

Study on Sustainable Livelihoods, Vulnerability and Adaptation to Climate Change in District Swat



By
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A thesis submitted to the University of Peshawar in partial fulfillment of the
requirements for the degree of **Doctor of Philosophy** in Environmental
Sciences

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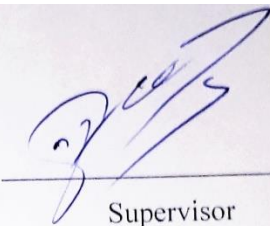
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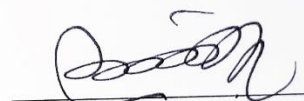
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DECLARATION

I hereby declare that this dissertation is the outcome of my own efforts and has not been published anywhere else before. The matter quoted in the text has been properly referred and acknowledged.

Muhammad Suleman Bacha

**DEDICATED
TO
MY LOVING PARENTS**

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Muhammad Suleman Bacha

LIST OF ACRONYMS

ADB	Asian Development Bank
AR5	Fifth Assessment Report
BAP	Biodiversity Action Plan
BOD	Biological Oxygen Dem
CBD	Convention on Biological Diversity
CBNRM	Community Based Natural Resource Management
CBOs	Community Based Organizations
CC	Climate Change
CDM	Clean Development Mechanism
CNG	Compressed Natural Gas
CR	Critically Endangered
CRI	Climate Risk Index
CVCA	Climate Vulnerability and Capacity Analysis
DCR	District Census Report
DNA	Designated National Authority
EN	Endangered
EPA	Environmental Protection Agency
ESC	Environmental Standards Committee
EU	European Union
GCISC	Global Change Impact Studies Centre
GCMs	Global Circulation Models
GDD	Growing Degree Days
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GLOP	Glacial Lake Outburst
GSL	Growing Season Length
HADCM3	Hadley Centre Coupled Model Version 3
HKH	Hindu Kush Himalayan Region
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
KP	Khyber Pakhtunkhwa

MAPs	Medicinal and Aromatic Plants
MEAs	Multilateral Environmental Agreements
NBSAP	National Biodiversity Strategy and Action Plan
NCS	National Conservation Strategy
NDMA	National Disaster Management Authority
NEQs	National Environmental Quality Standards
NGOs	Non-Governmental Organizations
NTFPs	Non-timber Forest Products
PDMA	Provincial Disaster Management Authority
PEPA	Pakistan Environmental Protection Act
PEPC	Pakistan Environmental Protection Council
PG	Postgraduate
PMD	Pakistan Meteorological Department
PRA	Participatory Rural Appraisal
RCMs	Regional Circulation Models
SDPI	Sustainable Development Policy Institute
SPSS	Statistical Package for Social Sciences
TFCC	Task Force on Climate Change
TS	Total Solids
UC	Union Council
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
US/USA	United States of America
VA	Vulnerability Assessment
VETS	Vehicular Emissions Testing Station
VU	Vulnerable
WCS	World Conservation Strategy
WSSP	Water and Sanitation Services Peshawar

ABSTRACT

Like any other developing country, Pakistan is confronting the problem of climate change. The unprecedented flooding of 2010 and other subsequent events directs to the fact that this region is most vulnerable to climatic hazards. Despite the fact and importance, the public concerns and understandings of the issue in the region is not studied yet.

This research is based on a case study carried out in District Swat of Khyber Pakhtunkhwa province of Pakistan. The main objectives covering the study were i) to get insight of the public perceptions of climate change and adaptation in the study area and ii) to assess the various impacts of climate change on livelihood sources of indigenous communities. An attempt was made to utilize mixed methods approach to get an in-depth investigation of the underlying factors and determinants influencing the public understanding about climate change.

Using stratified sampling technique, 25 *union councils* (wards) were selected from the nine *tehsils* (sub-districts) of the study area. Information was collected from 1066 households using structured questionnaire. The information was analyzed using SPSS (version 20) and the association between the climate change knowledge and demographic variables were explored using chi-square tests and Cramer's V statistics. The study revealed that majority (88.5%) of the respondents were aware of the climate change in the area. Deforestation (37.2%), natural causes (29.7%) and combustion of fossil fuels (14.7%) were the main reported causes of climate change. Natural hazards such as floods (16.8%), dry spells (16.2%), vector borne diseases (10.8%), changes in biodiversity (10.5%), lower agricultural productivity 10.1%) and heat waves (9.9%) were among the major perceived impacts of climate change. A Significant relationship ($p < .05$) was found between the demographic variables and climate knowledge in the study area.

The study also revealed that climate change has affected multiple livelihood resources in the study area. Climate induced hazards such as floods, droughts, extreme weather events and erratic rainfall are the main factors affecting livelihood sources in the study area. The floods of 2010 has resulted in a major setback to the overall socio-economic fabric of the area. The floods washed out large numbers of agriculture lands, crops and fruit orchards spreading havoc. Most of the hotels and other tourism infrastructure along

the River Swat got damaged as the result. The devastation left thousands of individuals jobless as their livelihoods were shattered by the floods.

Adaptation measures dictates the various steps taken by the government and communities to adapt to the negative impacts of climate change. Government funded as well locally adapted measures have been found in the study area. After the severe flooding event of 2010, government departments are involved in multiple rehabilitation efforts. Watershed management, reforestation / afforestation, rehabilitation of the damaged water supply and sewerage systems, embankments of the River Swat, and construction of new reservoirs are some of the efforts commenced by the government. Locally adapted measures include changes in irrigations system, change in crop variety and seeds, change in the house structure, communal protection of the forest resources and grazing lands.

Although a unanimous agreement about climate change was found in the study area, differing views about the causes and impacts of climate change among the survey respondents existed. The findings present ample evidence to materialize this prerogative. Perceptions and understandings of climate change is highly affected by the age, education and income level of the respondents. Elderly people are more knowledgeable about the causes and impacts of climate change as they have been observing the climate system since long. Educated people tend to blame anthropogenic causes for climate change compared to others who opt for natural causes. The demography of a study area is a major contributing factor to the understanding of climate change beliefs of a community.

This research recommends that the role of environmental institutions should be enhanced at provincial level and should be extended to the district level. Public should be provided with climate education leading to better understanding of climate change and its impacts on their communities. Moreover, they should be made aware about the importance of forests, negative effects of deforestation and how to take care of these resources using individual and communal efforts.

Further research is recommended to explore to the entire depth of the affected livelihood resources with emphasis on agriculture, fisheries and tourism sectors.

CHAPTER I INTRODUCTION

1.1 Background

Pakistan is an agro-based country and majority of population is dependent on agriculture. Climate change is going to impact the agriculture sector by affecting temperature and water availability. Like any other country, Pakistan is vulnerable to the climate change induced hazards including floods, droughts, water shortages, shifts in weather patterns, loss of biodiversity and melting of glaciers (Planning commission GoP, 2010). Extreme events in the recent history provide more evidence to the changing pattern of climate in the country. This includes floods of 2010 resulting in huge lives losses and billions of Rupees damages to property and agriculture lands. It is anticipated that more incidents of similar nature will occur the coming decades. Moreover, variability in the monsoon pattern will increase chances of droughts in the future, thus affecting the food availability in Pakistan (IUCN, 2009a).

The American meteorological society defines the term climate change as “(It is) any systemic change in the long-term statistics of climate elements (such as temperature, pressure, or winds) sustained over several decades or longer” (Dessler, 2012). According to Regional Circulation Models (RCMs), the yield of major cereals will decline by 15 to 20% in the coming decades. It will also impact the other sources of livelihoods such as livestock production, rangelands, fruits, vegetables and horticulture (IUCN, 2009b). Climate change will threaten the food security of the country by reducing the productivity of crops, livestock and fisheries (Planning commission GOP, 2010). Increased temperature has resulted an increase in the Growing Degree Days (GDDs) and decrease in growing season length. Increase in temperature in the future would result in the decreased crops yield in mountainous areas, such as Swat district (Hussain and Mudasser, 2007).

Scientists have observed that globally averaged combined land and ocean surface temperature show a warming of 0.85°C over the period 1880 to 2012 (IPCC, 2013). The 1990s have been regarded as the warmest decade since the start of temperature recording since 1860. Climate change has threatened the life from on earth, as it has induced direct impacts on multiple sectors. These include Impacts on the economy,

health and safety, food production, security, and other dimensions. For instance, changing climate patterns threaten food production through irregularities in rainfall, flooding due to the rising of sea levels, and pole-ward spread of pests and diseases due to warming atmosphere. (VijayaVenkataRaman et al., 2012).

It is of the consensus that humans are explicitly associated in causing the global warming and climate change and so the impacts will be obviously catastrophic for natural systems and humans too. People around the world will be affected equally both physically and economically (Schellenhuber, 2006; IPCC, 2007). Two different strategies can be used to respond to these threats; mitigation and adaptation to climate change (McCarthy et al., 2001). Mitigation of climate change focuses all the efforts on reducing the sources of greenhouse gases (GHGs) and augmenting the sinks of these gases (McCarthy et al., 2001). Effective mitigation benefits not only human systems but also all natural systems. Reducing GHG emissions entails concentrated efforts globally as well as regionally and could likely be slow due to the lethargy of the global climate system. It is therefore necessary to take timely action against the drivers of climate change, but often the actions are slowed due to a variety of barriers, technical as well as political hurdles. Mitigation efforts also requires support from different sectors such as public, industry and commerce. These sectors are capable of hindering the implementation process of climate change mitigation. Public can play a vital role in combating climate change by behavioral change and engaging in low carbon lifestyle and reducing the GHGs through domestic consumption and personal transportation (Semenza, 2008).

Adaptation encompasses preemptive measures to avoid, respond to and prepare for the significant impacts from climate change. The prime objective of adaptation is to decrease the related hazards to population health through various interventions including health behaviors, clinical procedures, or technical/structural measures (McMichael and Kovats, 2000; Ebi and Semenza, 2008). Adaptation measures can be based on both short term and long term planning. The short term adaptation measures are spontaneous, direct and tangible while the long term can be indirect, intangible and impersonal (Semenza, 2007).

Although there is strong confidence among the scientific community regarding the anthropogenic climate change, yet the public consensus on the subject has not been established (Marquart-Pyatt et al., 2011). A considerable effort has been put by Ministry of Climate Change (then Ministry of Environment), Government of Pakistan to formulate a National Climate Change Policy in 2011 that highlights the most vulnerable sectors to climate change. As per the goals of Planning Commission's Vision 2030, the policy stresses adaptation measures for energy, forestry, agriculture and livestock sectors (Government of Pakistan, 2012).

However, the difficulty in the understanding of public perception obstructs the development of climate change adaptation policies (de Jalón et al., 2013). Due to the complex and versatile nature of climate change issue, it is important to address the subject not only by integrating perspectives from pertinent disciplines but also from different societies and relevant stakeholders around the world (Roser et al., 2015). The climate perceptions by individuals, public and other actors have got importance and evidence pertinent to the subject has accumulated extensively in the form of empirical and theoretical data (Myers et al. 2013; Capstick et al. 2015). Local and indigenous communities have received increasing attention in the policy discussion, due to their high vulnerability to climate change (Roser et al., 2015; Jurt et al., 2015).

Studies on public perceptions are necessary to explore the degree of public support for climate change mitigation and adaptation policies and their willingness for the adoption of mitigation and adaptation behavior. (Bord et al., 2000; Lorenzoni et al., 2007). A true understanding of global warming and climate change is necessary for informed decision making related to solutions and policy matters about climate change. Countries like Pakistan are in urgent need to context specific studies on public perception about climate change for effective decision making towards mitigation and adaptation of the expected climate change. This research work aims at filling this gap by focusing Swat area as a case study.

1.2 Problem Statement

Climate change is most noticeable in the mountainous communities, and has a direct effect on the livelihoods of people living there. Increased climate variability and change can cause frequent and high intensity climate induced hazards, thus by pushing the communities to adapt to these changes or force to migrate from their areas. The

mountainous communities are predominantly vulnerable due to their livelihoods dependency on natural resources such as forest, agriculture and tourism etc. The affected communities may not cope on their own and may need external support for better understanding of climate change phenomena. Public perception about the changing climate in these areas is still not scientifically developed, but yet they cope with the changing climate using the local knowledge and strategies. The local knowledge can be utilized in the climate change adaptation policy framework. It is therefore required to explore sources of livelihood in the mountainous areas, vulnerability of climate change to these sources and the role of indigenous knowledge in the current and future adaptation strategies.

1.3 Hypotheses

- Mountainous communities are more vulnerable to the impacts of climate change.
- Climate change has a negative impact on the agriculture, forests, bio-diversity and tourism and other livelihood sources in district Swat.
- Indigenous knowledge can play a vital role in coping the adverse effects of climate change and formulation of adaptation policies.

1.4 Objectives of the study

The study is aimed to achieve the following objectives;

- To explore the public perceptions about climate variability and role of local knowledge in the climate change adaptation.
- To understand the climate change vulnerability and local adaptation strategies in the study area.
- To investigate the impacts of climate change on livelihood sources in selected mountainous communities of the study area.
- To review the presently adopted climate change policies of Pakistan in the light of indigenous knowledge.
- To formulate the optimal mix of climate change policies.

CHAPTER II

DESCRIPTION OF STUDY AREA

2.1 District Geography

Swat is the administrative district of Khyber Pakhtunkhwa, Pakistan. It is located at 34°46'58"N and 72°21'43"E latitude/longitude. Swat district bordering Chitral in the North, Dir in the West and Gilgit-Baltistan in the North-east. Swat district covers an area of 5337 Km² with a population of 1.26 million (GOP, 1999; Bangash, 2012). The area is connected to Peshawar and Islamabad by different metallic roads one via Charsadda, Mardan and Motorway (Sabir, 2002).

Historically the district Swat consisted of two parts; Swat Kohistan and the main Swat Valley. The Swat Kohistan entails the areas upstream Madyan (Sabir, 2002; Khan and Khan, 2009). The District Headquarter of Swat is Saidu Sharif, but the main town in the district is Mingora. Saidu Sharif is at a distance of 131 Kilometer (km.) from Peshawar, the provincial capital, towards the northeast. The total area of District Swat is 5337 Square Kilometer (sq. km), divided into nine tehsils.

Topographically, Swat is a mountainous region, located among the foothills of the Hindukush mountain range. This range runs in the general direction of North and South and has a varied elevation within the Swat area, beginning from 600 meters above sea level in the South and rising rapidly up towards the North. Some of the peaks has elevations starting from 4500 to around 6,000 meters above sea level. (Bazinni, 2013; PPAF, 2015). The Swat region, containing the meandering Swat River, is also home to lush green valleys, snow-covered glaciers, forests, meadows and plains (PPAF, 2015). The lofty Hindu Raj mountains surrounds the area and drained by a single watershed of Swat River originating in the high mountains to the north having an altitude more than 6000 m (Ahmad et al., 2015).

2.2 Population

The Swat district has a population of 1.25 million according to the 1998 census, with a growth rate of 3.9% and migration of 3.2% (GOP, 1999). Three ethnic groups; Pathans, Gujars and Kohistanis inhabit the district. The pathans who are basically Yousafzai by descend depend mainly on agriculture and occupy plains. Gujars who are the Indian

Aryans by descend are the original inhabitants of the area and they generally use the foothills for agriculture, and highland meadows for grazing pastures. Kohistanis are Dardic in origin and they are based in the northern mountain gorges in of Swat Kohistan. They occupy the sub humid to temperate zone, beyond the reach of monsoons. They practice livestock herding and agriculture as sustenance (Ahmad et al., 2015).

According to table 2.1, the estimated current population of the district Swat is about 2.27 million with an average growth rate of 3.3% per year. The estimated population is taken from “Development Statistics of Khyber Pakhtunkhwa-2016” report. Based on these projections the current urban and rural population of district Swat is 0.362 and 1.909 respectively (GoKP, 2016).

Table 2. 1: Estimated Population of District Swat (in Million)

	Overall	Urban	Rural
1998 – Census	1.258	0.174	1.084
2012-013 (Projected)	2.056	0.321	1.735
2013-014 (Projected)	2.125	0.334	1.791
2014-015 (Projected)	2.197	0.348	1.849
2015-016 (Projected)	2.271	0.362	1.909
Growth Rate [1998-2014]	3.30	3.30	3.31

Source: Development Statistics of Khyber Pakhtunkhwa 2016

2.3 Climate

The study area lies in the temperate zone where various factors including altitude, latitude, Indian ocean monsoon and western cyclonic currents control the climate. June is the hottest month while January is the coldest month in the area. The average rainfall in the study area ranges from 1000mm to 1200mm annually ((Dahri et al., 2011; Bazinni, 2013). Table 2.2 provides monthly mean temperature and rainfall data for district Swat at Saidu Sharif. Swat is divided in to different climatic region. A brief description of the climatic regions is given under; (Bazinni, 2013; Ahmad et al., 2015).

- **Subtropical Zone:** This zone comprises of the areas with 600 to 1000m in lower to upper Swat. It come under monsoon range having mild winter with very little or no snowfall in winter. Trees species such as *Dodonaea viscosa* (sanatha),

Olea cuspidata (kau), *Acacia modesta* (phulai) are found in this zone while at elevation above 1000-meter elevation *Pinus roxburgii* (chir) is found.

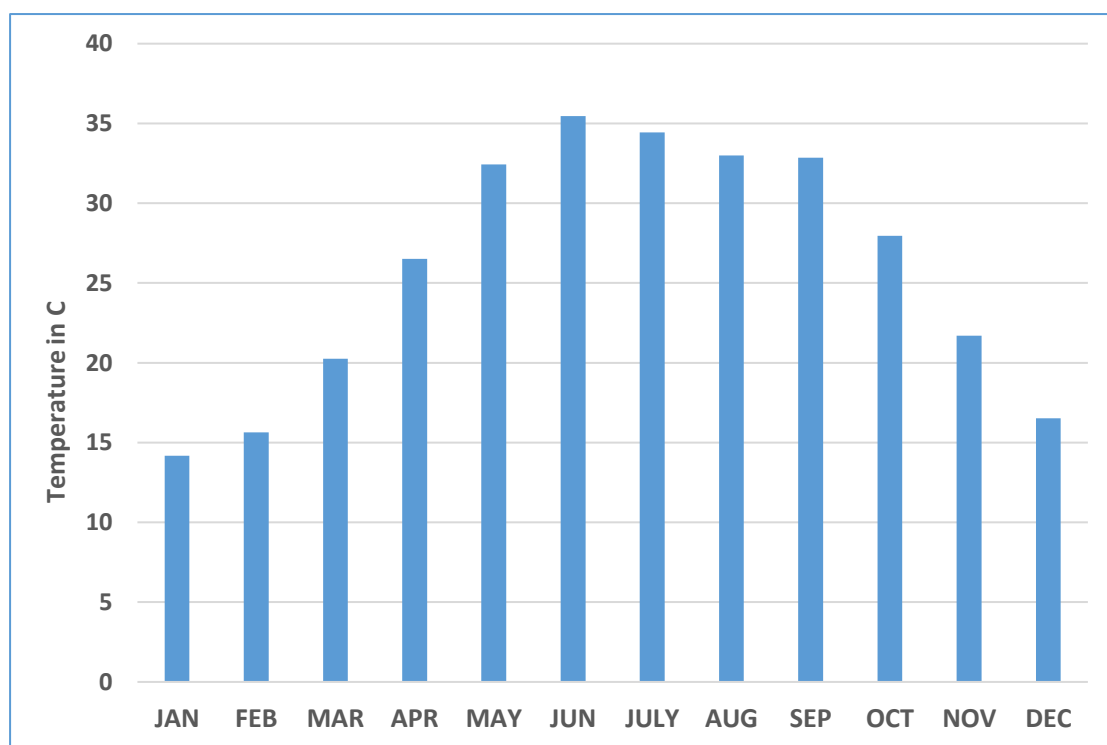
- ***Humid Temperature Zone:*** This zone receives heavy monsoon rainfalls and comparatively little snowfall, and extends up to an altitude of 1500 m. The main forest species of this zone are *Cedrus Deodara* (deodar), *Pinus Wallichiana* (Kail), and *Abies pindrow* (fir).
- ***Sub-Humid Temperate Zone:*** This zone covers high mountainous areas, at the altitude between 1500 and 3200 meters. The natural vegetation comprises of *Pinus Wallichiana* (kail), *Abies pindrow* (fir), *Pinus morinda* (sprice) and *Cedrus Deodara* (deodar).
- ***Subalpine Pastures:*** This zone covers the high-altitude plains which retains snow for five to six months annually. The agro-ecology of this areas can be seen at altitude of 2300-3600 m.
- ***Alpine Zone:*** This zone is among the highest agro-ecological regions of River Swat catchment, at the altitude of 3600 to 4600 m. This zone is mostly exploited for grazing livestock and collection of medicinal plants.
- ***Cold Desert Zone:*** This zone is represented by the highest mountain peaks above the vegetation line, at the altitude of 4700-6261m. Glaciers, ice fields and permafrost are main characteristics of this zone, and is responsible for continued flow of Swat River.

As shown in figure 2.1, historical climate dataset of district Swat shows that minimum recorded temperature from December to March is -2 °C while summers shows moderate season with a maximum recorded temperature of 35 °C. Figure 2.2 depicts the annual precipitation system in the study area. The winter rains start in December ending in February occurring normally in continuous rainfall of one to two week long, also known as “Jarai” in local language. From mid-January to the end of February snowfall takes place in the plain areas while in mountainous area snowfall takes place from beginning of December to the end of March. On the other hand, the summer rains begin from June and last till September. The study area experiences the flood occurrences mostly in this part of the year (PDMA, 2015).

