flooding (Date: 23/9/2016) Source: Author’s own picture

Author's biography

Wahid Ullah pursued his doctoral studies in the field of human geography at the department of human system science from Hokkaido University of Japan. His doctoral research focuses on farm-level risk perceptions, vulnerability and adaptation of rural farmers toward climate change induced natural disasters in Khyber Pakhtunkhwa, Pakistan. Prior to joining Hokkaido University, he did masters in natural and environmental resource management at Bogor Agricultural University of Indonesia and bachelor's in environmental sciences from University of Peshawar, Pakistan.

Wahid's research interests focus on human-environment interactions, climate change and its impacts on rural farming, disaster risk reduction, sustainable agriculture, and community empowerment. He has conducted researcher in Indonesia and Pakistan. He is both academic and professionally skilled in designing research surveys, interviews, focused group discussions, community meetings and facilitating discussions.

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