Table 2. 2: Monthly mean Temperature and Rainfall in District Swat (Saidu Sharif)

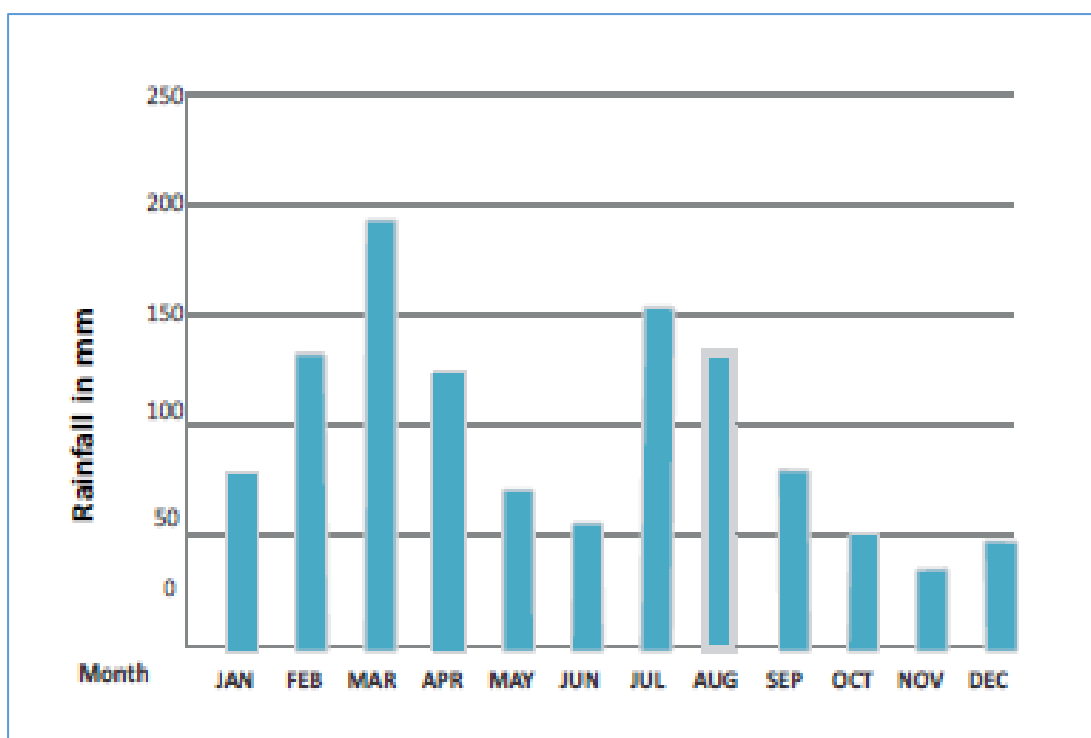
Months	2012			2013			2014		
	Max Temp	Min Temp	Total rainfall in M.M	Max Temp	Min Temp	Total rainfall in M.M	Max Temp	Min Temp	Total rainfall in M.M
January	12	1	75.5	4.6	1.4	21.7	4.6	1.4	21.7
February	12.9	2.1	84.1	15.1	4.1	315	15.1	4.1	315
March	20.2	7.6	41.2	21.7	9.5	128	21.7	9.5	128
April	26	13.4	123.8	25.9	12.5	67	25.9	12.5	67
May	30.3	16	37.2	32.2	17.6	38	32.2	17.6	38
June	36.6	20.6	0.1	35.4	21.2	192.5	35.4	21.2	192.5
July	36.4	22.1	133.9	33.6	23.2	119.2	33.6	23.2	119.2
August	33	22.1	78.4	31.5	21.6	314.1	31.5	21.6	314.1
September	29.8	18.8	124.6	31.5	18.8	56.6	31.5	18.8	56.6
October	26.6	14.8	20.5	27.8	14.8	45.7	27.8	14.8	45.7
November	21.5	6	8.3	19.9	6	35.3	19.9	6	35.3
December	15.9	3.9	25.4	17.1	3.6	1.2	17.1	3.6	1.2
Total	301.2	148.4	753	296.3	154.3	1334.3	296.3	154.3	1334.3
Mean	25.1	12.37		24.69	12.86		24.69	12.86	

Source: Pakistan Meteorological Department Peshawar 2014



Source: Pakistan Meteorological Department, Peshawar

Figure 2. 1: Monthly Maximum Temperature of the District Swat (1974-2011)



Source: PDMA 2015 based on Pakistan Meteorological Department Data Peshawar 2014

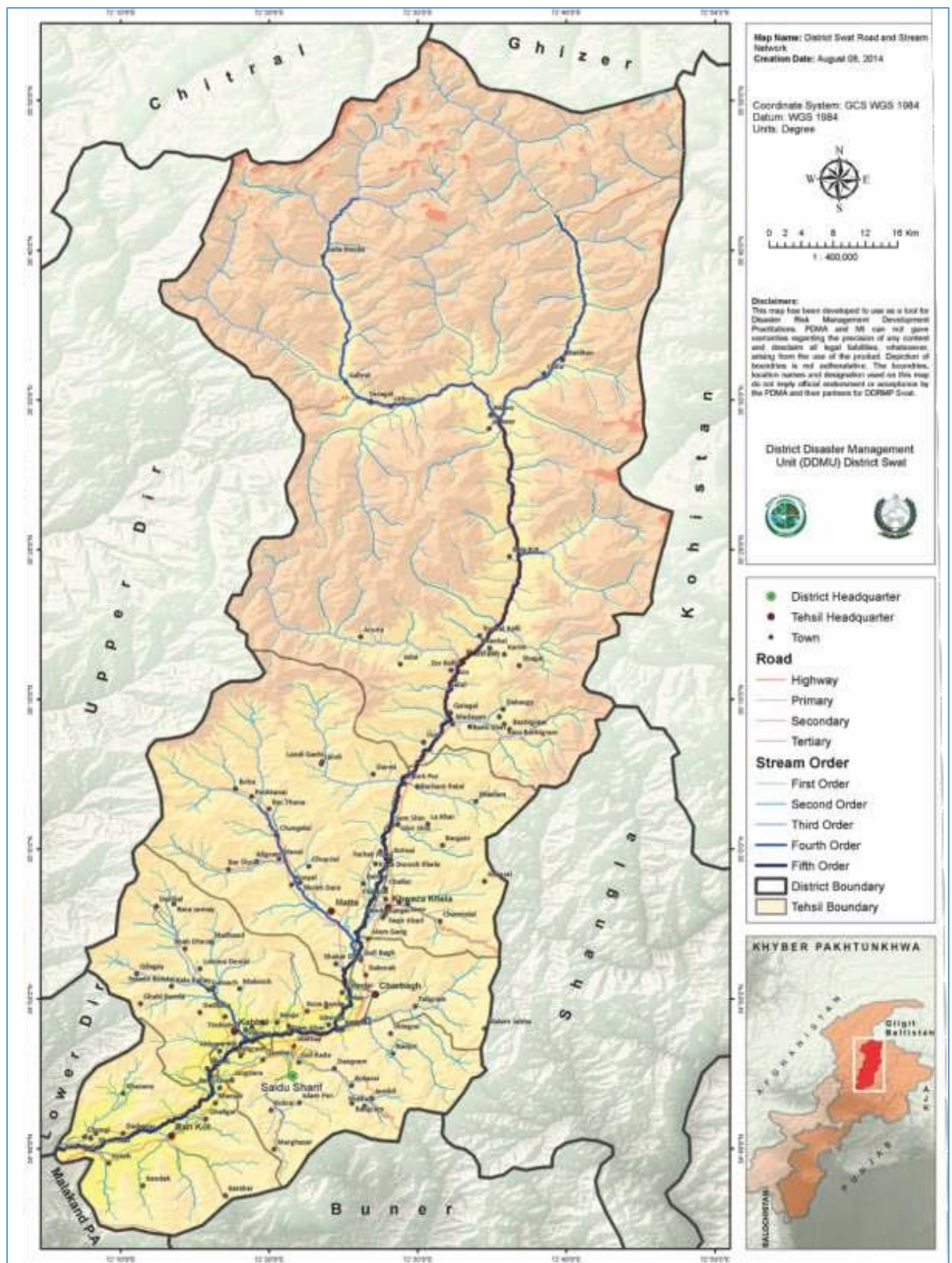
Figure 2. 2: Average Monthly Rainfall for Saidu Sharif, District Swat (1978-2011)

2.4 The River Swat

Swat River serves as the only drainage basin of district Swat. The River is originated in the upper part of the district, in the form of rushing streams of glacial lakes and permanent ice caps. The river flow is mostly determined by snow melt and monsoon rainfall in the months of March to June and July to August respectively. In the valleys of Mahodand and Gabral, these streams merge forming Ushu Gol and Gabral River. After flowing southwards, the two rivers after covering a distance of 34 to 40 km, give rise to the Swat River at Kalam (Ahmad et al., 2015). The length of River Swat is about 250 km from Kalam to its confluence with Kabul River near Charsadda. Although direct seepage contributes most of the part to the permanent streams and Swat River, but it is the related tributaries (Figure 2.3) that control the flow, productivity and quality of the River Swat. Many tributaries (seasonal and perennial) join River Swat as it flows downstream. From its origin to the end, about 50 species of freshwater species have been recorded in River Swat (Hasan et al., 2013; Yousafzai et al., 2013; Ahmad et al., 2015).

The whole freshwater network of River Swat can be divided into two types of ecology i.e. “The monsoon-excluded spating river ecology” and “the monsoon-prevailing sluggish river ecology”. The first system is constrained to Swat Kohistan characterized by the torrent cold water. Trout love to live in this cold water ecosystem, therefore it is also termed as Trout ecology. While the latter type of ecological system prevails in the lower part of the river and is represented by the cold but relatively slow water movement. This part of the ecosystem is called non-trout ecology (Ahmad et al., 2015).

The Swat River is playing a substantial role in the local economy of the study area. The river is an attraction source to thousands of visitors and recreation for local people. The river is used for water supply to irrigation and domestic purposes. Due to pollution, unplanned urbanization, deforestation, illegal fishing, encroachments etc., the River Swat is facing serious threats to the riverine ecosystem and water quality. (PDMA, 2015). The situation needs immediate attention from the government and policy makers. Moreover, the above problems coupled with climate change results devastating flash floods during monsoon season. The year 2010 saw a major flood in the Swat River responsible for huge losses to the ecosystem, infrastructure and human settlements (Yousafzai et al., 2013). The details of the damages instigated by the floods in River Swat (Figure 2.4) are described comprehensively in literature review and results and discussion chapters.



Source: District Disaster Management Plan, Swat (2015-2010)

Figure 2. 3: River Swat and its Tributaries

2.5 Livelihood Sources

The population of Swat is dependent on Agriculture, Horticulture, Livestock, Fisheries, Tourism and Forest resources of the area (Sabir, 2002; Khan and Khan, 2009). Apart from dependency on the natural resources, the people also finds their jobs in a number of industries and have employment in multiple public and private sector organizations (Sabir, 2002). Moreover, some of the households are dependent on local and foreign remittances (Khan and Khan, 2009). Some of the important livelihood sources of the study area are given in the flowing paras.

2.5.1 Agriculture

This sector represents the major livelihood source harboring around 42% of the population in the area (GoKP, 2015). Wheat, Maize, Tomato, Onions, Persimmon, Peach, apricot are some of the important cash and fruits grown in district Swat (Khan and Khan, 2009). Due to several reasons, the total cultivated area is just 19.3% of the district's area. Most of the cultivatable lands are located in Saidu Sharif, Kabal, Matta, Barikot and Khawazakhela tehsils, that constitute the southern part of the district (Bazzini, 2013). The statistics for land utilization in terms of cultivated, cropped and un-cultivated areas is given in Table 2.3 and figure 2.5. The major crops in the district as shown in table 2.5. Wheat and maize are sown on 63683 and 61067 hectares respectively (according to the 2014-015 data while in the previous years the production area for these crops is reversed) making the main chunk in the cropped area in the district. in 2013 Swat valley produced about 271 lakh tons of green stuff such as peach, golden apple, apricot, oranges, onion, potato and garlic (PDMA, 2015).

Table 2.4 gives a brief overlook of the irrigation sources in district Swat. The main irrigation sources are canals, tube wells, wells and lift-pumps. Evidently, canals form the major source of irrigation with about 42% share in total irrigated areas.

Table 2. 3: Land utilization in the study area (hectares)

	2011-012	2012-013	2013-014
Reported Area	506528	506528	506528
Cultivated Area	95464	96528	97744
Cropped Area	182359	180586	180287
Un-cultivated Area	411064	410000	408784

Source: Statistics Department, KP

Table 2. 4: Different Sources of Irrigation in District Swat (Irrigated by Area in Hectares)

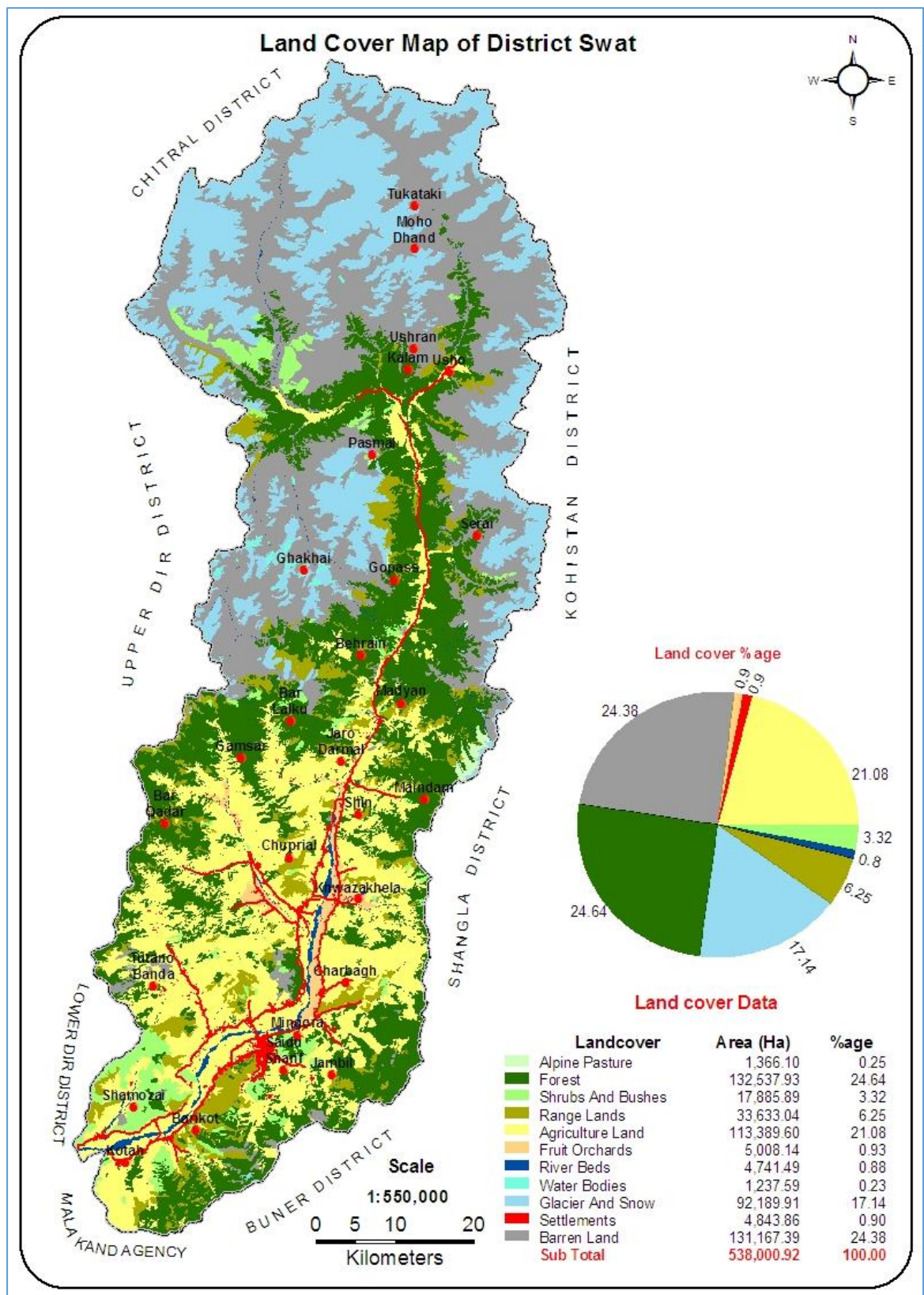
Sources	2012-013	2013-014	2014-015	% Area Irrigated from different sources
Canals (Govt.)	3623	3672	4046	4.15
Canals (Private)	36300	36350	36360	37.31
Tube Wells	8075	8095	8125	8.34
Wells	14100	13978	13770	14.13
Lift Pumps	16200	16200	15900	16.31
Others	6620	6625	6750	6.94

Source: Statistics Department, KP

Table 2. 5: Area (Hectares) and Production (Tonnes) of Major Crops in District Swat

Crops	2012-013		2013-014		2014-015	
	Area	Production	Area	Production	Area	Production
Maize	60456	100870	61307	107077	61067	113315
Wheat	59850	106694	62428	111328	63683	111346
Fruits	12470	80920	-	-	-	-
Vegetables	8380	88160	-	-	-	-
Rice	5698	13840	5559	13834	6649	17246
Onion	3820	100240	-	-	-	-
Canola	1950	780	-	-	-	-
Rape Seed & Mustard	1384	615	175	88	387	181
Peas	1290	10320	-	-	-	-
Barley	447	480	333	385	418	445
Garlic	130	1040	-	-	-	-

Source: Development Statistics of Khyber Pakhtunkhwa 2016; PAFF, 2015



Source: Billion Trees Tsunami Project, Forestry Environment and Wildlife Department, Government of Khyber Pakhtunkhwa

Figure 2. 5: Land Cover Map of District Swat

Due to the environmental advantages, some of the off-season winter vegetables are grown in summer in upper parts of the district which makes it available throughout the year, and bears decent economic value. The areas along the River Swat in the lower part of the district are experiencing a shift from traditional crops to fruit orchids. While the fruits cultivation started on commercial scale in Matta sub-division, this sector is now even advanced and shifted to other parts of the district. Apple, persimmon and peach are the main fruit species cultivated in these areas while the other fruits grown on smaller scale are grape, plum, pear, apricot and walnut. The intercropping of the cereals with fruits trees are common the area. According to agriculture statistics, agriculture sector engages 56% of the labor force creating more than PKR 5.4 billion during the years (PDMA, 2015).

2.5.2 Livestock

Livestock is an important livelihood source in rural areas of the district. Table 2.6 shows the livestock population by animal type and poultry calculated during livestock census 2006 (GoKP, 2016). The table shows that Cattle, Buffalo, Goat and Sheep are the major type of livestock in the district.

Table 2. 6: Population of Livestock in District Swat

Animal Type	Numbers
Cattle	253790
Buffalo	117101
Sheep	80048
Goats	236229
Poultry	1141678
Camel	256
Horse	4833
Mule	3020
Asses	17577

2.5.3 Fisheries

Fisheries sector constitute a major livelihood source of the study area. The district is also famous for the production different varieties of fish including trout and non-trout fishes. The Development statistics of Khyber Pakhtunkhwa 2016 shows that district

Swat contributes 50% of the total fish production in the province and 14.5% of the total Trout Fish production (Table 2.7). A large fishery/hatchery is situated in Madyan where Trout fish are reared. Some private Trout fisheries are operated in Swat Kohistan, which is a prime attraction for the tourists visiting Swat valley. Apart from that, the River Swat provides a permanent habitat to the fish round the year. (PPAF, 2015). “Mahsher” fish is abundant in lower areas while “Trout” fish is common in the upper part of River Swat with very cold water temperatures.

Table 2. 7: Fish Production in District Swat (M. Tons)

Fish Type	2012-013	2013-014	2014-015	% in Province total
Trout	25	23	18	14.84
Non-Trout	723	826	1084	51.98
Total	748	849	1102	49.94

Source: Development statistics of Khyber Pakhtunkhwa 2016

2.5.4 Forestry

Khyber Pakhtunkhwa is blessed with abundant natural resources and accounts for 40% of the country forest resources. Dir, Hazara, Swat, Chitral and Kohistan are home to about 3 million acres of forests. Swat is famous for its fertile lands and well wooded forests. According to the chief conservator of forests, Khyber Pakhtunkhwa, the total area of the forest cover in district Swat is 409,591 acres as shown in Table 2.8 (Bazzini, 2013). The forest area is further divided in to protected forests spreading over an area of 338,544 acres, private plantations with an area of 707,03 acres and other categories of 344 acres’ area. Around 20% of the district Swat is under forest. Since the early times, Swat remained thickly forested and was known for world top Cedar forest (Khan and Khan, 2009). The district is still rich in forest resources despite of indiscriminate deforestation. Based on forest management, the district is divided in to two forest divisions, Swat Forest Division and Kalam Forest Division (Table 2.9). Swat forest division comprised of the areas geographically called as Swat proper covering an area of 2154 Km² while Kalam Forest Division cover the areas geographically called as Swat Kohistan. This forest division covers an area of about 3183 Km² (Divisional Profile, 2014).

The forests in the northern areas of Madyan and Kalam are declared protected forests by the government. Apart from their aesthetic value, these forests serve a major livelihood source for the local population as the wood is supplied for cooking and heating purposes (Bazzini, 2013; PPAF, 2015). The forest area of district Swat can be seen in the land cover map (Figure 3.1). The forest resources have a vital role in the rural livelihoods of Khyber Pakhtunkhwa province. Most of them are dependent on these resources and obtain for timber, fire wood and fodder for maintenances. Moreover, the locals collect the other NTFPs (Non-timber forest products) for household use and cash income (Sajjad et al., 2015).

Table 2. 8: Area Under the Control of Forest Department in District Swat [2011-12]

Forest Type	Area (Acres)	% of the Province
Protected Forest	338544	29.10
Private Plantation	70703	4.00
Miscellaneous Forest Area	344	0.045
Total	409591	8.09

Source: Chief Conservator of Forest, Khyber Pakhtunkhwa

Deforestation is a serious and unmanaged phenomenon in the area. According to the study conducted by Khan and Khan 2009 the forest cover has decreased since the princely state of Swat was merged in Pakistan. While previously the area was preoccupied by the rich forests of various categories, has now exposed to manmade degradation. Nearly 95% of wetlands were converted to croplands while huge areas of subtropical forests were transformed to croplands. On the high mountains where the temperate forests were established, terracing uprooted the forests turning into croplands. The unwise forests degradation of the district is responsible for accelerated erosion and limiting the recharging capabilities of springs (Ahmad et al., 2015). The overcutting of the trees and selling the timber to markets is banned by the government, but this has shifted the concern of the locals towards smuggling of timber.

Table 2. 9: Forest Divisions in District Swat

Swat Forest Division		
Sub- Division	Name	Head Quarter
	Swat Forest Sub-Division	Mingora
	Matta Forest Sub-Division	Matta
Range	Kabal Forest Range	Kabal
	Fatehpur Range	Fatehpur
Kalam Forest Division		
Sub- Division	Name	Head Quarter
	Behrain (South) Forest Sub-Division	Madyan
	Behrain (North) Forest Sub-Division	Behrain
	Kalam Forest Sub-Division	Kalam
Range	Utror Range	Utror

Source: Divisional Profile of Kalam Forest Division, 2014

2.5.5 Tourism

The district is “an ideal place in summer for kings” is visited by many local and international tourists throughout the year. The Swat district presents tons of great attraction place for tourists to visit, providing sustenance source and employment opportunities to the locals of Swat (Ahmad et al., 2015). There is a well-established hotel industry in the study area. According to the Tourism Development Corporation, there are 850 hotels and restaurants engaging 15000 people as direct employed, in the form of owners and servants while 25000 indirect employed in terms of suppliers and other related businesses. The district bears two-folded importance for local and international visitors, that is the scenic beauty of its landscape and rich cultural history of Gandhara Civilization and widespread archeological sites (PDMA, 2015).

The 2010 flooding event in Rive Swat proved fatal to the tourism industry in the district. The monsoon floods significantly damaged road infrastructure, tourist spots and hotel industry of the area, thus by depriving the livelihoods of thousands related to the industry (Khan et al., 2010; Khaliq, 2011b). The government has been engaged in the rehabilitation efforts and revival of the tourism industry in the area. The area is prone to Climate induced weather related that could the affect the area in the future, therefore

particular focus should be given to the district to safeguard the natural resources and numerous livelihood sources.

2.5.6 Minerals and Industry

The rich geology of Khyber Pakhtunkhwa province provides enormous mineral wealth but exploration of these minerals and related development work have remained feeble. The precious stones industry of KP holds tremendous value in terms of exports. It is estimated that with proper use of modern techniques the export of these gemstones can be increased to \$ 50 Million. Apart from that Swat, Mohmand, Bajaur and Khyber agency have 2 billion tons of marble deposits. Mullagori marble of Swat district is ranked among the best marbles in the world. The few minerals explored in district Swat contain Soap clay, China clay, Marbles and Emeralds. The Swat emeralds extracted in Mingora area are famous worldwide, and is a substantial source of income for many individuals.

According to the Directorate of Commerce and Industries KP (GoKP, 2016), there are a total of 246 industrial units in district Swat with 239 running units in 2015 (Table 2.10). The people of Swat are involved in various economic activities such as cottage industry, textile industry, wooden industry, embroidery, automobile, silk, cosmetics, mining industry among the others. During the security crisis in district Swat in the years 2006 to 2009, industrial sector suffered great losses rendering thousands of workers unemployed. The World Bank and Asian Development estimated a loss of PKR 153 million in the “Preliminary Damages and Needs Assessment Report” in 2009 (Asian Development Bank, 2010; PDMA, 2015).

Table 2. 10: Total Number of Registered Industrial Units, Running and Closed in District Swat

	2012-013	2013-014	2014-015
Total	220	164	246
Running Units	205	157	239
Closed Units	15	7	7

Source: Directorate of Commerce and Industries KP

CHAPTER III

REVIEW OF LITERATURE

This chapter sheds light on the available literature related to the current study; international insights in relation to the local perspectives. As the study is in continuation to the various other researchers conducted around the world which provides it a firm structure. Being a prime focus of current research, climate change is a global phenomenon and induces a variety of hazards in varying degrees to communities around the world. District Swat is no exception to this man-made threat and is going to affect the health, livelihood sources and natural environment in the study area. In Pakistan, studies on climate change are yet in the infancy stages and the available literature is too little, yet an effort has been made in this chapter to give a descriptive picture of the problem with the help of local and international efforts done so far.

3.1 Climate Change

The combustion of coal, oil and other fossil fuels increases the amount of greenhouse gases (GHGs) in the atmosphere creating the problem of Global warming (Honjo, 1996). This increase rises the global air temperatures leading to climate change. Rise in sea levels, change in rainfall patterns and other multiple problems are caused due to climate change. It is a scientifically known hazard to the humanity. Elevated ranges of GHGs are accountable for global warming and overall changing of the climate system globally (Honjo, 1996).

According to Intergovernmental Panel on Climate change (IPCC) the warming of climate is “unequivocal” and since 1950, the changes has been observed unprecedentedly (IPCC, 2007). As the result of increase in greenhouse gases, the atmosphere and ocean has increased, the amount of snow and ice decreased and rise in the sea level has been detected (IPCC, 2013). Since the recording of temperature period in 1850, the last three decades has been marked as the warmest of the century. A calculation by Linear trend in the temperature data shows a rise of 0.85 °C since 1880 to 2012 for combined land and surface while the increase between the average of 2003-2012 compared to 1850-1900 is 0.78 [0.72-0.85] °C (IPCC, 2013).

It is estimated that most of the rise accounts for ocean warming, with more than 90% of the energy stored within the time period of 1971-2010. Scientist are sure (by the term “*virtually certain*”) that since 1971 to 2010 the upper ocean ranging from 0-700m has warmed while it is also possible that the ocean gets warmed through the years 1870-1971 (IPCC, 2013) while there is a warming trend of 0.11°C per decade from the surface to 75 m since 1971-2010 (IPCC, 2013). Since over the past two decades, glaciers all over the world have shrunk while the ice in Greenland, Antarctica and Arctic Sea are decrease and losing mass. In the meanwhile, globally sea level has risen by 0.9 (0.17 to 0.21) m (IPCC, 2013).

On 25th September 2015 the General Assembly of United Nations in New York unanimously agreed upon a resolution known as “Transforming our world: the 2030 Agenda for Sustainable Development”. The agenda consists of 17 SDGs (Sustainable Development Goals) and 169 targets. The 2030 agenda also demands about taking action against climate change (UNGA, 2015). According to the UN every country in the world is now affecting by climate change; affecting human lives, communities and economies of the countries. The goal 13 is targeted to strengthen resilience and adaptive capacity against climate induced hazards, incorporating it within the country and region wide policies and capacity building of the public and institutions. The UN has bounded the developed countries according to the pledge taken under UNFCCC to help the developing counties an amount of \$ 100 billion annually by the year 2020 and onwards for implementing mitigation actions and operationalize the Green Climate Fund (UN General Assembly, 2015).

3.2 Climate Change in Pakistan

Due to its diverse climatic and geographical characteristics, climate change possesses a great challenge to Pakistan. A large part of Pakistan belongs to northern mountainous ranges and sea shores which are studied to be the hot spots of climate change and should therefore be protected (Rasul et al., 2012). In 1994 Pakistan ratified United Nations Framework Convention on Climate Change (UNFCCC) presenting full commitment to the obligations of that convention and since then, Pakistan have taken various steps in combating climate change (Jeswani, 2008).

A study conducted by **Salma et al., (2010)** illustrates that climate change is happening in Pakistan with a big increase in the temperature in big cities. A 30 years' dataset from 30 meteorological stations was used in the estimation of temperature increase. The results showed a positive trend in the mean (0.11 C/decade), minimum (0.1 C/decade) and maximum temperature (0.12 C/decade) in the whole country. The increase in temperature is still low from the global average but it is speculated that the situation will get worse in the future with climate change induced hazards are knocking on the door. The current hazards of floods and extreme weather conditions are indications of something big is occurring in the region and if mitigatory measures are not taken, it could get worse in the future.

Iqbal et al., (2016) studied the changes in maximum and minimum temperatures by analyzing data from 37 meteorological stations from Pakistan for annual, seasonal and monthly resolutions. The study revealed significant increase for maximum temperature in annual and pre-monsoon season with the sharpest increase observed for the month of march. Likewise, the minimum temperature showed increase in pre-monsoon and annual timescales. A faster increase in maximum temperature was observed in the northern areas compared to the minimum temperatures both on annual and all the seasons studied.

According to **Farooqi et al., (2005)**, climate of Pakistan is changing and impacts owing to these changes will be soon evident in different aspects of life across the country over time. In addition to climate mitigation, adopting climate adaptation strategies would be necessary. The global climate models predict varying level of impacts on water resources, food supply, health, transportation, industry and ecosystem sustainability. The previous climatic observations and GCMs/RCMs are in agreement that climate induced hazards would increase in the future, with potential socio-economic repercussions to the existing stressed infrastructure and institutions.

Abbass (2009) reported that as a result of emissions from anthropogenic sources over the last 50-60 years, it is now universally accepted that greenhouse gases are responsible for changing earth climate. Pakistan is also victim of climate change like many other under developed nations despite the fact that it doesn't not contribute much and its per capita emissions of GHGs fall far below the global average.

According to **Chaudry et al., (2009)** like the other countries of the world Pakistan is also facing climate change and the overall temperature has been increased over the past years. Pakistan ranks among the 12 most vulnerable states of the world. The study shows a considerable increase of 0.099 °C/decade with a total warming of 0.47°C over 47 years. The warmest year recorded in Pakistan climate history is 1988 and the second warmest is 2002.

Khan et al., (2009) reported that the emissions of various greenhouse gases including CH₄, CO₂ and N₂O were estimated for major contributing sectors in Pakistan during July 2007 to June 2008. The net estimated emissions of carbon dioxide, N₂O and Methane from various sectors are 104939.3, 192.1 and 5132.3 Giga grams respectively. The various sectors contributing to the emissions of CO₂ are energy, industrial processes and land use & forestry with 74.3%, 16.0% and 9.7% respectively. The major sectors emitting CH₄ gas are energy, agriculture, and waste with the 16.0%, 74.4% and 9.2% respectively.

According to **Khan (2011a)**, Pakistan has been declared as a climate vulnerable state although it contributes negligible amount of greenhouse gases and is placed at 135th position among the global greenhouse gas emitters. The country is mostly vulnerable to food security. Among the other impacts due to climate change are biodiversity loss, melting of glaciers, freshwater availability, droughts and desertification. The devastating floods in the recent past, especially 2010 is an evident example of the changing climatic variability which costed around 10 billion dollars and turned 20 million people refugees.

3.4 CC Vulnerability of Pakistan

The term Vulnerability is defined as “The state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt” (Adger, 2006).

According to German watch Pakistan is 8th on the Climate Risk Index (CRI) among the top 10 countries associated with the impacts of weather related events (**Kreft et al., 2015**).

Abbass (2009) reported that Pakistan is vulnerable to a number of natural disasters. It is estimated that about 40% of the people living in Pakistan are highly exposed and vulnerable to climate induced hazards. It is predicted that the situation will get intense in the coming future with variation in rainfall patterns, storms, floods and droughts.

Asian Development Bank (2010) reported that Pakistan is vulnerable to flooding, droughts and other related climate hazards. Previous to the floods of 2010, Pakistan has also experienced flooding events in 1950, 1988, 1992 and 1998 which resulted in human losses and damages to property. Likewise, the events of droughts recorded during 2000-2002 and fourteen cyclones recorded during 1971-2001 caused havoc and momentous damages. The change in the rainfall patterns and increase in precipitation during monsoon seasons is a clear indication of changing climate in the country. The future scenarios conducted for Pakistan points towards increase in the rainfall events over the north-west region instead of north-west. Due to the reason Indus and Kabul Rivers will be more vulnerable to flooding events in the future.

GCISC (2016) reported that Pakistan is among the 10 major vulnerable countries. The major concerns related to climate change are increased monsoon variability, projected recession of HKH glaciers, increased risk of extreme events (floods, cyclones, droughts, extreme temperatures), deforestation, severe water stressed conditions leading to reduced agricultural productivity and increased health risks. A few instances of the vulnerability are devastating floods of 2010, worst droughts during 1999 to 2002, extreme heat waves and severe cyclonic storms in the recent past.

According to the **IPCC (2007)** South Asia is the region that will face serious water shortages despite the spells of rainfall in monsoon seasons. This will have a serious direct impact on the agriculture sector around the globe. As a result, the production yield of the cereal crops could reduce by more than 20 to 40% creating huge food shortages.

Farooqi et al., (2005) studied that Global circulation models and regional circulation models predict that the occurrences of extreme weather conditions like drought and flooding will increase in the future. The predicted weather conditions will exert extreme

pressure on infrastructure with major consequences to the socio-economic conditions of the country.

Daniel (2011) illustrated that studies underline the observed environmental change with regard to changing rainfall patterns and frequency of floods in Pakistan. The precipitation in summer and winter months is increased over the past 40 years. Moreover, in coastal and arid regions a decrease of 10-15% precipitation was observed. Climate change is also responsible for the water stress in Pakistan. Droughts and decreasing precipitation pattern is threatening wetlands and ecosystems in Pakistan.

IUCN (2009) regarded Pakistan as a front-line state with serious implications to climate change. The enhanced activity of floods, droughts and frequent receding of the glaciers in the region showcase the scenario. Precipitation in Pakistan is highly associated with monsoons during the months of July to September. According to IPCC precipitation will increase during monsoon by 2030. The situation in Pakistan as already under stress due to frequent floods will exacerbate in the future.

Hussain & Mudasser (2007) studied that increase of 1.5°C of temperature would improve the crop yields by 14% in Chitral and decrease the production by 7% in district Swat. This shortening of the GSL (Growing Season Length) has a positive impact on wheat yield in Chitral valley located in the high-mountain areas, but has a negative impact on wheat yield in Swat valley located in the sub-mountain region.

ADB (2010) reported that due to excessive rainfall in the months of July to September 2010, Pakistan experienced unprecedented flooding in the whole country that affected about 20 million people and brought a death toll of 1800 people. The flooding event was recorded as one of the worst since 1929. Moreover, the flash floods caused great damages to the infrastructure affecting entire villages, urban centers, homes, crops and agriculture lands. The direct damages by the floods were calculated to US\$ 6.5 billion while the indirect costs were calculated to be US\$ 3.6 billion. The main sectors that were affected during the flooding were agriculture, livestock and fisheries costed US\$ 5.0 billion. The duration, intensity and damages of the flooding event was unmatched with all the previous floods in the history of Pakistan.

According to **Houze Jr et al., (2011)**, UN Secretary General while addressing to UN General Assembly in the aftermath of floods 2010 said that “almost 20 million people need shelter, food, and emergency care. That is more than the entire population hit by the Indian Ocean tsunami, the Kashmir earthquake, Cyclone Nargis, and the earthquake in Haiti—combined.” The TRMM satellite indicated that the event was uncommon in the region and it usually associated with northeastern India and Bangladesh producing copious monsoon rains.

According to **PDMA (2015)**, Pakistan is exposed to a variety of climate induced hazards. The flood events are gaining momentum since the 2010 episode. Since then, multiple occurrences have been recorded in various parts of KP. In 2015 flash floods due to heavy rainfall and Glacial Lake Outburst Flood (GLOF) struck Chitral district of KP bringing devastation to houses, human lives, roads, irrigation channels and water supply schemes. Moreover, standing crops and livestock were swept away by heavy floods. According to the official data the event caused 36 deaths, 151 houses damaged totally and 38 partially. The recovery and rehabilitation cost was calculated to be approximately PKR 8.07 Billion. In April 2015, a severe storm struck Peshawar city and other parts of KP province. The met department of KP termed the event as mini cyclone. The mini cyclone caused death of 49 people and 267 injuries. The phenomenon is rare in these areas therefore no warning/forecast could not be issued by the Pakistan Metrological Department.

According to **Tariq et al., (2014)**, that climate change is observed in the Kabul river and trans-boundary watershed. Statistics showed an increase in temperature and variation in rainfall pattern over Chitral and Peshawar valleys, indicating the negative impacts on the future environmental sustainability. The study shows increase of urban areas and barren lands while a decrease in the vegetation.

3.5 CC Impacts on Livelihood Sources

Studies indicate that climate change has alarming effects on livelihoods (Dube and Phiri, 2013; Elasha et al., 2005; Lyimo and Kangalawe, 2010; Haque et al., 2012; Gentle and Maraseni, 2012; Simatele et al., 2012; Barnett and Adger, 2007). Extreme weather conditions like floods and droughts have become more prevalent thus by affecting the rural livelihoods (Miller-Kuckelberg, 2012; Lyimo and Kangalawe, 2010;

Oremo, 2013; Simatele et al., 2012). Climate change has disturbed the physical geography thus effecting natural flora and fauna and other natural habitats which happen to be the livelihood sources of many communities around the world. Local communities are aware about the changing climate patterns as their own observations of variability in temperature in rainfall (Lyimo and Kangalawe, 2010, Lyimo and Kangalawe, 2010). Farming is getting difficult due to decrease in precipitation and increased temperature, therefore declining food productivity giving way to food insecurities (Dube and Phiri, 2013). Floods and droughts are destroying the crops in developing countries and harvest of the farmers leaving the communities with miserable conditions (Mller-Kuckelberg, 2012). Climate change is also affecting the fisheries and the livelihoods depending on the fisheries. The distribution of the fish species is being changed by climate change with the most changes in size, habitat, diversification and fish productivity (Omitoyin and Tosan, 2012).

The emergence of social research on climate change in early 1980's (Bord 1998) revealed that mostly people assign little significance to climate change in their daily life (Norton 2004; Bord 2000). Moreover, a lay fellow often fails to distinguish between the different environmental hazards such as ozone depletion, climate change and air pollution. A number of people see climate change as more of a threat to others than to themselves (Leiserowitz 2006).

Gentle and Maraseni (2012) studied that impacts of climate change tends to be more severe in the mountainous regions where the livelihoods are weather dependent such as rain-fed agriculture. The adaptive capacity of the mountainous communities is low due to few livelihood options and poor access to services. It is studied that the climate change is proving additional burden on the poor living in the mountainous communities with additional risks pertaining to their livelihoods in the future.

According to **Barnett and Adger (2007)** climate change reduces access to natural resources, which are important to withstand livelihoods of some communities. Apart from these impacts states can also show failure in providing basic services and opportunities to maintain livelihoods. These circumstances can lead to increased risk for violent conflicts.

Shakoor et al., (2011) investigated that climate change is inducing negative impacts on the agriculture productivity. Increase in rainfall could be envisaged with the increase in income or revenue but the negative impact of temperature rise is higher than rainfall increase. Therefore, for every degree rise in temperature would result in a substantial amount of income per year.

IISD (2003) reported that generally the way people respond to impacts of climate change are mostly determined by different forms of livelihood assets. Each and every asset is desirable but for the poor and vulnerable communities, the natural resources are extremely important. The worsening environmental factors greatly affect the poor because of their dependency on ecosystem services.

Rennie and Singh (1996) reported that the poverty-environment linkage has been accepted numerous times that; mostly the lower economic class depends on natural resources for their sustenance using various livelihood sources. In order to make these livelihoods sustainable, the resources they depend on should be sustained.

IUCN (2009b) stated that over 47% of the population living in Pakistan is dependent on agriculture, contributing to 24% of the country's GDP. Due to anthropogenic interventions, the agriculture sector has become vulnerable to negative impacts of climate change.

3.6 Adaptation to climate change

According to IPCC adaptation is “adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects” (Smit et al., 2001). Adaptation includes adjustments to the harms or benefits from climate change variability. It can range from specific actions to systemic changes such as farmers switching from a variety of crop to another or diversifying rural livelihoods as a fence against climate change variability and extremes, respectively. Moreover, it can be in the form of institutional reforms; for instance, revising ownership and user rights for land and water to create incentives for better resource management. Adaptation is also a process. Learning about risks, creating favorable conditions for adaptation, evaluation of the response options, organizing resources, implementation of adaptation options, all come under the process of adaptation. All these things come under adaptation but the

genesis of adaptation as a process is often the most important for formulating public interventions that will have lasting benefits (Leary et al., 2007).

Adaptation to climate change has not been sufficiently studied yet (Berkes and Jolly, 2002). It is suggested that the subject of adaptation in climate change should be dealt as isolated strategy but should be kept aligned with the efforts to overcome poverty and struggle against environmental vulnerabilities. Despite the local effects of climate change as seen more evident, the policy and actions shouldn't be limited to local scale only, rather an integrated approach encompassing national and district level policies and strategies should be adopted. From the livelihood point of view, the adaptation requirements of poor households are much higher than the wealthy and well-off groups (Gentle and Maraseni, 2012). The ability of the people to address the negative changes of climate change is affected by the limits and hurdles to adaptation and therefore they cannot manage the risk that helps in maximizing their well-being (Islam et al., 2014). Effective adaptation to climate change requires engagement of individuals and international institutions at relevant scale (Bohensky et al., 2015).

Enete et al., (2011) studied climate change impacts on agriculture production, which is important due to the fact that most developing countries are susceptible to the impacts of climate change on agriculture based livelihoods. The most prominent effects of climate change studies were reduced crop production, reduction in quality of crops, loss of rangelands among the others. The adaptation measures adopted by the farmers were multiple cropping, afforestation, mulching, water harvesting and use of resistant crop varieties. The main barriers in the adaptation measures were identified as poverty, lack of skills, lack of knowledge and poor land tenure system.

Deng et al., (2012) studied that climate had a tendency of changing from warm drying to warm wetting. Perceptions about changes in climate, cryosphere and water resources, and adaptive measures by the public in response were focused. The study revealed that majority of the respondents chose to mention the government implemented adaptation measures. The demography impacts the public choices of adaptation measures for the changes in changes in climate and cryosphere.

Panda (2016) studied that drought prone areas are more vulnerable to climate change especially the areas with high poverty and lack of agricultural facilities and productivity. The local perceptions, adaptation practices and barriers to adaptation are essential to understand at individual and community levels. The major adaptation barriers revealed by the study were lack of accessibility to irrigation, information about adaptation and early warning systems, lack of government intervention, lack of information about drought resistant crop varieties among the major barriers at household and community level. The local perceptions and barriers to climate adaptation should be incorporated for improved adaptation planning.

3.7 Role of Public Perceptions in CC Policy

“Climate change is no longer an unfamiliar term” (Deng et al., 2012). Climate change is narrated through personal knowledge, experience, benefits and costs by most of the individuals. Climate change can pose great threats to various aspects of life if the human influence on the climate is remained unchecked. How the people and societies are endangered by the impacts of climate change is a current debate in the policy making process (Lorenzoni and Pidgeon, 2006). To strengthen communities’ adaptation against poverty and wellbeing issues, various policies and strategies are needed (Petheram et al., 2010).

Adaptation and mitigation involves knowledge of the causation and consequences of climate change and disposition to change the behaviors pertaining to greenhouse gas emission contributions (Niles & Mueller, 2016). The linkage between climate knowledge and beliefs has been studied. The adoption of climate mitigation and adaptation behaviors are affected by perceived personal experiences of climate change. The individual may perceive climate change because of the individuals support for climate policies or because it can alter their own climate change related behaviors but regardless of that, the perceptions might be effected by many factors other than local shifts in weather (Spence et al., 2011; Niles & Mueller, 2016). The perceptions about climate change are affected by a multiplicity of factors, that can play a role in climate adaptation decisions (Niles & Mueller, 2016)

Perceptions of climate change has been studied by many researchers around the globe. It can be produced by different qualitative and quantitative social methods of research (Lorenzoni and Pidgeon, 2006; Jurt et al., 2015). A global consensus is found among

the scientific community that there is an association between anthropogenic activities and climate change. The change is caused by a combination of reasons involving both the natural and anthropogenic changes contributing to GHGs increase due to fossil fuels burning (Houghton et al., 2001). After the enforcement of Kyoto Protocol climate change became the focus of attention of the international community which can be regarded as the starting block in the climate change reduction efforts (Lorenzoni and Pidgeon, 2006).

Although the public are not well aware of the technical scientific knowledge, yet they show good understanding of climate change and environmental policies (Gao et al., 2015). Despite the growing attention to development of climate change adaptation policies and strategies worldwide yet the local perspectives of indigenous people are not included (Petheram et al., 2010). The information collected about climate change public perceptions can play an effective role in public awareness (Akerloff, 2013). Since several years, public opinions about climate change has become a matter of interest among the scientific community and policy makers. A variety of methods including qualitative and quantitative surveys are used to draw the public views about climate change (Lorenzoni and Pidgeon, 2006).

Some of the recent studies conducted in US shows that there is a limited understanding among the public about the issue, as well as the climate issue is considered less important compared to their personal and social issues (Lorenzoni and Pidgeon, 2006). A study conducted by Leiserowitz, 2005 shows that some of the American public doesn't look at the climate change as an eminent threat while some Americans believe that climate change impacts will have a moderate severity and will have faraway impacts on communities and non-human nature. While some of the public can be related as alarmists who believe that any more increase in the human and anthropogenic activities will result in catastrophic changes, the others are of the view that the human activities don't have any negative impact on the climate system or even it can impact positively.

Policy makers gives due importance to the to the public risk perceptions about a phenomenon because it plays an important role in compelling social, economic and political actions addressing various risks. Public perceptions and opinion about the risks

can influence the policies such as treaties, laws, duties and subsidies related to climate change (Leiserowitz, 2006). The public responses to climate initiatives or impacts bear importance for the scientific community because these responses can quantify the impacts (Bord et al., 1998). The preferences of the local communities should be taken in to account when coping strategies for environmental changes are designed and public should be provided proper guidance for their motivation towards for the measures to be taken in the future (Deng et al., 2012). Moreover, in order to design climate policies that will be supported by the public, policy makers should know the exact choice and need of public (Bord et al., 1998).

Demographic factors such as gender, age, religion, education, nationality and occupation impacts the perceptions about the adaptive measures for climate change among the public (Deng et al., 2012). It is advised that government should implement the adaptation measures in accordance with the local conditions (Deng et al., 2012). The public perceptions research plays an important role in global climate change and sustainable development. Public understanding and scientific valuation is essential in understanding human response actions against climate change (Bord et al., 1998; Wardekkher et al., 2009).

Some studies conducted about the public perceptions about climate change are as follows;

Maryam et al., (2014) studied the perceived impacts of climate change on the local community in the upper part of district Swat, Pakistan using semi-structured interview. She concluded that climate change has occurred in the area with evident risk to the community affecting their lives negatively. The government should take solid steps in reducing the greenhouse gas emissions from anthropogenic sources, in order to mitigate the negative impacts of climate change.

DeBrono et al., (2012) studied that climate change is caused due to human anthropogenic changes. Human health is effected by a range of climate induced hazards such as heat waves, floods, storm and food and water shortages. The study shows that support among the public for climate change mitigation policy and willingness to act is due to the perceptions that climate change causes human diseases, claim lives, causes shortage of water and reduce the standard of living. So in order to get more public

support about climate change policies, the issue should be highlighted in terms of threat to human and general well-being.

Morghariya and Smardon (2014) studied that despite most people don't know the scientific explanation of climate change, yet they have observed changes in climate. The public have varying levels of understanding about climate change based on their priorities. Compared to the causes and solutions used by scientists, the public draw their information from different sources and trust their own explanations to phenomenon. In relation to demographic conditions, environmental conditions were found to influence more individuals' understanding of climate change. The research recommends that the local conceptual models and understandings about climate change should be studied and local perspectives should be included in the climate change communications efforts.

Lorenzoni and Pidgeon (2006) reviewed the public views of climate change and concluded that a widespread concern and awareness about the environment and climate change is existed in US and EU but it is considered less important than other social and personal issues. Moreover, there is limited understanding about factors causing climate change and its solutions. Plus, the public attribute government to take actions against climate change rather than intervening in the issue to get to a feasible solution.

Whitmarsh (2005) used a mixed methodology to examine the potential influences on the public perceptions and behavioral responses to climate change. The study found that climate change and flooding are viewed as separate issues by the public. On the other hand, environmental problems such as ozone depletion and air pollution were linked to climate change. Furthermore, the study found out that there is a huge difference between the expert and public perceptions to climate, and the actions suggested by the policy makers compared to the actions suggested by public to mitigate climate change. The study suggests that public response to climate change can be achieved by demonstrating the effectiveness of personal actions against climate change. A participatory approach in policy making against climate change is also necessary.

Sarkar and Padaria (2010) studied that about 38% of the public are aware of climate change and perceived that rapid industrialization is the main cause of climate change. The respondents were aware that increase in temperature, reduction in livestock and agricultural productivity and sea level rise while they had minimum knowledge of frequent cyclones, cold waves, heavy fog and precipitation. The study also shed light on the poverty-environment nexus as most of the respondents linked climate change as risk to socioeconomic and cultural life.

CHAPTER IV

MATERIAL AND METHODS

The following chapter explains the methods adopted in conducting out this research activity. The research is mostly based on primary data collection from the field which consisted of varying degree of data sets. A large number of respondents were interviewed using a structured questionnaire using interview schedule, interviews and key informant interviews. The collected data was carefully administered and processed using SPSS version 20 for various statistical analysis. The methods adopted in the research are explained in detail in the following text;

4.1 Research Framework

The case study approach (Yin, 1984; Eisenhardt, 1989; Crowe et al., 2011) is adopted to explore the dynamics related to climate change in district Swat using quantitative and qualitative research tools. The study area is selected because the impacts of climate change are more evident in the mountainous areas compared to the plain areas. The study area fits to this description as the climate of the area is already changing and might get worse in the future (Khan & Mahmood-ul-Hasan 2016; Shah & Hussain, 2012; Ali et al., 2014; Ali 2015). The flooding of 2010 in River Swat brought destruction to a large area of district Swat costing human lives and badly affecting agricultural lands, tourism spots, transportation and public property. Thus, there was a dire need to explore the impacts of climate change on the livelihood sources of people living in Swat district, their understanding about the climate change and future adaptation strategies. The research framework for public perceptions of climate change and impacts on various livelihood sources in district Swat is given in figure 4.1.

4.2 Data Collection

The data is collected using mixed method approach including both Quantitative methods and Qualitative methods. Quantitative methods included structured household questionnaires were used to collect contextual data (Islam, 2012) while Qualitative methods including oral interviews, Focused Group Discussions (FGDs) and key informant interviews were employed to get detailed contextually grounded

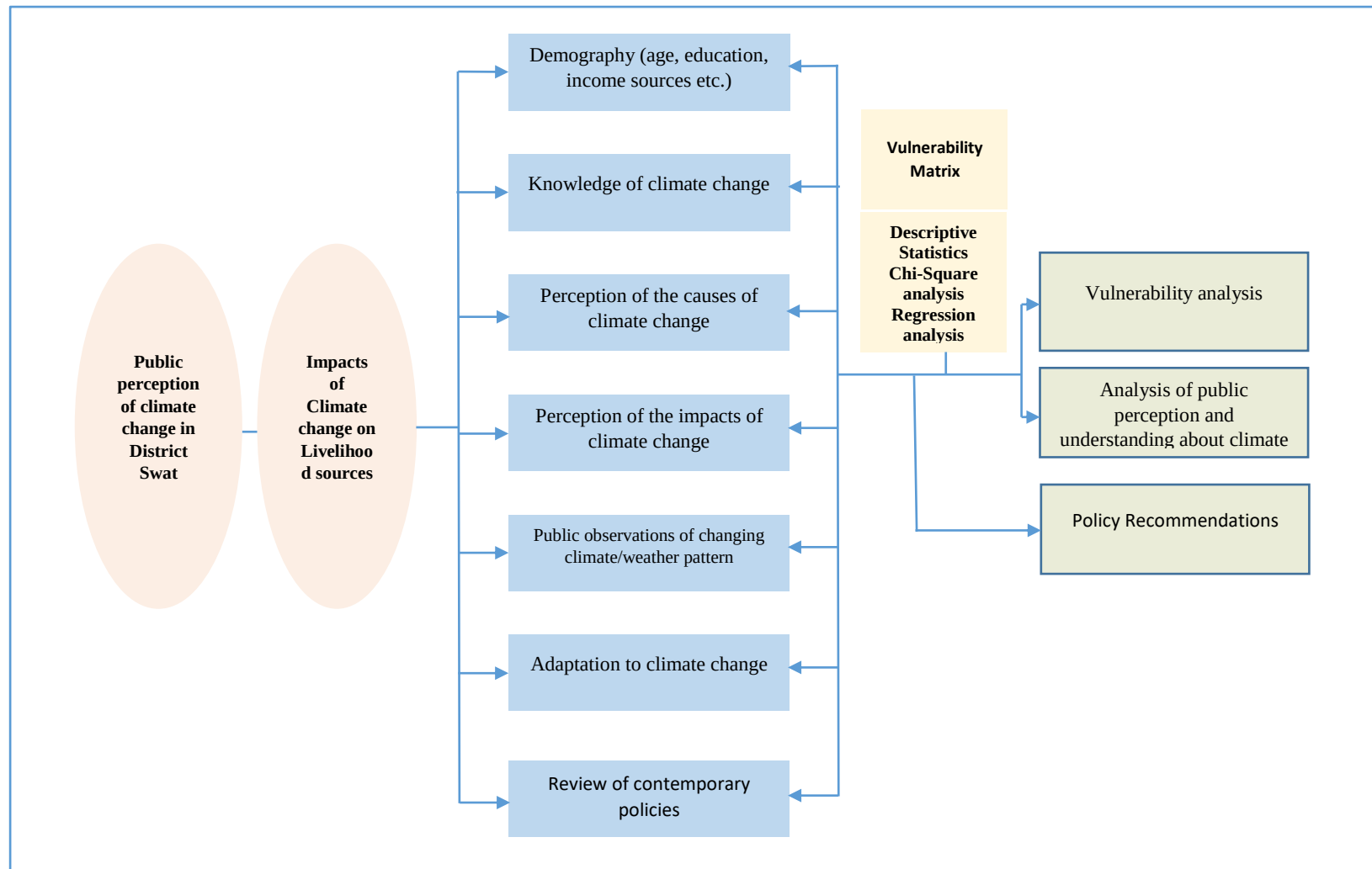


Figure 4. 1: Research Framework for Public Perceptions of Climate Change in the Study Area

data (Nightingale, 2003). The mixed methodology approach is most appropriate in probing the contextual elements and dimension of public understanding, beliefs and response to climate change (Whitmarsh, 2005).

4.2.1 Structured Household Questionnaires

Questionnaire survey is a great tool for data gathering in climate change affected communities. The firsthand information collected from the respondents holds a great value in climate change and environmental research. Structured questionnaires were employed to collect data from households, farmers, general public and departments working in the study area. Two type of questionnaires were employed he questionnaires covered the aspects of livelihood sources in the region, public perception about climate change, impacts of climate change on various sectors and local adaptation strategies. The sources of livelihoods included agriculture, horticulture, aquaculture and tourism. Great care was taken in designing the questionnaire to include questions and terms that are easily understandable to respondents, and that can have a significant effect on the answers obtained. The questionnaire was pre-tested on a small number of respondents in the study area, which resulted in some modifications to the original questionnaires (section 4.4). The questionnaires consisted of both quantitative and qualitative questions, based on a mixture of closed and open-ended questions. The open ended provided elicitation of detail and personal opinion from the respondents about climate change impacts and adaptation.

4.2.1.1 Sample Size

The questionnaire survey was divided in two distinct parts; the first part included questionnaires to get data about general public perceptions about climate change. This part of the survey was conducted in the whole district Swat using multistage cluster sampling technique. In order to ensure the validity of the findings, proper sample size was selected from the study. District Swat consists of nice sub-districts (known as *tehsils*). After wards, each sub-district was divided in to clusters (*union councils*) based on population. Using random number generation technique, clusters from each zone were selected for sampling. In order to get greater accuracy in our results, sample size was selected using 95% confidence level and 3% confidence interval. The total sample size against the total population was calculated as 1066, which was then proportionally allocated to union councils by using the proportional allocation sampling method

(Sekaran, 2003; Bowley, 1925). The sample size was calculated using the following formula;

$$ss = \frac{Z^2 * (p) * (1 - p)}{C^2}$$

Where:

Z = Z value (e.g. 1.96 for 95% confidence level)

p = percentage picking a choice, expressed as decimal
(.5 used for sample size needed)

c = confidence interval, expressed as decimal
(e.g., .04 = ± 4)

The detailed calculation of the sampling size for the survey on public perceptions of climate change can be found in Table 4.1. The extent of the study area for the questionnaire survey about public perception about climate change in District Swat is depicted in figure 3.1.

The second part of the questionnaire survey included questionnaires from the various livelihoods sources i.e. Agriculture/Horticulture, Tourism. Among the above surveyed respondents sample size for agriculture, tourism and fishery based livelihoods were purposively selected. The total sample against agriculture was selected 333, tourism as 172 and fisheries as 71. The respondents selected during the survey were the locals attached with these the livelihood sources.

4.2.1.2 Pre-Testing of Questionnaires

In order to get the desired results, pre-testing of the questionnaires was carried out (Grimm, 2010). The researcher went in to the field to know the ground realities and get acquainted with the environment. The pre-testing was carried out in May 2015 while the actual survey was conducted and completed in 9 months from September 2015 to May 2016. The pre-testing was helpful in determining the key aspects of the research according to the vulnerabilities to the major livelihood sources in the district. Moreover, it helped in targeting the main indicators that were included in the main survey later. The pre-testing was also helpful in pointing out the shortcomings in the questionnaire, phasing out the un-necessary information and adding the useful and needed questions to get genuine and illustrative data from the respondents.

Table 4. 1: Sample size for the Questionnaire Survey of the Public Perceptions of Climate Change in District Swat

S.No	Tehsils	Clusters (Union Councils)	Population	Sample Size
1	Barikot	Ghaligay	45,250	55
		Shamozai	45,422	55
		Islampur	41,418	50
2	Babuzai	Udigram	34,267	41
		Rahim Abad	33,338	40
		Manglawar	34,968	42
3	Kabal	Bara Banda	42,122	51
		Totanu Banda	24,055	29
		Kala Kalay	44,187	53
		Dewlai	32,546	39
4	Charbagh	Kishawara	30,965	37
		Charbagh	42,000	51
5	Matta Sabujni	Shawar	35,328	43
		Bara Thana	34,642	42
		Gowalairaj	35,896	43
6	Khwazakhela	Miandam	28,682	35
		Khwazakhela	42,958	52
		Fatehpur	40,465	49
7	Bahrain	Bahrain	32,792	40
		Mankyal	21,810	26
8	Mata Khararai	Chuprial	41,149	50
		Asharay	25,078	30
		Sakhra	38,750	47
9	Kalam	Kalam	36,625	44
		Utror	17,743	21
			882,456	1,066

(Source: GoP, 1999)

4.2.1.3 Questionnaire Distribution

Due to the low literacy rate in the study area, the questionnaires were filled using face to face interviews from the respondents. The intention was to ensure that each one of the questionnaire is filled and recorded properly. The key terms related to climate change and all the other variables were explained to the respondents in the native language (Pashto) to get hold of the idea, and what it meant in simpler words for them.

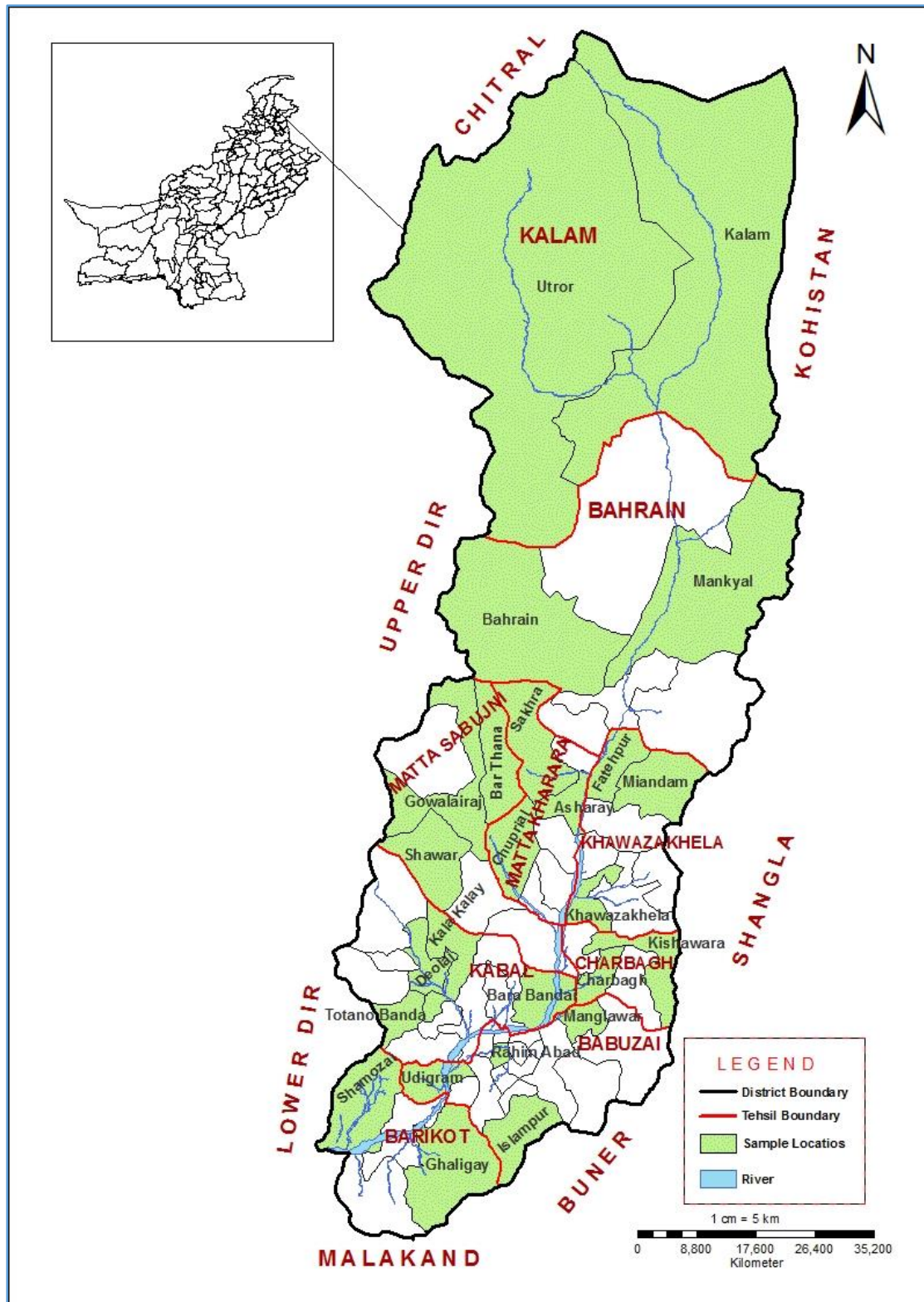


Figure 4. 2: Map showing the Selected Union Councils for the Public Perceptions Survey in the Study Area.

The questionnaire was filled by the researcher and two trained research assistants. As the major part of the study is based on the public understanding of the public, it was

attempted that the questionnaire should be filled from household heads and old age respondents. Old age respondents carried more knowledge about the area the changing patterns of climate. Due to this reason the survey didn't included age groups less than 20 years. Some of the questions required more age to get a better response to an issue, therefore old age respondents were targeted by the researcher.

4.2.2 Focused Group Discussions (FGDs)

Focused group discussions was conducted with the community to gather collective wisdom from the community about climate change. A total of 25 FGDs were conducted during the study. The topics covered during these FGDs were general changes in the climatic variables, observations of the respondents about these changes and the impacts of these changes on their livelihoods sources and general well-being.

4.2.3 Interviews

In order to find the social processes and insight in the people lives, oral interviews were conducted during the research study. The interviews included interviews from key informants and experts. A total of 100 interviews were conducted from the key informants in the study area. The interviews were semi-structured to allow the respondents to express their knowledge and experiences in the local language. The interview covered some of the following topics:

- Understanding about climate change
- Changes in the state of climate e.g. rainfall, temperature over the past years
- Major climatic events/hazards in the past and related impacts on the community
- Adaptation measures taken
- Barriers in adaptation

Moreover, the respondents were asked about the climate change vulnerabilities to their specific livelihood sources i.e. agriculture, fisheries and tourism and coping mechanism against the vulnerabilities.

4.2.4 Vulnerability Matrix

To get the community scale information regarding the climate change vulnerability assessment (VA) was used. Vulnerability assessment fall under the participatory rural appraisal (PRA) techniques. Climate vulnerability and capacity analysis (CVCA) was

used for vulnerability assessment in the area. The methodology is developed by CARE International (Daze et al., 2009). The methodology is helpful in the assessment of climate change impacts on people's livelihoods and their coping strategies.

Vulnerability matrix was used to determine the greatest hazards to the major livelihoods sources in the community and identify the coping strategies used to address the identified hazards. In order to do so, a group of 6 to 8 people were gathered and a matrix was prepared using chart paper. The group was then asked about their important livelihood sources and the related major hazards to their livelihoods. The group was then asked to agree upon a scoring system for the hazards against the livelihood sources with identification of significant, medium, low and no hazard. The score decided for the identified hazards was as; 3, 2, 1 and 0 for significant, medium, low and no impact on resources respectively. The group was then asked to decide with mutual consensus on the degree of impact that each of the hazards has on each of the livelihood resources. After the matrix completion the group members were asked to further expedite the impacts of climate induced hazards and the coping strategies to these environmental stresses.

4.3 Data Analysis

4.3.1 Quantitative Data

The basic tool used for the quantitative data collection was structured questionnaire. The questionnaire data included structured responses although a few of the questions were kept open. The qualitative and qualitative responses were input in SPSS version 20. The questionnaires were manually input by the researcher himself to keep the consistency intact. A great care was taken in the data input using encoding of the variables. The variables were encoded properly as follows;

- As a limitation of the study, all the respondents of the study were male due to some societal constraints. The gender was assigned Values 0,1 for Female and Male respectively.
- Age of the respondents were divided in to four groups (21-30, 31-40, 41-50 and 51 or Above) and coded as 1, 2, 3, and 4 respectively.

- Most of the questions in the questionnaire survey contained multiple responses, therefore every category in the question was termed as individual variable and were coded as dichotomous (0,1).
- Income level of the respondents is shown by recoding the income per month in PKR to income groups i.e. Very Low Income (up to 10000), Low Income (10001-20000), Middle Income (20001-30000), High Income (30001-40000) and Very High Income (40001-50000).

4.3.2 Qualitative Data

The Qualitative data in the research study included the data from key informant interviews, focused group discussions and interviews for expert opinions. The qualitative data was input and processed using SPSS 20 and Microsoft Excel in the form of illustrations while explanatory responses from the interviews are shown in boxes throughout the results chapters. The recommendations from the interviews for expert opinions is given in policy recommendations of results chapter.

4.3.3 Statistical Analysis

The questionnaire survey results were analyzed using descriptive statistical tools such as percentages, mean and standard deviation. The descriptive statistics are illustrated in the form of tables and graphs.

4.3.3.1 Trend analysis

Trend analysis was carried out for 31-years temperature and rainfall data acquired from Pakistan meteorological department (PMD) using the inbuilt linear regression feature of MS Excel 2016. The annual mean maximum, minimum and mean temperatures as well as mean annual and mean seasonal rainfall was analyzed and their trends was studied (Salma, 2011). The linear trend between the time series data for the whole 31-years' time period was calculated using the following equation;

$$y = a + bt$$

Where,

y = temperature/rainfall

t = time (year)

a and b are constants (estimated by the least square principle)

The above method was helpful in visualizing the per year variation in temperature and rainfall. Moreover, the decadal variation in temperature and rainfall was calculated by dividing the data in to three decades and comparing their means.

The rainfall data was analyzed for mean annual (January to December) and four seasons as shown by Nayava (1980). The four seasons are given as winter (December to February), pre-monsoon (March to May), Monsoon (July to September) and post-monsoon (October to November)

4.3.3.2 Chi-square analysis

Responses from respondents with different climate characteristics (observations, experiences, beliefs, understanding, knowledge of climate change) and demographic variables (Age, Education, and Income etc.) were compared for significant differences using the Chi-Square test. The strength of the relationship is determined using Cramer's V statistic. For simplicity and easy the abbreviation *, **, *** have been used throughout the chapter to indicate where the differences are significant at 0.05, 0.01 and 0.001 levels, respectively.

4.3.3.3 Calculation of Severity Scores for Natural Hazards

In order to rank the natural hazards such as floods, droughts, hear waves etc., Likert scale questions (based on 5-point scale from Not Severe to Very Severe with 1 = Not Severe, 2 = Least Severe, 3 = Moderate Severe, 4 = Severe, 5 = Very Severe) was used. The mean severity score was calculated using "Mean" function of SPSS for all the observed values. The hazards with highest mean score was ranked first and vice versa.

4.4 Uncertainty and Limitation of the Data

District Swat is mountainous area and the climate conditions of the area are largely affected by the topography. In order to get the whole picture of the area, meteorological data at multiple sites are required to reflect variations according to the variations of the topography. But due to the lack of met observatories in the area, therefore climatic data of only one station is used for temperature and rainfall trend analysis.

A large sample size (1066) was selected for the Structured Questionnaire Survey, so that a composite response is obtained from the respondents but due to low climate information/awareness and poor data communication in the area, information provided by some households may not represent all the climatic factors required for this research. Therefore, this is a possibility that some of the cases, could have been biased.

Due to the lack of time and resources, only 25 FDGs were considered during the study.

CHAPTER V

RESULTS AND DISCUSSION (PART-I)

PUBLIC UNDERSTANDING AND BELIEFS ABOUT CLIMATE CHANGE

This part of the chapter discusses in detail the general public perceptions about climate change, their understanding about the observed changes in the weather pattern and the different factors that controls the belief system about climate system. This section is based on objectives 1 & 3 of the study, so quite an endeavor is put to clearly demonstrate the results of the study. Moreover, descriptive statistics of the results of this is based on the questionnaire survey entailing “Public Perceptions about Climate Change” in the study are.

5.1 Trend analysis of temperature and rainfall data

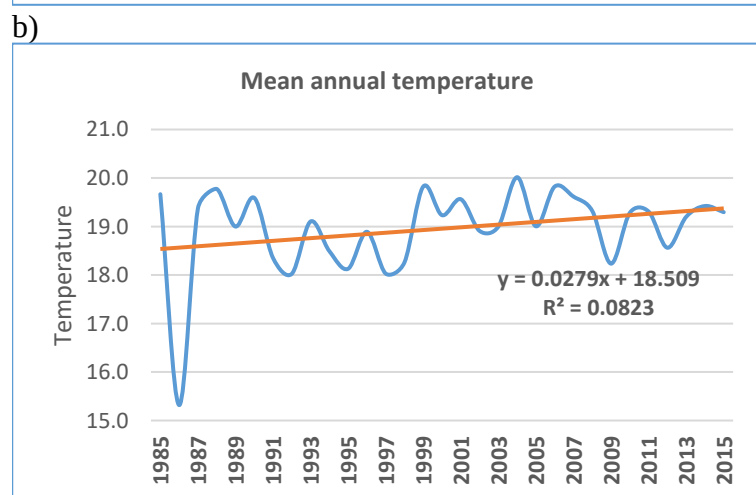
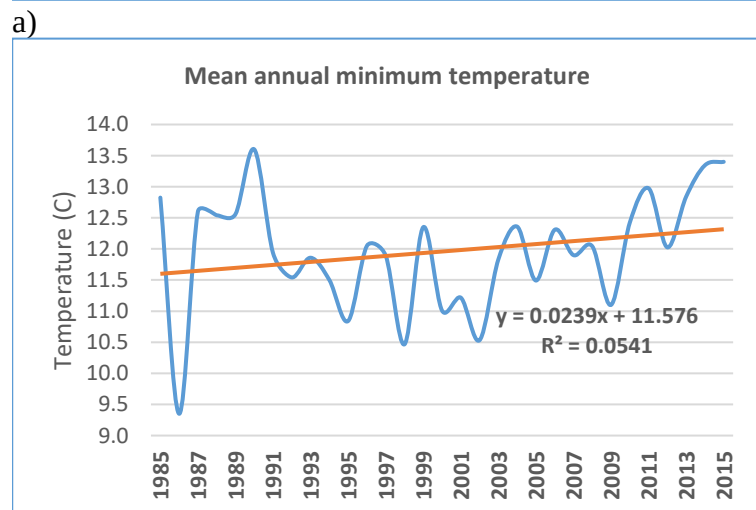
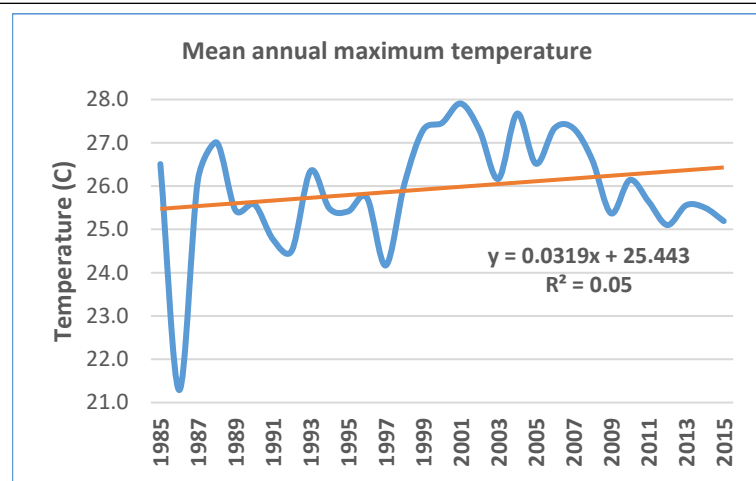
5.1.1 Increase in Temperature

The trend analysis of 31-years temperature data (1985-2015) revealed an overall increase in temperature of the area. The linear trend line for the mean annual maximum temperature indicated an increasing trend of 0.0319 °C per year ($y = 0.0319x + 25.433$, $R^2 = 0.05$) while the mean annual minimum temperature showed an increasing trend of 0.0239 °C per year ($y = 0.0239x + 11.576$, $R^2 = 0.0541$). likewise, the mean annual mean temperature showed an increase of .0279°C per year ($y = 0.0279x + 18.509$, $R^2 = 0.0823$) for 31-years period. The lowest and highest mean annual temperature were recorded in 1986 and 2004 as 15.32 °C and 20.02 °C respectively.

The months of March and October show an overwhelming increasing trend for mean maximum temperature of .0979 °C per year ($y = 0.0979x + 19.282$, $R^2 = 0.1129$) and .0578 °C per year ($y = 0.0578x + 26.949$, $R^2 = 0.0895$) respectively. On the contrary April and March shows an increasing trend of .0518 °C per year ($y = 0.0518x + 11.291$, $R^2 = 0.1771$) and .0469 °C per year ($y = 0.0469x + 7.1535$, $R^2 = 0.0878$) respectively for mean minimum temperature. Similar increase for the month of march has been reported for 37 meteorological stations in Pakistan by another study by Iqbal et al., 2016.

The highest maximum temperature was recorded as 27.91 °C in 2001 while the lowest minimum temperature was recorded as 9.35 °C in 1986. The overall temperature increase is evident in the maximum temperature compared to mean and minimum temperature. Figure 1a shows the temperature trends at Saidu Sharif meteorological station that represents the study area.

The decadal variation of the temperature data also shows an increasing trend in maximum, minimum and mean annual temperature with more pronounced changes in the mean minimum and mean annual temperatures (Table 5.1). The minimum temperature in the last decade (2006-2015) is increased by 0.51 °C compared to 1985-1995 while the mean annual temperature is increased by 0.59 °C compared to 1985-



c)

Figure 5. 1: Trend Line and Linear Regression Analysis for a) Mean Annual Maximum, b) Mean Annual Minimum and c) Mean Annual Temperature for 31-Year Dataset

1995. The mean maximum temperature shows an increase of 0.66 °C between the two decades.

The above results suggest that temperature of the study area has increased and the effects of the increased activity have manifested in the climate system of the area in the form of natural hazards and extreme weather events.

Table 5. 1: Variation of Mean Annual Maximum, Minimum and Mean Temperature in the Last 31 years (1985-2015)

Year	N	Mean min temperature (°C)	Mean max temperature (°C)	Mean annual temperature (°C)
1985-1995	10	11.9	25.3	18.6
1996-2005	10	11.5	26.6	19.1
2006-2015	10	12.4	26.0	19.2

Source: Pakistan meteorological department, GoP

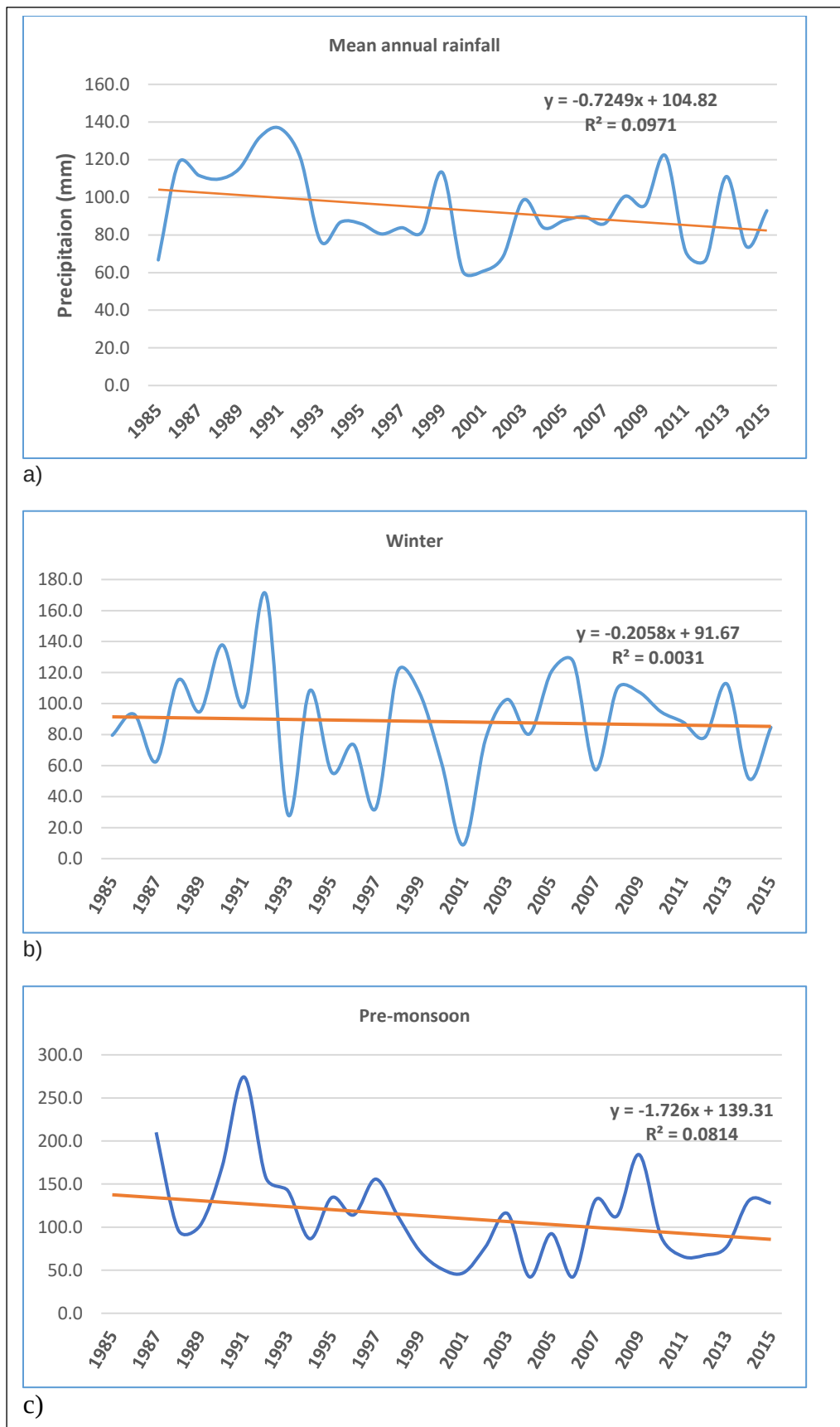
5.1.2 Decrease in Rainfall

The statistical analysis of 31 years' rainfall data (1985-2015) revealed a noticeable variation in the precipitation pattern. The linear trend line for the mean annual precipitation indicated a decreasing trend of -0.7249 mm per year ($y = -0.7249x + 104.82$, $R^2 = .0971$) while winter ($y = -0.2058x + 91.67$, $R^2 = 0.0031$), pre-monsoon ($y = -1.726x + 139.31$, $R^2 = 0.0814$), monsoon ($y = -0.2557x + 112.83$, $R^2 = 0.0035$) and post-monsoon ($y = -0.4398x + 48.084$, $R^2 = 0.0252$) all showed a gradual decrease in mean precipitation. The highest decrease was noted in the post monsoon period with the trend line showing a decrease of -1.726 mm/year for the 31 years' data.

The 31-years rainfall data shows that maximum precipitation event was recorded as 136.7 mm in 1991 (wettest year or with more rainfall) while the minimum precipitation was recorded as 60.9 mm (drought prone or driest year) in 2000. The highest monsoon precipitation (226.5) occurred in 2010 which resulted in massive flooding event in the valley (Atta-ur-rahman & Khan, 2011; ADB, 2010).

Table 5.2 shows the decadal variation in the precipitation. A general decreasing trend is observed for mean annual, winter, pre-monsoon, Monsoon and post-monsoon for the period of 1985-2015. A remarkable decreasing trend was found in post-monsoon rainfall. Average post-monsoon rainfall was found in decreasing trend from 48.4 mm

(1985-1995 decade) to 37.6 mm in the next decade (1996-2005) followed by 36.4 mm in the decade 2006 to 2015.



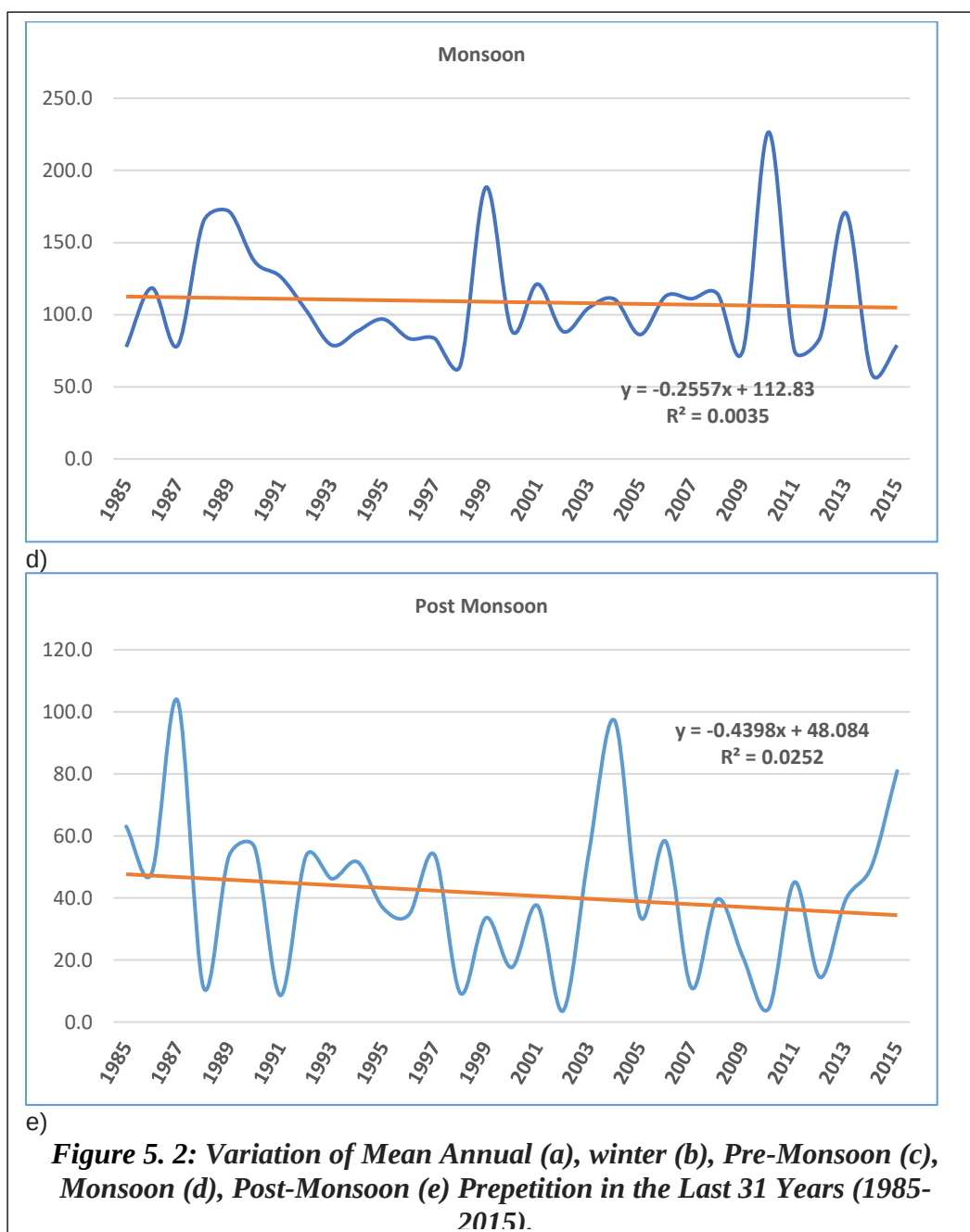


Table 5. 2: Change in Precipitation Pattern (mm) in the Last 31 Years (1985-2015)

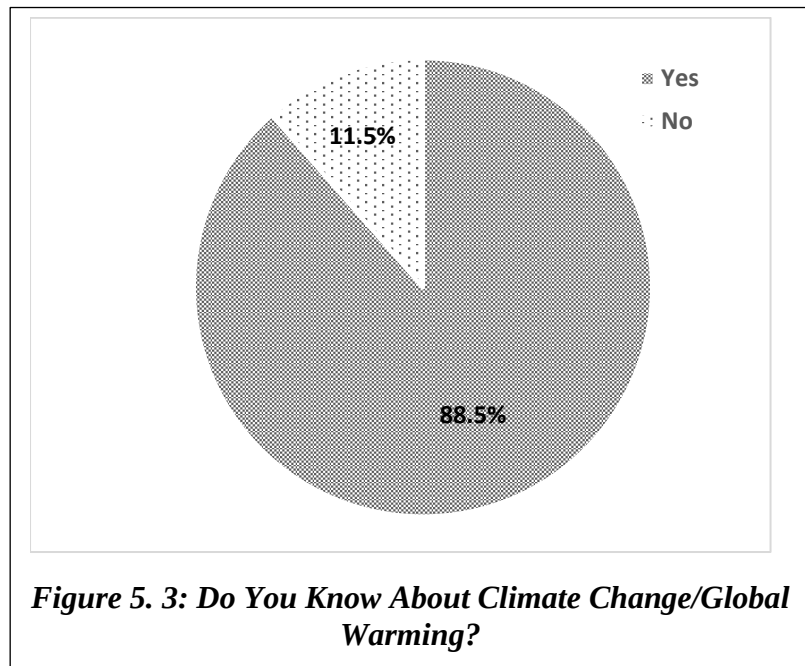
Source: Pakistan meteorological department, GoP

Year	Mean annual (Jan-December)	Mean Winter (Dec-Feb)	Mean Pre-Monsoon (March-May)	Mean Monsoon (June-Sep)	Mean Post Monsoon (Oct-Nov)
1985-1995	105.5	93.1	139.0	112.9	48.4
1996-2005	81.9	78.4	88.2	102.1	37.6
2006-2015	91.0	91.1	103.0	110.9	36.4

5.2 Climate Change knowledge

5.2.1 The Term “Climate change”

Figure 5.3 shows the respondents knowledge about climate change when asked whether they knew climate change. The majority (88.5%) of the respondents were affirmative about climate change while a minor (11.5%)



number of the respondents didn't know about the climate change. The specific terms “climate change” or “global warming” were new to some of the respondents but when it was explained in the native language and paraphrasing the term, they got hold of it. In fact, most of the respondents with no formal education knew the climate change in other varying terms. “Change in weather”, “increase in temperature”, “decrease in rainfall” instead of “climate change” seemed more convenient to the respondents. The study revealed that almost all the respondents have observed climate change one way or the other but they could not name it properly or scientifically. Results of the similar nature has been produced by other studies in Bangladesh (Kabir et al., 2016), China (Yu et al., 2013) and USA (Liu et al., 2014).

Public understanding encapsulates broadly “in terms of people’s knowledge, attitudes, beliefs and level of concern in relation to climate change” (Whitwash, 2005). The respondents explained climate change based on their own experiences and observations of the changes in weather patterns since their childhood. Qualitative analysis from interview and FGDs revealed that most of the respondents attributed climate change with the changes in weather pattern. According to the respondents the weather changes

include increase in temperature, increased summers, reduced winters, more floods, droughts and more health problems. Some of the excerpts from the interviews are given in Box 5.1.

Table 5.3 elaborates the results of the 2nd question asked from the respondents as how they recognize climate change. The question was asked using various

precursors or indicators of climate change. The question contained multiple responses so more than one answer was observed. The categories with less than 20 responses have been excluded from the statistical analysis.

The results of the individual component of the table are discussed in the following text.

5.2.2 Increase in Temperature

Majority of the respondents have chosen increase in temperature (73.6% of the respondents) as major recognizing effect of climate change/global warming. The temperature increase is always

evident in the recognition factors of climate change, and directly effects the people so therefore it could be observed directly. Statistical analysis of the results indicates that significantly more respondents aged 51 or above (78.7 %**) have experienced increase in temperature compared to other age groups.

Box 5.1: Public Knowledge About Climate Change

“Weather has been changed. Ten years ago, we used to experience cold till the month of May but now we observe warm weather in April. In the past we used to have cold season after August but now we cannot see any change in the summers till September and October. The weather is changed now”.

Another respondent stated that;
“There were no floods before. When it rained before it wasn’t damaging. We now experience extreme rainfall with storms which sometimes causes floods”.

A respondent from Kalam stated that;
“Weather was very cold before. Snowfall was much more in the past. Summers have gotten worse now. The weather is changed now”.

Box 5.2: Public Views about Climate Change

“The temperature is quite increased in district Swat and now there is no difference between the (temperature of) Swat and plain areas in the southern side anymore”.

Table 5. 3: Descriptive Statistics and Chi-square Analysis of Public Understandings About Recognizing Climate Change in the Study Area

Recognition of CC	Total	Increase in Temperature (%)	Erratic rainfall (%)	Extreme Weather Events (%)	Changes in Bio-diversity (%)	Melting of Ice-caps/ Glaciers (%)	Other (%)
Responses (N)	2380	763	572	532	356	146	11
Responses (%)	100	32.1	24.0	22.4	15.0	6.1	.4
Cases (%)	229.7	73.6	55.2	51.4	34.4	14.1	1.1
Tehsils (Sig.)		.000	.000	.000	.000	0.00	
Cramer's V		.203	.209	.223	.283	.451	
Barikot	-	62.3	49.1	34.6	25.8	5.7	-
Babuzai	-	67.5	55.3	51.2	40.7	1.6	-
Kabal	-	62.6	62.0	53.2	50.9	5.8	-
Charbagh	-	73.0	48.3	52.8	33.7	16.9	-
Matta Sabujni	-	78.0	38.6	58.3	20.5	11.8	-
Khwazakhela	-	78.6	65.6	59.5	38.2	15.3	-
Bahrain	-	90.8	33.8	36.9	15.4	50.8	-
Matta Khararai	-	72.7	66.9	66.1	47.9	4.1	-
Kalam	-	89.6	58.2	29.9	6.0	55.2	-
Age Groups (Sig.)		.003	.968	.004	.461	.001	
(Cramer's V)		.114	.016	.113	.049	.125	
21-30	-	64.6	52.9	53.4	35.9	7.8	-
31-40	-	70.3	55.1	43.0	35.6	12.3	-
41-50	-	76.9	54.5	54.1	32.8	20.0	-
51 or above	-	78.7	54.1	56.8	29.5	14.2	-
Education (Sig.)		.609	.004	.071	.001	.000	
(Cramer's V)		.058	.128	.098	.142	.181	
Primary/Middle	-	70.3	50.2	46.0	33.9	12.1	-
Matric/O-Level	-	77.1	41.4	52.1	32.1	10.7	-
FSc/A-Level	-	66.0	54.7	54.7	35.8	9.4	-
BA/BSc	-	74.1	51.9	70.4	59.3	37.0	-
MSc/BSc(Hons.) / Postgraduate	-	66.7	50.0	72.2	72.2	50.0	-
No Education	-	72.9	59.4	50.0	31.6	13.5	-
Income (Sig.)		.081	.085	.100	.005	.000	
(Cramer's V)		.089	.088	.086	.119	.142	
Very Low Income	-	75.4	52.9	45.5	30.4	20.9	-
Low Income	-	76.3	54.8	46.4	27.4	15.6	-
Middle Income	-	70.8	47.2	55.6	35.2	14.8	-
High Income	-	69.5	59.9	54.5	38.5	5.3	-
Very High Income	-	64.6	59.2	53.1	43.8	10.8	-

The interview results can be attributed to questionnaire survey results about increase in temperature. Most of the respondents from the interview data are of the opinion that mean annual temperature and seasonal temperatures have changed. As a result, the summers have gotten warmer and winters less cold compared to the past 10-30 years ago. Box 5.2 states a respondent view from interview results. The analysis of historical data points out increasing trend in mean annual, mean annual maximum and mean annual minimum temperatures as discussed in section 5.1. The previous studies conducted show that temperature has shown an increasing trend in the past decades in Pakistan and will continue to rise in the future. Gadiwala and Burke (2013) observed an overall increasing trend of 0.66 °C for a period of 1961 to 2010 while the study conducted by Salma et al., (2010) reveal a positive trend in the mean (0.11 C/decade), minimum (0.1 C/decade and maximum temperature (0.12 C/decade) in whole Pakistan. The increase in temperature is still low from the global average but it is speculated that the situation will get worse in the future with climate change induced hazards are knocking on the door.

Ahmad et al., (2013) reported significant decadal variability of temperature in different parts of Pakistan by analyzing the month of march from 1950s to 2000s. The decade of 2000 was termed with the highest temperature anomalies, indicative of temperature above average and in agreement with global warming. Considerable warming was observed in the Karakoram-Himalayan regions followed by Hindu Kush region. Among the other areas in Punjab and Balochistan, Chitral and Swat in Khyber Pakhtunkhwa were the leading spots (Ahmad et al., 2013). A study conducted in Kalam valley of district Swat reveals a temperature increase of 0.9 °C with 0.4 °C increase in maximum temperature and 0.5 °C in minimum temperature (Khan & Mahmood-ul-Hasan, 2016). The available literature is in line with the survey results; the increase in temperature is responsible for climate change in the area and various climate induced hazards.

According to World Bank report the mean temperature has increased by 0.6 °C in the last century over the whole country. The future projections from the GCM outputs shows increase in temperature, close to 3 °C in the worst case scenario by 2050s. Temperature increases are estimated for both summer and winter, which are higher in northern Pakistan compared to southern Pakistan. However, the increase in temperature would be on average higher in winter compared to summer season (Yu et al., 2013).

5.2.3 Erratic Rainfall

The survey results show that about 55.2% of the respondents recognize climate change with changes in rainfall pattern or erratic rainfalls. Like temperature increase, change in rainfall pattern can easily be observed from personal observations, especially those areas where geography and livelihoods are dependent on rainfall distribution throughout the year. The results indicate that significantly more respondents with no formal education (59.4 %**) have selected change in rainfall pattern. The reason could be that those respondents can be dependent on rainfall based livelihoods (e.g. farmers etc.). There is no significant ($p > .05$) association between age (Cramer's $V = .016$) and income groups (Cramer's $V = .088$) for the changes in rainfall pattern while the sub-districts show a strong association (Cramer's $V = .209$, $p < .001$). significantly more respondents belonging to Matta Khararai (66.9%***) have reported changes in rainfall.

The interviews data also show that rainfall pattern is changed compared to the past accordingly. Box 5.3 states a respondent view from interview results.

Box 5.3: Public Views about Climate Change

“I have experienced change in change in rainfall pattern in both the summer and winter season. In winters we had rainfall spells that lasted more than a week or two but now these spells have receded, limiting to 2 or 3 days only. Similarly, the monsoons in summers have changed”.

The change in rainfall pattern from the survey results correspond with the empirical data analysis of meteorological data given in section 5.1. The 31-year historical data for the study area shows a decline in the mean annual rainfall and for all the seasons in the study area. A decrease of -2.8 mm precipitation has been observed in district Swat (Khan & Mahmood-ul-Hasan, 2016). The annual trend of precipitation shows a decline since 2010. The winter season marks a serious decline in rainfall while summers shows an increase in precipitation during monsoon and pre monsoon seasons (Khan & Mahmood-ul-Hasan, 2016).

Naheed & Rasul (2011) investigated the rainfall variability for Pakistan in terms of variability coefficient (V.C) based on 50-year precipitation data. They reported that V.C values for Hindukush region (where the study areas lies) shows a variation in the decadal trends with the decreasing trend in seventies to eighties while a gradual increase in the succeeding decades. According to The world bank there is an increase of 25% in

total precipitation around Pakistan over the past century, while precipitation pattern in the provinces are less clear. (Yu et al., 2013).

5.2.4 Extreme weather events

The survey results show that 51.4% respondents have chosen increase in extreme weather conditions as the recognition factor of climate change. Chi-square analysis indicated that significantly more respondents aged 51 or above (56.8 %, $p < .01$) have chosen increase in extreme weather events. This question was also asked from the experts and their reply was in support of questionnaire survey. the study area is experiencing an emerging number of extreme weather events such as floods, droughts, extreme heat etc.

Extreme weather events include spells of very high temperature, torrential rains, and droughts. Under an enhanced greenhouse effect, change can occur in both mean climate parameters and the frequency of extreme meteorological events (Rosenzweig et al., 2000). Weather and climatic extremes can have serious and damaging effects on human society and infrastructure as well as on ecosystems and wildlife (Meehl et al., 2000). Developing countries are vulnerable to extremes of normal climatic variability which causes substantial economic damage, and climate change is likely to increase the frequency and magnitude of some extreme weather events and disasters (Mirza, 2003). Due to temperature increase and variability in the rainfall patterns, extreme weather events are resulting in various kinds of weather related hazards. The country has to combat the extreme weather conditions including water shortage by improving water infrastructure, river water flows and adapting water conservation techniques in order to manage food and water supply demands (Salma et al., 2010; Gadiwala & Burke, 2013).

5.2.5 Changes in biodiversity

As much as 34.4% of the respondents viewed changes in biodiversity as the recognition factor of climate change. Chi-square analysis of the results show that significantly more respondents with Masters/PG (72.2 %, $p < .001$) education have selected changes in biodiversity. Significantly more respondents with very high income (43.8 %, $p < .05$) have selected changes in biodiversity which shows their concern about the phenomena. Due to warmer climate and change in precipitation regime in this century, many plants

and animals are going to affect, and may go extent (Araujo & Rahbek, 2006; Willis & Bhagwat, 2009).

Pakistan is marked for harboring some of the world's rarest animals and plants but due to overuse and loss of natural habitat, these are now in danger. Processes such as overgrazing, deforestation, salinity, soil erosion and water logging are biggest threats to the remaining biodiversity of Pakistan. In recognition to the importance of these issues, the government of Pakistan prepared the National Conservation Strategy (NCS) in 1992 and became part of the Convention on Biological Diversity(CBD) in 1994. As a required of the CBD, a Biodiversity Action Plan (BAP) was prepared in 1999 which was approved by the Pakistan Environmental Protection Council in 2000. A review of the BAP 2000 was carried out in 2014 and a draft Pakistan's National Biodiversity Strategy and Action Plan (NBSAP) was prepared in 2015 (GoP, 1999; GoP, 2015c).

The study area being part of the Hindukush-Himalayan region offers a wide range of biodiversity and is subject to the influence of various kind of disturbances including natural as well anthropogenic i.e. soil erosion, landslides, earthquakes, over grazing, deforestation, loping of tree branches, forest fires etc. (Ali et al., 2016). According to Ahmad et al., (2015), the natural biodiversity of Swat is diminishing. The effects of climate change on various trees species, NTFPs (non-timber forest products) and MAPs (medicinal and aromatic plants) in the region have been widely studied (Sherazi et al., 2010; Ali et al., 2014a; Ali et al., 2014b, Ali, 2015). The future projections using HADCM3 (Hadley Centre Coupled Model, version 3) model show that by the year 2080 some of the important tree species (*Abies pindrow*, *Acacia modesta*, *Taxus baccata* and *Pinus Wallichiana*) will show significant change in the distribution and density. Some of the afore-mentioned species will have increased density while others would be narrowed to small sub-climatic regions. Furthermore, all the species would move to higher altitudes towards the cooler climatic regions of the Hindu Kush (Ali, 2015). The over exploitation and over grazing by the local communities are threatening some the important plant species in the study area, and needs conservation (Sher et al., 2010; Khan et al., 2015b; Ali et al., 2015).

Table 5.4 shows some of the important threatened species in the study area. The conservation status of these species were conducted using IUCN categories and criteria (Hamayun et al., 2006; Shah & Hussain, 2012; Majid et al., 2015).

Table 5. 4: Natural and Anthropogenic Threats to Commercially Important Forest Flora in the Study Area

No	Species	Reference	Status	Threat	Sampled Locations
1	<i>Olea ferruginea</i>	Shah & Hussain, 2012; Khan et al., 2015b; Khan et al., 2015c	Endangered	Exploitation by the local population, cutting	Swat, Dir lower and Dir upper
2	<i>Abies pindrow</i>	Shah & Hussain, 2012; Ali et al., 2014; Ali, 2015	Endangered	Extinction due to climate change; changes in density and distribution	District Swat, Shangla District
3	<i>Acacia modesta</i>	Shah & Hussain, 2012; Ali, 2015	Endangered	Extinction due to climate change; changes in density and distribution	District Swat, Shangla District
4	<i>Taxus baccata</i>	Ali, 2015		Extinction due to climate change; changes in density and distribution	District Swat
5	<i>Pinus roxburghii</i>	Shah & Hussain, 2012;	Endangered	Over Exploitation	Shangla District
6	<i>Pinus Wallichiana</i>	Shah & Hussain, 2012; Ali, 2015	Endangered	Extinction due to climate change; changes in density and distribution	District Swat, Shangla District
7	<i>Berberis lyceum,</i>	Shah & Hussain, 2012;Khan et al., 2015c; Jabeen et al., 2015	Endangered	Over grazing, excessive fuel consumption, deforestation, burnt due to local conflicts, terrace farming	TEHSIL BARAWAL UPPER DIR, District Shangla
8	<i>Myrtis communis</i>	Shah & Hussain, 2012; Khan et al., 2015c	Vulnerable	Over grazing, excessive fuel consumption, deforestation, burnt due to local conflicts, terrace farming	TEHSIL BARAWAL UPPER DIR, District Shangla
9	<i>Rheum emodi</i>	Khan et al., 2015c		Over grazing, excessive fuel consumption, deforestation, burnt due to local conflicts, terrace farming	TEHSIL BARAWAL, UPPER DIR
10	<i>Bistorta amplexicaulis</i>	Adnan et al., 2015; Hamayun et al., 2006	Endangered	Over exploitation and overgrazing from natives and nomads	Miandam Valley, District Swat
11	<i>Berginia ciliata</i>	Shah & Hussain, 2012;Adnan et al., 2015; Hamayun et al., 2006	Endangered	Over exploitation and overgrazing from natives and nomads	Miandam Valley, District Swat, District Shangla

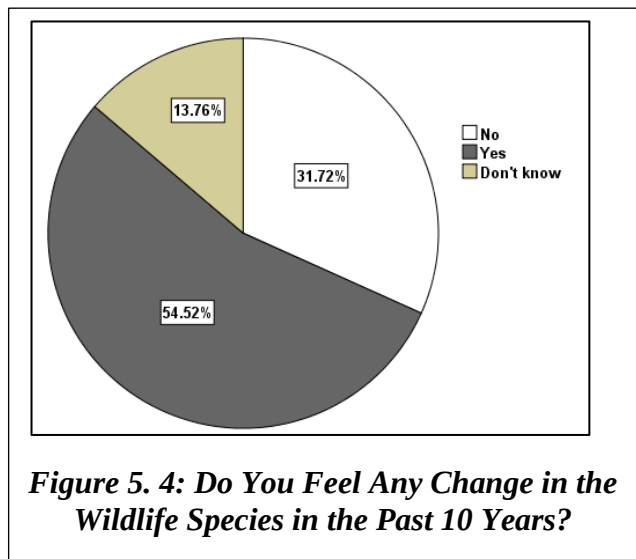
12	<i>Valeriana jatamansi</i>	Shah & Hussain, 2012; Adnan et al., 2015; Hamayun et al., 2006	Vulnerable	Endangered, Over exploitation and overgrazing from natives and nomads	Miandam Valley, District Swat, District Shangla
13	<i>Viola canescens</i>	Masood et al., 2014; Adnan et al., 2015; Hamayun et al., 2006	Rare	Over exploitation and overgrazing from natives and nomads	Miandam Valley, District Swat
14	<i>Poenia emodi</i>	Hamayun et al., 2006; Shah & Hussain, 2012; Adnan et al., 2015; Sher et al., 2010	Endangered	Over exploitation and overgrazing from natives and nomads	Miandam Valley, District Swat, District Shangla
15	<i>Podophyllum emodi</i>	Shah & Hussain., 2012; Adnan et al., 2015; Sher et al., 2010	Vulnerable	Over exploitation and overgrazing from natives and nomads	Miandam Valley, District Swat
16	<i>Meconopsis aculeata</i>	Majid et al., 2015	Endangered	Critically Endangered (CR), collection for medical purposes, snow avalanche, over grazing	Northern Pakistan
17	<i>Acorus calamus</i>	Hamayun et al., 2006	Endangered	Over Exploitation	District Swat
18	<i>Bunium persicum</i>	Hamayun et al., 2006	Rare	Over Exploitation	District Swat
19	<i>Berberis vulgaris</i>	Hamayun et al., 2006	Endangered	Over Exploitation	District Swat
20	<i>Dioscorea deltoidea</i>	Hamayun et al., 2006	Endangered	Over Exploitation	District Swat
21	<i>Morchella conica</i>	Hamayun et al., 2006	Rare	Over Exploitation	District Swat
22	<i>Morchella esculenta</i>	Hamayun et al., 2006; Shah & Hussain, 2012	Vulnerable	Over Exploitation	District Swat, Shangla District
23	<i>Mentha longifolia</i>	Hamayun et al., 2006	Rare	Over Exploitation	District Swat
24	<i>Polygonatum verticillatum</i>	Hamayun et al., 2006	Endangered	Over Exploitation	District Swat
25	<i>Plantago lanceolatum</i>	Hamayun et al., 2006	Rare	Over Exploitation	District Swat
26	<i>Podophyllum hexandrum</i>	Hamayun et al., 2006	Endangered	Over Exploitation	District Swat
27	<i>Viola biflora</i>	Hamayun et al., 2006	Vulnerable	Over Exploitation	District Swat, Shangla District

Source: Secondary Data (Studies conducted in the study area) 2016

The government of Khyber Pakhtunkhwa is specifically interested in the wellbeing of biodiversity in the province. Owing to that reason, the government has enacted “Khyber Pakhtunkhwa Wildlife and Biodiversity Act” in 2015 with the aim of protection, preservation, conservation and management of wildlife species in the province. The act has paved path for the protection of wildlife species by stopping the illegal hunting

through recognizing wildlife sanctuaries, national parks, wildlife refuges, biosphere reserves, national natural heritage site and site of special scientific interest etc. The site of special scientific interest could be declared by the government to mitigate the effects of climate change to protect flora and fauna species and related habitats or landscape having scientific importance (GoKP, 2015).

District Swat is also experiencing changes in wildlife. As shown in Figure 5.4. respondents were asked whether they have experienced any change in the wildlife species in the study area, about half (54.52%; less than half in actual results which includes missing values. See table 5.5 of the respondents stated that they have observed changes in the wildlife species. A small fraction of the respondents (13.76%) didn't know about the change in wildlife species. About 25.6% of the respondents skipped the question and chose not to answer the question.



The results indicate that most of the respondents having affirmative answer belong to age group 51 or above (72.9 %***) and middle income class (60.5 %*). Significantly more respondents with no formal education (62.6 %***) have observed change in wildlife species in the study area.

Table 5. 5: Public Observation About the Change in wildlife Species (Missing Values Included)

Changes in wildlife species	N	Total (%)	Valid Percent
No	249	23.6	31.7
Yes	428	40.6	54.5
Don't know	108	10.2	13.8
Total	785	74.4	
Missing	270	25.6	
Total	1055	100.0	100.0

The respondents who chose don't know for answer were most likely belong to age group 21 to 30 (28.9 %***) and Very Low Income class (21.3 %*). Significantly more respondents with primary education didn't knew about the change in wildlife species in District Swat. According to the interview data, the respondents reported that different species of birds and animals have completely disappeared or their population is decreased to minimum in the study area. The birds among these included different species of partridges, sparrows, chakor, wild hens, sparrows, Ducks, Koklas peasant, Swallows, woodpecker, Hawks etc. while the animals include Jackals, Rabbits, Monkeys, Wolf etc.

According to khan et al., (2010) that floods had affected a pheasantry maintained by KP wildlife department at Fiza Ghat Park near mingora city. The infrastructure was hugely damaged by the floods and the area was silted up. The damages included collapse of cages, brood rooms and severe damages to 22 bird cages. Some of the pheasants were rescued by the wildlife department officials while others were lost to the floods.

The IUCN Red list enlists 45 species of internationally threatened animals in Pakistan. Four of them are Critically Endangered (CR), twelve Endangered (EN) and twenty-nine are Vulnerable (VU). Out of these threatened species, 18 are animals, 9 reptiles, 17 birds and one fish (IUCN, 2016). According to Akhtar & Pathan (2013), hunting and habitat destruction due to deforestation and natural hazards are among the major threats to the wildlife in district Swat. The study area contains rich avian fauna due to thick flora. Most of the birds in the study area are migratory while a few are indigenous.

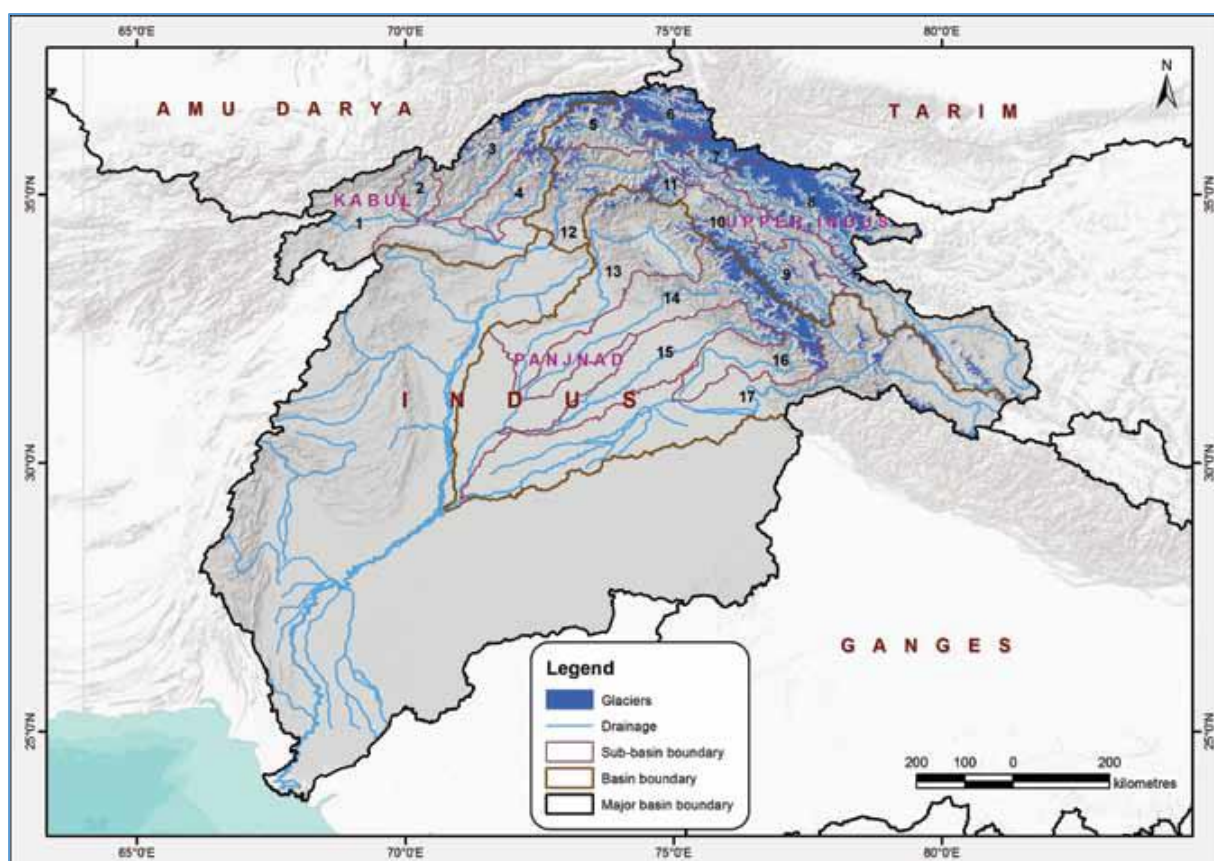
Falcons, swans, cranes, ducks, waders, flamingos and geese are important migratory birds while chukars, house sparrows, house crow, pheasants, bulbuls and mynas are among the indigenous or resident birds. The floods of 2010 affected the wildlife species to a greater extent by destroying their habitats in the province. The floods swept away all the birds and animals, including 24 black bears in the Kund Park in Khyber Pakhtunkhwa along the River Kabul (Panhwar, 2011).

5.2.6 Melting of Ice-caps or Glaciers

A considerable number of respondents (14.1%) have selected melting of ice-caps or glaciers as their way of recognizing climate change. The melting of glaciers has been reported in the upper parts of District Swat Such as Kalam, Utror etc because most of the glaciers of the district are found in these upper reaches of study area. The respondents of these UCs recorded retreat in the glaciers as they have experienced in their respective areas. Chi-square analysis shows that significantly more respondents aged 41 to 50 (20 %***) have selected melting of glacier. More respondents with Master/PG education (50 %***) and very low income (20.9 %***) have selected melting if ice-caps or glaciers.

The above results reveal that demographic features such as age, educational qualification and monthly income are significantly related to the knowledge and public understandings about climate change. People with high age and high education tends to have more knowledge about climate change as also studied by Witwash, 2005; Kabir et al., 2016 in other parts of the world. The glaciers of district Swat are vulnerable due to increase of temperature in the region (Khan & Mahmood-Ul-Hasan, 2016) as the snow-covered areas of the study area is decreasing acquiring immediate attention.

The glaciers of the district Swat are part of Hindu Kush Himalayan glaciers (Bajracharya & Shrestha, 2011) and a topic of heated debate due to the rapid melting and retreat (Bajracharya et al., 2015). Remote sensing based assessment reveal changes in the extent of these glaciers, highly diverse but irrefutable impacts of climate change (Bajracharya et al., 2015). The Hindu Kush Himalayan (HKH) region is the freshwater tower of South Asia. The glaciers and snow melt water plays an important role in the water supply for the rivers downstream, particularly the large irrigation system widely depend on these upstream resources. Therefore, changes in these resources have major impact on timing and quantity of water availability in the region (Rabatel et al., 2013).



Source: Bajracharya & Shrestha, 2011: ICIMOD

Kabul basin Upper	Indus basin*	Panjnad basin*
1. Panjsher-Ghorband	5. Gilgit	9. Zaskar
2. Alingar-Alishing-Nuristan	6. Hunza	10. Shingo
3. Kunar	7. Shigar	11. Astor
4. Swat	8. Shyok*	12. Upper Indus*
		13. Jhelum
		14. Chenab
		15. Ravi
		16. Beas
		17. Sutlej*

*drainage catchment partly in China

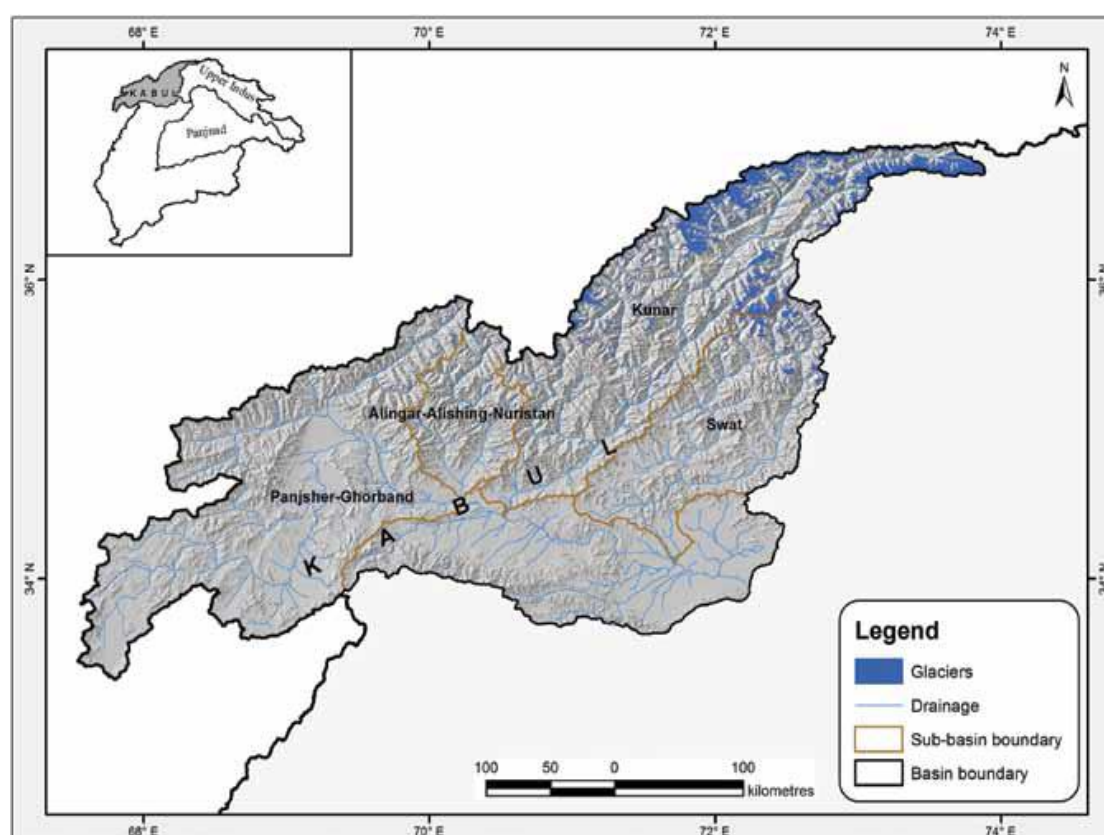
Figure 5. 5: Basins and Sub-Basins in the Upper Reaches and Distribution of Glaciers in the Indus River System

Figure 5.5 shows the major basins of Indus River system; the Kabul, Upper Indus and Panjand. The Swat sub-basin lies within the Kabul basin along with Panjsher-Ghorband, Kunar and Alingar-Alishing-Nuristan Sub basins. The sub-basin Swat covers an area of 1722 Km² with a total number of 327 glaciers. The total estimated ice reserves in the sub-basin are 5.3 Km³ (Table 5.6). Figure 5.6 provides a closer look at the sub-basin in the Kabul Basin.

Table 5. 6: Glaciers Characteristics in Kabul Basin in the Indus River System

Basin	Sub-basin	Number of glaciers	Glacier area (km ²)	Estimated ice reserves (km ³)	Highest elevation (m a.s.l.)	Lowest elevation (m a.s.l.)	Largest glacier area (km ²)
Kabul	Panjsher-Ghorband	88	14.6	0.4	5,242	3,857	2.5
	Alingar-Alishing-Nuristan	37	5.8	0.2	5,284	4,162	1.5
	Kunar	1,149	1,573.90	176.8	7,578	3,114	189.5
	Swat	327	127.4	5.3	5,580	3,772	4.9
	Total	1,601	1,721.70	182.7	7,578	3,114	189.5

Source: Bajracharya & Shrestha, 2011: ICIMOD

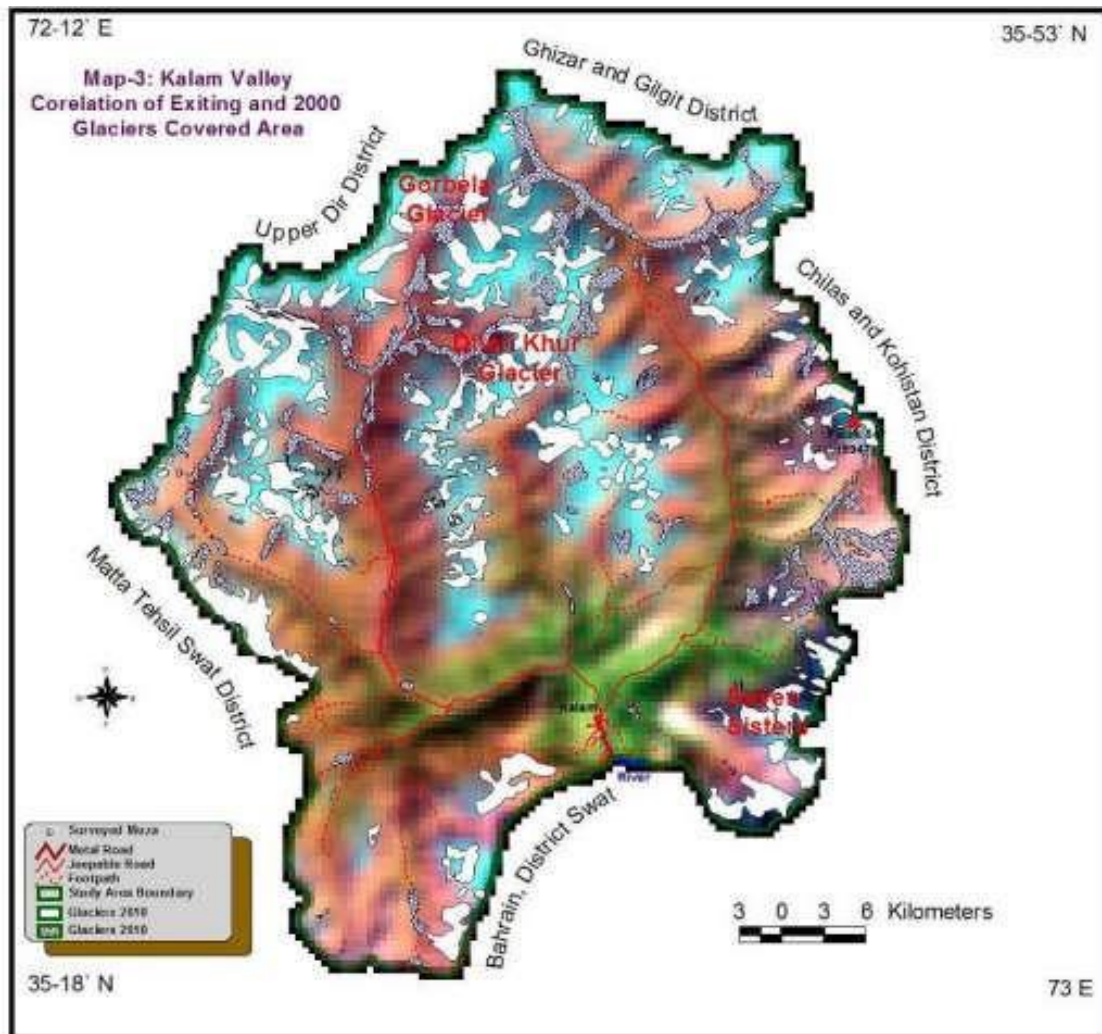


Source: Bajracharya & Shrestha, 2011: ICIMOD

Figure 5. 6: Glaciers in the Kabul basin (in the Indus River System)

Based on satellite imagery, the difference between the glacial area between the years 2000 to 2010 was conducted by Khan and Mehmood-ul-Hasan (2016). The results show deterioration in the glaciers covered area and tendency of retreat in most of the glaciers (Figure 5.7). There is a decline of about 50% of the glacial area. The floods of 2010 have resulted major damages and due to the widening and deepening processes of running water, snow accumulation of the valleys lost and most of these glaciers were

vanished into the River Swat. The loss of these glaciers have also contributed to the increase of temperature in the area, more melting of the glaciers and running to the Utror and Ushu Rivers. On the other hand, the melting of glaciers in the north of Ushu River have contributed to the formation of Ribbon and Cirque lakes.



Source: Khan & Mehmood-ul-Hasan (2016) based on satellite imagery

Figure 5. 7: Comparison of the Glacial Extent (2000-2010) in Kalam Valley, District Swat

5.3 Causes of Climate Change

Table 5.7 shows the public perceptions about the causes of climate change. The question was structured so they were provided with a set of multiple responses. The response categories were chosen generally and not specific, the purpose being to avoid details of the causation of climate change due to nature of the study and sample selected.

Table 5. 7: Descriptive Statistics and Chi-square Analysis of Public Understandings About the Causes of Climate Change

Causes of CC	Total	Greenhouse Gases (%)	Fossil Fuels Burning (%)	Deforestation (%)	Natural Causes (%)	Act of God or Nature (%)	Other (%)
Responses (N)	1794	147	264	668	532	170	13
Responses (%)	100.0	8.2	14.7	37.2	29.7	9.5	.7
Percent of Cases	176.6	14.5	26.0	65.7	52.4	16.7	1.3
Tehsils							
Sig.	-	.000	.000	.000	.000	.001	-
Cramer's V	-	.230	.315	.427	.525	.159	-
Barikot	-	30.2	44.0	30.8	67.3	11.9	-
Babuzai	-	15.3	28.2	54.0	62.1	18.5	-
Kabal	-	16.4	35.1	53.8	77.2	14.6	-
Charbagh	-	11.2	12.4	52.8	75.3	13.5	-
Matta Sabujni	-	11.0	7.9	96.1	8.7	10.2	-
Khwazakhela	-	6.1	29.0	87.8	32.8	18.3	-
Bahrain	-	4.6	4.6	81.5	6.2	32.3	-
Matta Khararai	-	12.4	29.8	69.4	65.3	12.4	-
Kalam	-	3.0	1.5	58.2	17.9	26.9	-
Age Groups							
Sig.	-	.213	.181	.001	.048	.682	-
Cramer's V	-	.065	.068	.127	.087	.038	-
21-30	-	18.0	23.3	61.7	51.9	16.5	-
31-40	-	12.3	28.8	70.1	44.8	16.8	-
41-50	-	12.4	21.7	62.8	53.8	16.9	-
51 or above	-	15.3	24.6	52.5	55.2	13.1	-
Education							
Sig.	-	.000	.000	.000	.000	.000	-
Cramer's V	-	.416	.202	.189	.148	.148	-
Primary/Middle	-	13.8	27.2	65.7	51.0	17.2	-
Matric/O-Level	-	11.4	37.9	78.6	41.4	7.1	-
FSc/A-Level	-	45.3	41.5	79.2	45.3	11.3	-
BA/BSc	-	59.3	37.0	74.1	18.5	0.0	-
MSc/BSc(Hons.) / Postgraduate	-	83.3	50.0	83.3	33.3	0.0	-
No Education	-	7.5	18.2	56.2	54.9	19.6	-
Income							
Sig.	-	.000	.007	.366	.000	.310	-
Cramer's V	-	.206	.116	.064	.144	.068	-
Very Low Income	-	9.9	16.2	58.6	48.2	16.2	-
Low Income	-	8.4	25.5	66.0	42.4	17.4	-
Middle Income	-	15.3	24.5	65.7	50.9	12.5	-
High Income	-	14.4	27.7	60.1	61.7	14.9	-
Very High Income	-	31.5	33.8	64.6	58.5	20.8	-

5.3.1 Deforestation

The survey results show that deforestation has been termed as top factor (65.7% of the respondents) causing climate change. This shows the level of deforestation in the study area. Chi-square analysis show significantly more respondents aged 31 to 40 (70.1 %***) have selected deforestation as the cause of climate change. Significantly more respondents with education Masters/PG level (83.3 %***) and FSc/A-Level (79.2 %***) have selected deforestation as the cause of climate change. Among the tehsils more respondents (96.1%**) belonging to Matta Sabujni have reported deforestation.

Pakistan has a total forest cover of 4.2 million, equivalent to 4.8% of the total land area which is quite low compared to 30% standard for the world (Shahbaz et al., 2007). According to 2015 data of KP Statistics Department, the total forest area of Khyber Pakhtunkhwa province is 2047222 hectares, out of which district Swat carries a share of 8.1% (165756 hectares). Forests in Khyber Pakhtunkhwa are under extreme pressure from a multitude of problems. Millions of livelihoods security in rural areas is dependent largely on these resources, who lives in and around these forests (Shahbaz et al., 2007). According to a survey conducted in the late 1990s that due to growing demand and supply developments, the forest resources that existed in 1995 would be consumed completely between the years 2015 and 2025 (Shahbaz et al., 2013).

District Swat contains a large cover of forest stretched over a large area and some of them are still virgin forests. Due to the lack of natural gas and other fuels, forests are cut and used for burning and other domestic purposes. A large variety of forest species are found in Swat, used as timber in the study area, and transported to the plain area of Pakistan. Apart from legal cover of the forest department, smuggling and black marketing of the timber is also on the peak despite the heavy check of the government on these culprits (Khan & Khan, 2009). According to Khan et al., (2015a) the forest resources of the district are declining due to extreme pressure from local population demands and are in need of conservation. One of the negative aspect of deforestation is that it can contribute to high temperatures, decrease in water resources and loss of biodiversity by making the mountains barren lands (Ali et al., 2006). Moreover, the change in forest cover leads to devastation of ecosystems and related livelihoods (Qasim et al., 2014).

Deforestation in District Swat is long standing problem. According to Kruseman and Pellegrini (2013) in 1996 the forest cover was 5% compared to the 20-25% in 1850 while Qasim et al., (2014) reports a decrease of 36% forest in the low lands and 69% in high elevations based on the temporal analysis of forest cover between 1968 to 2007. Moreover, the annual deforestation rates of 1.86%, 1.28%, and 0.80% are observed in scrub forest zone, agro-forest zone and pine forest zone respectively. The forest had always served as an important livelihood source for the local populations. Now with the increase in population, the rate of deforestation is double folded and that's reason the local communities are at increased risk not only from decreasing forest stocks but also from landslides and erosion as well as threats to biological diversity. Forest resources play an important part in the lives of rural populations living close to the forest areas of KP (Shahbaz, 2007). The locals reap the benefits from forests include firewood, pastures, timber, edible plants and medicinal plants. The forest dependent communities are reliant on the use of natural resources and are among the poorest segments of the society (Shahbaz, 2007). Besides the exploitation of forest resources from the locals, more damage was done by the armed forces due to security risk in the area (Khan et al., 2015b). According to the study conducted by Qasim et al., (2013) environmental and technological factors, convenience and proximity to local markets, over grazing of the pastures, massive use of firewood, institutional weaknesses and conflicting property rights were the main driving forces for deforestation and agriculture expansion.

As shown in Table 5.8, Khan and Khan (2009) provides an overview of the change in natural resources in from 1969 to 2005 based on the survey responses of 403 natural resource questionnaire. The table shows that forest resources are rapidly decreasing in while the agricultural land is increasing which represents the encroachment the study area. The reason behind the deforestation is the dependency on the natural resources for subsistence use and income generation source for the residents of district Swat.

Pellegrini (2011) studied corruption and forest management in district Swat. The study revealed that corruption is impairing the sustainable forest management in the area.

Table 5. 8: Change in Quantity of Natural Resources (1965–2005) in District Swat

Natural Resource	Swat Valley		Kohistan	
	Increase/decrease	Change (%)	Increase/decrease	Change (%)
Conifer forests	Decrease	–62	Decrease	–34
Oak forests	Decrease	–75	Decrease	–43
Agriculture land	Increase	29	Increase	N/A
Pasture land	Decrease	N/A	Decrease	N/A
Water	Decrease	–53	N/A	N/A

Source: Khan and Khan, 2009 based on SDPI survey

Unlike the other countries where deforestation is primarily defined by clearing the forest areas permanently and converting to agriculture and pasture lands, in Swat deforestation is driven primarily by logging in order to extract wood resulting in the clearance of coniferous forests. The study finds that corruption is a fundamental contributor to the current forest exploitation. It takes place in every step of the process, right from extraction of logs and to transport and marketing.

The policy level interventions and reforms for the conservation of forests are not sufficient to answer the pressure exerted on these resources today. These policies and laws are ineffective if there is no political and administrative will to end the status quo. Community participation should be made requisite for sustainable forest management. The pressure on forestry sector could be reduced by making the forestry an instrument of policy rather than its objective and eventually would lead to achieve sustainable livelihoods (Suleri, 2002).

The above discussion rightly pointed towards the discomfoting deforestation trends in district Swat which coincides with the results from the questionnaire survey and interviews. The underlying reasons being the unavailability of alternative fuel resources, poor economy and administrative problems.

5.3.2 Natural Causes

The natural causes were termed second (52.4% of the respondents) major reason of climate change after deforestation. Chi-square analysis of the questionnaire survey results show that significantly more respondents aged 31 to 40 (70.1 %***) have selected natural causes. Significantly more respondents having no formal education

(54.9 %***) have selected natural causes as reasons for climate change. Comparatively more respondents with high income (61.7 %***) have selected natural causes while more respondents (77.2%**) belonging to Kabal had reported natural causes. Interview results show that some of the respondents were of the opinion that there are natural causes behind the change and “*how can we stop it*”.

Along with anthropogenic activities like burning of fossil fuels and emissions of GHGs, Natural causes such as *changes* in Earth's orbit, *changes* in solar activity, or volcanic eruptions are also responsible for changing weather patterns.

5.3.3 Greenhouse Gases

Table 5.3 shows that 14.5% of the respondents have the view that GHGs are responsible for Climate change. Statistical analysis of the results indicated that more highly educated (Masters/PG) respondents (83.3 %***) have chosen GHGs as the one of the main reasons causing climate change. Comparatively the significantly least responses have been recorded from the respondents with no formal education (7.5 %**), so it can be attributed that education level affects the respondents’ choice selecting GHGs as a cause of climate change. Significantly more respondents related to very high income group (31.5 %**) and Barikot (30.2%**) have chosen greenhouse gases as the cause of climate change.

Given the literacy rate in the study area, the question included Greenhouse Gases as a whole including all the gases responsible for global warming / climate change (i.e. CO₂, CH₄, N₂O etc.) rather than asking about individual greenhouse gases as shown by other studies (Whitmarsh, 2005).

5.3.4 Combustion of Fossil fuels

The survey results show that 26% of the respondents have selected fossil fuel combustion as the main cause of climate change. Chi-square analysis indicate that significantly more respondents having masters or higher education (50 %**) have selected combustion of fossil fuels as cause of climate change. Significantly more respondents having very high income (33.8 %**) and belonging to Barikot (30.2%**) have selected the same causal reason for climate change. It can be attributed from the results that high educated and high income groups are more concerned about climate change and have more knowledge compared to other groups with respect to fossil fuels burning.

The interview data shows that respondents were of the opinion that due to population increase the number of vehicles and industries increased thus by increasing the consumption and combustion of fossil fuels.

5.3.5 Act of God/Nature

As the belief system in the study area is more dominant towards God religiously, a hefty number of respondents (16.8%) said the weather changes are just will be God, we can't do anything about it. We don't have control over the weather and it would change anyway. Chi-square analysis of the results show that respondents with no formal education (19.6 %***) have chosen the act of God or nature causing climate change. On the other hand, neither of the respondents with higher education (bachelors and higher) have chosen the said reason causing climate change. This implies that educated respondents negate the act of God or nature as the main cause of climate change. They tend to select GHGs, combustion of fossil fuels, deforestation as causal reasons for climate change.

The public perceptions about climate change may be influenced by personal beliefs (Niles & Muelller, 2016). The belief system of a population is governed by many factors; it could be religion, social or societal norm. The belief system in the study area is more dominant towards God or religion, a hefty number of respondents that change in climate change is the will of God, we can't do anything about it. Similar results have been reported by Haq & Ahmad (2016).

Collectively close to two third (60.1%) of the respondents perceive anthropogenic sources are responsible for causing climate change which are consistent with other similar studies (Whitmarsh 2008; Yu et al. 2013; Kabir et al. 2016).

5.4 Impacts of Climate Change

Table 5.9 show the public perceptions about the impacts of climate change. The survey results are shown in the figure. The most common impact recorded by the respondents is flooding (70.6% of the respondents). The second most common impact of climate change observed by the respondents is Droughts or Dry Spells (68.1% of the respondents). The other mentioned impacts are Vector Borne Diseases (45.4%), Changes in Flora and Fauna (43.9%), Lower agricultural productivity (42.4%), Change

Table 5. 9: Descriptive Statistics and Chi-square Analysis of Public Understandings About the Impacts Of Climate Change

Impacts of Climate Change	Total	Flooding (%)	Droughts or dry spells (%)	Vector borne diseases (%)	Changes in flora and fauna (%)	Lower agricultural productivity (%)	Change in temperature (%)	Decrease in winter days (%)	Increase in extreme events (%)	(%)Low/no rainfall	Extended summer days (%)	Landslide (%)	Road Erosion (%)	Miscellaneous (%)
Responses	4416	743	716	478	462	446	437	427	256	125	103	90	71	62
Responses (%)	100	16.8	16.2	10.8	10.5	10.1	9.9	9.7	5.8	2.8	2.3	2.0	1.6	1.4
Cases (%)	419.8	70.6	68.1	45.4	43.9	42.4	41.5	40.6	24.3	11.9	9.8	8.6	6.7	5.9
Tehsils (Sig.)		.000	.000	.000	.000	.000	.001	.000	.000	.000	.052	.000	.000	
Cramer's V		.343	.523	.317	.209	.359	.155	.324	.318	.212	.121	.316	.528	
Barikot		58.9	44.3	17.1	34.2	21.5	38.6	19.6	3.2	12.7	8.2	1.3	0.0	
Babuzai		54.8	39.5	52.4	46.8	56.5	43.5	50.0	22.6	11.3	11.3	0.0	0.0	
Kabal		62.6	46.8	55.0	48.5	62.6	50.3	50.9	23.4	25.1	11.7	1.8	0.0	
Charbagh		46.6	51.1	29.5	48.9	40.9	56.8	26.1	22.7	10.2	9.1	2.3	2.3	
Matta Sabujni		95.3	98.4	57.5	36.2	29.9	31.5	36.2	32.3	7.9	12.6	22.8	3.9	
Khwazakhela		82.4	91.6	53.4	38.2	41.2	38.9	51.9	38.9	5.3	6.9	13.0	6.9	
Bahrain		83.1	98.5	27.7	70.8	21.5	29.2	32.3	15.4	1.5	3.1	24.6	24.6	
Matta Khararai		87.7	81.1	63.9	33.6	67.2	42.6	65.6	46.7	14.8	15.6	6.6	3.3	
Kalam		65.7	98.5	40.3	61.2	16.4	35.8	13.4	6.0	4.5	3.0	19.4	52.2	
Age (Sig.)		.060	.000	.607	.761	.101	.918	.437	.056	.571	.520	.001	.017	
Cramer's V		.084	.166	.042	.033	.077	.022	.051	.085	.044	.046	.127	.099	
21-30		74.8	77.2	44.7	42.2	37.9	39.3	36.9	24.3	9.7	7.8	8.7	9.7	
31-40		73.5	73.5	48.1	46.0	40.1	42.0	43.6	28.9	11.5	9.1	12.0	8.0	
41-50		65.9	62.4	43.8	43.4	47.9	42.1	40.0	20.7	12.4	11.0	8.3	5.9	
51 or above		67.2	56.3	43.2	42.1	43.2	42.1	39.3	20.8	14.2	11.5	1.6	2.2	
Education (Sig.)		.002	.000	.347	.801	.019	.078	.223	.110	.824	.328	.013	.104	
Cramer's V		.134	.194	.073	.047	.113	.097	.081	.092	.045	.074	.117	.093	
Primary/Middle		74.1	73.6	43.9	42.3	34.3	41.4	38.5	23.4	9.6	8.4	9.2	8.4	
Matric/O-Level		75.7	79.3	43.6	45.7	37.9	42.9	42.1	28.6	10.7	5.7	14.3	7.1	
FSc/A-Level		84.9	86.8	60.4	39.6	41.5	22.6	30.2	30.2	13.2	9.4	9.4	15.1	
BA/BSc		77.8	81.5	40.7	33.3	37.0	37.0	33.3	7.4	11.1	7.4	11.1	7.4	
MSc/BSc(Hons.) / Postgraduate		88.9	83.3	50.0	44.4	38.9	55.6	61.1	38.9	11.1	16.7	22.2	5.6	
No Education		65.6	60.4	45.1	45.0	47.2	42.7	41.7	23.4	13.0	11.3	6.3	5.2	
Income (Sig.)		.090	.000	.000	.448	.000	.217	.000	.141	.000	.008	.018	.000	
Cramer's V		.088	.179	.151	.060	.171	.074	.172	.081	.209	.115	.107	.188	
Very Low Income		70.7	75.9	38.2	48.2	30.9	40.3	32.5	19.4	9.4	3.7	8.4	16.2	
Low Income		74.7	74.4	42.2	41.9	37.8	41.9	32.8	25.0	6.3	10.0	11.6	6.6	
Middle Income		71.8	70.4	45.8	46.3	42.1	38.0	41.7	22.7	9.7	12.0	10.6	3.7	
High Income		63.3	56.9	60.6	39.9	56.4	48.9	53.7	30.3	16.0	9.6	4.8	2.1	
Very High Income		67.7	54.6	41.5	44.6	49.2	39.2	49.2	22.3	27.7	15.4	3.8	5.4	

in temperature (41.5%), Decrease in cold days (40.6%), increase in extreme weather events (24.3%), low/no rainfall (11.9%), Extended summers/increase in the number of warm days (9.8%), landslides (8.6%), road erosion (6.7%) and storms (1.5%). The results are discussed in the flowing section.

Climate change is known to exert a various range of impacts on the environment and human ecosystem. The responses of the question about impacts of climate change were structured. The reason behind that was the respondents can get a clear idea of about the impacts of climate change if structured, otherwise they couldn't have recorded their response accordingly. The question was generally related to impacts of climate change and was not specific to the study area but it is expected that the responses could be affected by experience and observations of respondents related to the impacts of climate change in the study area.

The most common response of the survey was *flooding*. The study area has experienced a large number of high intensity flooding recently, therefore it is expected as the common response to the impacts of climate change. Chi-square analysis shows that significantly more highly educated respondents (Masters/PG, 89 %**) and FSc/A-Level (85 %**) have observed flooding as the main impact of climate change in district Swat.

Table 5.9 shows *droughts* as the second common selected response (68.1% of the respondents) to the impacts of climate change. Chi-Square analysis indicates that significantly more respondents aged 21-30 (77.2 %***) have selected droughts compared to the other age groups. Significantly more FSc/A-level (86.8 %***) respondents have recorded droughts while significantly more Very Low Income group (75.9 %***) and Low Income group (74.4 %***) have selected droughts as a response to the impacts of climate change. It could be attributed to the high dependency of the low income groups on the environment and agriculture practices, therefore they tend to have more observation related to the droughts compared to the other income groups. It can be attributed from the results that the respondents have observed droughts in the study area which corresponds to less rainfall or having dry spells in the study area.

Current evidence suggests that climate variability have a direct influence on the epidemiology of vector-borne diseases. It is estimated that by 2100 the average global temperature will rise by 1.0-3.5 C increasing the transmission of vector-borne diseases in new areas. Some of the vector-borne diseases are malaria, dengue fever, lyme disease, Schistosomiasis etc (Githeko et al., 2000; Martens et al., 1995).

The survey results show that respondents chose the *vector-borne diseases* as the third major impact of the climate change in the study area. More respondents aged 31 to 40 (48.1%) have chosen vector-borne diseases as impact of climate change. Significantly more respondents in High Income group (60.6 %***) have selected vector-borne diseases compared to the other income groups.

Climate change is going to affect the agricultural productivity of some regions in the world. The survey results showed that about 42.4% of the respondents selected *lower productivity* as an impact of climate change. Chi-Square analysis indicates that significantly more respondents with education of FSc/A-Level (41.5 %*) have selected lower agricultural productivity. With respect to income groups, significantly more respondents related to High Income group (56.4 %***) have selected lower agricultural productivity.

A large number of respondents chose the *decrease in winter days* (40.6%) and relatively small proportion of the respondents selected *Increase in warm days or Extended summers* (9.8%) as impacts of climate change. One of the impacts of climate change is the variation in summer and winter seasons. As a result of temperature rise, the number of summer days are increasing while the number of winter day are decreasing. Results indicate that significantly more respondents related to high income group (53.7 %***) have selected decrease in winter days while significantly more respondents related to Very High income group (15.4 %**) have selected the extended summers as impacts of climate change. The observations of the respondents about change in winter and summer days are discussed in section 3.

The survey results show that a slightly less number of respondents have chosen the *landslides* (8.6%) and *road erosion* (6.7%) as impacts of climate change compared to other listed impacts. Chi-Square analysis indicates that significantly more respondents aged 31 to 40 (12 %***) have selected landslides while significantly more respondents

aged 21 to 30 have selected road erosion as impacts of climate change. Significantly more respondents with education Masters/PG (22.2 %*) have selected landslides. In the income groups, significantly more respondents related to Low Income group (11.6%*) have selected landslides while significantly more respondents related to Very Low Income group (16.2 %***) have selected road erosion as impacts of climate change.

5.5 Sources of Climate Change Information

Table 5.10 shows the sources of information of the respondents about climate change. The results indicated that the information about climate change is imparted through various kinds of media in the study. The respondents were asked how they got to know the understanding of climate change. It should be noted that the question is open for choosing more than one option, therefor the total number response exceeds total number of respondents. The various sources of climate change information are further discussed individually.

Table 5. 10: Sources of Information of the Respondents About Climate Change

Source	N	% of Total
Television	88	5.5
Radio	12	0.8
Newspaper	72	4.5
Internet	9	0.6
Special publications/academic journals	2	0.1
Environmental groups/NGOs	11	0.7
School/College/University	132	8.3
Government Agencies	14	0.9
Friends/Family	357	22.4
Local Community gatherings	738	46.2
Self-Observed	125	7.8
Other	36	2.3
Total	1596	100.0

5.5.1 Local Gatherings

The most common recorded response to this question is local community gatherings (46.2%). Chi-Square analysis of this group shows that significantly more respondents

from the age group 41-50 (76.3%*) have heard about climate change compared to age group 21-30 who have heard the least (59.3%*) from the Local Community Gatherings about the climate change issue.

The changes in the weather and climate are mainly discussed in community gatherings (Hujra, Janaza etc). The local gatherings in a designated place called “Hujra” locally where the locals gather after work and day to day business and different topics are discussed. As most of the respondents belong to the local income and low literacy group, their information is mainly dependent on the second hand information from the elder of a Village or Mouza (like a village, a place with limited population). The villagers have various kind of belief system attached to change in weather conditions, storm, clouds and droughts (Box 5.4).

Box 5.4: Public Views About Climate Change

“It is said commonly, that when the days and night equally become warm in summer season (near May to June), then it rains according to the local weather but when the nights get cooler compared to days, then that’s a sign of rain pause or short term drought”

Such and many other kind of information are shared by the elders of community at local gatherings. But education plays important role in bringing up realities to the world, thus by changing the old belief system of a community.

The role of local knowledge in the dissemination of climate change information has been broadly studied (Raygorodetsky, 2011; Rahman et al., 2015; Vogt et al., 2016). The indigenous people are excellent observers and interpreters of change in the environment, with a lot of knowledge about the land, sky and sea (Raygorodetsky, 2011). That’s why the community based information play an important role in community based adaptation and mitigation actions (Raygorodetsky, 2011).

5.5.2 Friends and Family

The second large response to the question is the category was friends/family (22.4%). Chi-Square analysis indicates that a relatively smaller proportion of age group 21-30 (29.1%***) has gotten the information about climate change from friends compared to the age group 51 or above (39.6%***). Significantly more postgraduate students (have heard about climate change from family or friends (50%***). with respect to income

of the respondents Low Income group has heard less least (21.6%***) from friends/family while the Very High Income Group has heard significantly more (50.0%***) from friends/Family.

Due to the family demographics of the study area, joint family system contributes to large household sizes. With elders in the family, information about various phenomena are shared within the family, from elders of the family.

5.5.3 School/College/University

This is the third large response recorded against climate change information. 8.3% of the respondents have heard about climate change in either School, College or University. This means that this category is significant means of communicating climate change information in the study area.

Chi-square analysis indicates that significantly higher proportion of respondents aged 21-30 (21.4 %***) have heard about climate change in either School, College or University compared to the age group 51 or above (6.0 %***) with the least group heard about climate change in School, College or University. The age group 51 or above is the least educated group as analyzed in the literacy of the respondents. Significantly more Masters Postgraduate students have heard about climate change in their respective institutions (68.8 %*** and 50.0 %*** respectively).

5.5.4 Media

The results of Television, Radio, Newspaper, Internet, and Academic Publications/Journals are categorized in Media. Media comprises a relatively smaller proportion (5.5%, 0.8%, 4.5%, 0.6% and 0.1% for Television, Radio, Newspaper, Internet, Academic Publications/Journals respectively) in the disseminating climate change information within the study area compared to the other researches where media plays a major role in communication of climate change information (Whatmarsh, 2005). Chi-square analysis of the results indicates significantly less proportion of the respondents aged 21-30 have heard about climate change through television (16.5%***) and Newspaper (2.4%*) compared to the high proportion of the respondents of that age group heard about climate change School, College or University (21.0%***). Significantly more respondents aged 21-30 have heard about climate change using Internet. Conversely significantly most educated respondents (PG) have

heard about climate change through television (50.0%***) compared to the non-educated respondents who have heard the least (4.0%***) about climate change through television. Significantly more highly educated respondents (PG, Masters and Bachelors) have heard about climate change through Newspaper (100%***, 31.3%*** and 18.5%*** respectively) and Internet (100%***, 12.5%*** and 18.5%*** respectively). The above results show that a little fraction of the survey respondents has sought information about climate change using media. It could be attributed to low education rate in the study area or low access of the respondents to media.

5.5.5 Government and NGOs

The Government and NGOs is also a source of information about climate change but during this study indicated that a very low proportion (0.9% and 0.7% for Government Agencies and NGOs respectively) of respondents had heard about climate change from these sources. Chi-Square analysis shows this significantly more educated respondents (Masters) have heard about climate change from Government agencies and Environmental Groups/NGOs (12.5%*** and 12.5%** respectively).

The low results of this category can be attributed to less efforts of the Government agencies in communicating the threats of climate change to the public of the study area and less involvement of the Environmental Groups (NGOs) in the climate change issue.

5.6 Observations of the Climate System

Based on six climatic change indicators, respondents were asked to record their observations over the past 20 years (1996-2015), firstly in terms of increase or decrease in these indicators and secondly the observing time span (since how long been you observing these changes?). The results are summed up in the following text (Table 5.11);

Table 5. 11: Descriptive Statistics and Chi-Square Analysis of the Changes in the Indictors of Climate Change as Observed by Respondents

Public observations	Change	N	Percent	Sub-Districts		Age Groups		Education		Income	
				Sig.	Cramer's V	Sig.	Cramer's V	Sig.	Cramer's V	Sig.	Cramer's V
Rainfall	Increased	260	25.4	.000	.567	.001	.131	.002	.136	.000	.176
	Decreased	763	74.6								
	Total	1023	100.0								
Temperature	Increased	780	76.3	.000	.545	.000	.160	.003	.131	.000	.164
	Decreased	242	23.7								
	Total	1022	100.0								
Snowfall	Increased	74	7.2	.004	.148	.012	.104	.467	.067	.153	.081
	Decreased	951	92.8								
	Total	1025	100.0								
Size of Glaciers	Increased	70	26.3	.000	.652	.000	.468	.032	.214	.008	.228
	Decreased	196	73.7								
	Total	266	100.0								
Floods	Increased	711	70.6	.000	.243	.021	.099	.507	.065	.500	.058
	Decreased	296	29.4								
	Total	1007	100.0								
Droughts	Increased	817	79.9	.000	.484	.000	.136	.003	.133	.000	.142
	Decreased	205	20.1								
	Total	1022	100.0								
Summer Days	Increased	818	83.9	.000	.268	.000	.180	.005	.130	.031	.105
	Decreased	157	16.1								
	Total	975	100.0								
Winter Days	Increased	120	12.1	.000	.325	.004	.116	.956	.033	.000	.144
	Decreased	869	87.9								
	Total	989	100.0								
Early Springs	Early	947	94.4	.000	.475	.181	.070	.028	.112	.000	.206
	Late	56	5.6								
	Total	1003	100.0								

4.6.1 Change in Temperature

With respect to observing change in temperature, a major portion (76.3%) of the respondents reported increase in temperature while 25.4% reported decrease in temperature. Chi-Square statistics showed moderate significance between the age (Cramer's $V = .160$), education (Cramer's $V = .131$) and income groups (Cramer's $V = .164$). More respondents aged 51 or above (85.0 %, $p = .001$) have observed increase in temperature. The increase in temperature decreases within age group from higher to lower age which validates that age plays an important role in understanding the changes in climate system. Conversely more respondents aged 21-30 (32.3 %, $p = .001$) have

observed decline in temperature which implies that low age is attributed to less experience and understanding of the climate system.

Significantly more educated respondents with education level Masters/PG and Bachelors have experienced increase in temperature (77.8%, $p = .01$ and 76.9%, $p = .01$ respectively) while more respondents with education equivalent to FSc/A-Level (41.5%, $p = .01$) have observed decrease in temperature with respect to other education groups. Comparably, more High Income and Very High Income groups (86.2%, $p = .001$ and 84.6%, $p = .001$ respectively) have experienced changes in temperature than the Low Income and Very Low Income groups (73.2%, $p = .001$ and 65.7%, $p = .001$ respectively).

The observing time span shows (Table 5.12) that majority (64.9%) of the respondents had observed changes in temperature since 6 to 10 years within a strong association within the age groups (Cramer's $V = .308$) and moderate association within education (Cramer's $V = .140$) and income groups (Cramer's $V = .180$)

4.5.2 Change in Rainfall Pattern

The survey respondents reported decreased rainfall amount in higher proportion (74.6%) while an increase was reported 25.4%. A moderately significant relationship between the demographic variables and change in rainfall pattern is observed (Table 5.11). Most observed decrease in rainfall lies in age group 51 or above (83.33 %, $p = .01$) while the least in aged 21 to 30 (66.34 %, $p = .01$). Conversely significantly more respondents of the same group aged 21 to 30 have experienced increase in rainfall (33.66%, $p = .01$) than any other group. More Non-Educated, Masters/PG and Primary Educated respondents have observed decline in overall rainfall (78.4%, $p = .01$, 77.8%, $p = .01$ and 74.2%, $p = .01$ respectively) while more FSc/A-Level educated respondents observed increase (45.3 %, $p = .01$) with a weak association (Cramer's $V = .131$) within the education group. With respect to the income of the respondents, significantly more Very High Income and High Income groups have observed decline in rainfall (84.6% $p = .001$ and 84.5%, $p = .001$ respectively).

With respect to the observing time span, 65% of the respondents had observed change in rainfall pattern since 6 to 10 years ago while 13.4% observed the change since 1 to 5 years ago. Chi-square statistics shows strong correlation between the age groups

(Cramer's V , 0.313), education (Cramer's V , 0.146) and income groups (Cramer's V , 0.182).

4.5.3 Change in Snowfall Pattern

Snowfall in the study area is responsible for the smooth flow of the River Swat, which originates from the upper reaches of District Swat (Ahmad et al., 2015). The River Swat is responsible for some of the major livelihood sources of this mountainous community or in other terms variation in Snowfall patterns bears gruesome consequences for the community. The results from the questionnaire survey shows that majority of the respondents are of the view that there is quite a significant change in the snowfall pattern of the study area. About 92.8% of the respondents have observed a decline in the snowfall throughout the study area.

Respondents aged 41 to 50 (96.5 %, $p = .05$) and 51 or above (94.3 %, $p = .05$) have observed decline in the Snowfall in District Swat. On the contrary, respondents from the age groups 31 to 40 and 21 to 30 observed increase in the Snowfall (9.6 %, $p = .05$ and 9.4 %, $p = .05$ respectively) compared to the old age groups. There is no significant relationship found between the education (Cramer's $V = .067$, $p > .05$) and income groups (Cramer's $V = .081$, $p > .05$) for the changes in snowfall pattern in the area.

The demographic variables show a moderate to strong Cramer's V association within age ($V = .312$), education ($V = .136$) and income groups ($V = .180$) with respect to the climate observance time span of the respondents.

4.5.4 Change in the Size of Glaciers

A major portion (73.7%) of the respondents holds to this belief that the glaciers in their areas are retreating. The results show that significantly more respondents aged 41-50 (85.1 %, $p = .001$) have observed decline in the size of the glaciers while less respondents aged 21-30 (33.9 %, $p = .001$) have experienced the retreat in glaciers. On the other hand, significantly more respondents of the same age group 21-30 (66.1 %, $p = .001$) have observed increase in the size of glaciers compared to elderly group 41-50 (14.9 %, $p = .001$). Significantly more respondents with No Education (77.5 %, $p = .05$) and FSc/A-Level (75 %, $p = .05$) have observed decrease in the size of Glaciers. With respect to income groups, significantly more Low Income (78.2 %, $p = .01$) and Very Low Income (75.7 %, $p = .01$) groups have observed retreat in glaciers or decrease in

the size of the glacier while significantly more respondents related to High Income group (64.3%, $p = .01$) have observed increase in the size of glaciers.

More respondents from the upper reaches of district Swat have observed decrease in size of Glaciers. These include Kalam (14.8%), Utror (7.7%), Bahrain (17.3%), Mankyal (9.2%) and Miandam (8.2%) among the total responses for the decrease in size of glaciers. The results illustrate that the change in Glaciers' size is more obvious to the respondent belonging to the upper reach of the district. The upper reaches of the study area consist of Glaciers or covered with snow.

Around 72.7% of the respondents reported that they have observed changes in size of glaciers since 6 to 10 years ago, while 23% of the respondents reported change in the same indicator since 1 to 5 years ago which implicates that 96% of the respondents are observing change in glaciers within 10 years' time frame, which is alarming than any other climate change indicator in the study area. Chi-square analysis of the results shows strong correlation (Cramer's V , 0.315) between the age groups for the aforementioned observed changes.

4.5.5 Change in Flooding

The flooding was termed dangerous by the respondents because most of the respondents recorded that floods have been increased 68.30% since the past years while some of the respondents (28.43%) reported decrease in floods. Chi-Square of the results indicate that knowledge about the increase in flooding is almost same in all the age groups. The reason being these events are new and almost all the people have observed that. Significantly more respondents aged 21 to 30 (78.4 %*) and 51 or above (73.7 %*) have observed increase in flooding in the study area compare to other age groups. With respect to education more respondents with Masters/PG (83.3 %) and FSc/A-Level (79.2%) education have observed increase in floods.

Table 5. 12: Time Interval of the Changes in CC Indicators Observed by the Respondents in the Study Area

Public observations	Change	N	Percent	Sub-Districts		Age Groups		Education		Income	
				Sig.	Cramer's V	Sig.	Cramer's V	Sig.	Cramer's V	Sig.	Cramer's V
Rainfall	1-5	137	13.5	.000	.277	.000	.313	.000	.146	.000	.182
	6-10	664	65.4								
	11-20	214	21.1								
	Total	1015	100.0								
Temperature	1-5	138	13.6	.000	.281	.000	.308	.000	.140	.000	.180
	6-10	658	64.9								
	11-20	218	21.5								
	Total	1014	100.0								
Snowfall	1-5	138	13.6	.000	.284	.000	.312	.000	.136	.000	.180
	6-10	653	64.5								
	11-20	221	21.8								
	Total	1012	100.0								
Size of Glaciers	1-5	47	23.0	.248	.176	.000	.315	.204	.181	.248	.159
	6-10	149	73.0								
	11-20	8	3.9								
	Total	204	100.0								
Floods	1-5	121	12.1	.000	.392	.000	.292	.000	.145	.000	.132
	6-10	643	64.5								
	11-20	233	23.4								
	Total	997	100.0								
Droughts	1-5	149	14.7	.000	.306	.000	.287	.000	.150	.000	.197
	6-10	638	62.9								
	11-20	227	22.4								
	Total	1014	100.0								
Summer Days	1-5	164	16.2	.000	.336	.000	.279	.000	.128	.000	.190
	6-10	621	61.5								
	11-20	225	22.3								
	Total	1010	100.0								
Winter Days	1-5	168	16.7	.000	.338	.000	.282	.000	.128	.000	.176
	6-10	614	60.9								
	11-20	226	22.4								
	Total	1008	100.0								
Early Springs	1-5	176	17.5	.000	.352	.000	.267	.000	.134	.000	.184
	6-10	608	60.3								
	11-20	224	22.2								
	Total	1008	100.0								

4.5.6 Change in Droughts

Droughts can be used interchangeably with low rainfalls because droughts conditions always arise due to the complete absence or change in rainfall patterns. One of the havocs of the climate change is termed as drought as water shortages leave the agricultural lands barren and unfit for growing crops. To check the presence of droughts in the study area, respondents were asked to furnish their observations over the past decades about the change in droughts (increase or in the study area. The results were quite astonishing as more (77.1%) respondents recorded that droughts have increased over the past years.

Chi-Square analysis of the results indicate that significantly more respondents aged 41 to 50 (85.6 %***) and 51 or above (83.2 %***) have observed increase in drought condition in the study area while conversely significantly less respondents belonging to the age group 21 to 30 (70.1 %***) have observed increase in droughts over the past years.

Significantly more respondents having No-Education (83.6 %**) and Primary Education (79.4 %**) have experienced increase in droughts. Conversely more respondents belonging to High Income (87.8 %***) and Very High Income (87.7 %***) groups have observed increase in droughts.

4.5.7 Change in the Number of Summer/Warm Days

Increase in global temperature is responsible for changes in seasons; extending the summers and shrinking the winters. The survey results indicate that a large portion (83.9%) of the respondents observed overall increase in the length of summer season. This implies that hotter days have increased than before.

Chi-square statistics shows a moderate to high significant relationship between the demographic variables and change in the number of warm days. More respondents aged 51 or above (94.8 %, $p = .001$) have observed the increase while significantly less respondents aged 21 to 30 have observed increase in the length of summer season. The relationship of age with increase in summer days' decreases with decrease in age groups. Significantly more respondents with Masters/Postgraduate (88.2 %, $p = .05$) education had observed increase in the length of summer season followed by respondents with No-Education (86.8%, $p = .05$) which implies that education has low importance in observing the length of summer season. Significantly more respondents

from the Middle Income class (88.7 %, $p = .05$) and High Income class (85.1 %, $p = .05$) have observed increase in the number of summer days.

The time span of observing the changes in climate system shows that majority (61.5%) of the respondents are observing these changes since 6 to 10 years ago, with a strong Cramer's V association between the age ($V = .279$), education ($V = .128$) and income groups ($V = .190$).

4.5.8 Change in the Number of Winter/Cold days

The major portion (87.9%) of the survey respondents observed decrease in the length of winter season. Chi-Square test indicates that significantly (Cramer's $V = .282$) more respondents from the higher aged groups have experienced changes in winter days than the low aged groups. Comparatively more respondents aged 51 or above (94.3 %, $p = .01$) have observed decline in winter season than the respondents aged 21 to 30 (87.0 %, $p = .01$). There is no significant (Cramer's $V = .033$; $p > .05$) relationship between the education groups. Significantly more respondents from High Income (95.1 %, $p = .001$) and Very Income (92.5 %, $p = .001$) groups have observed decrease in the winter days.

The demographic variables show a moderate to strong Cramer's V association between the age ($V = .282$), education ($V = .128$) and income groups ($V = .176$) with respect to time span of observing the changes in winter days.

Climate change is altering the seasons by shrinking the length of winter season and the number of cold days. Few cold days are experienced by the people now a days compared to a few decades ago.

The changes in the climate system are visible and almost all the respondents had a clear vision about these seasonal changes. Similar climate indicators have been reported by other studies (Akerlof et al., 2013; Howe & Leiserowitz 2013). The above results depict that the perceptions and observation of climate change is affected by the demographic variables such as age, education and income level of the respondents (Huda 2013; Yu et al., 2013; Liu et al., 2014; Haq & Ahmad 2016). Older respondents are more concerned and more knowledgeable about climate change than the younger people (Kabir et al., 2016). With respect to education, either no or a little significant association was found between the climate indicators and education levels which implies that education plays no major role in observing climate change. A varied response in the

income groups for climate observations was found but for most of the climate indicators, significantly more high income groups have observed changes compared to the other groups.

4.5.9 Change in Spring Arrival

The results from questionnaire survey shows that majority of the respondents (89.8%) has the view that spring is descending early compared to the past years. Chi-Square analysis of the results indicate that significantly more respondents with higher education i.e. Masters/Postgraduate (100 %*) have observed early springs followed by the respondents with no education (95.6 %*) which indicates that observing change in early descent of springs depends on personal observance and experience and doesn't rely on education only. Significantly more respondents from the High Income (100 %***) and Middle Income (97.2 %***) have observed early descent of spring season. The arrival of early springs has also been major contributing effect of climate change with winter season lasting quickly thus inviting the springs to kick in. this implies to the lengthening of the coming summer season with more hot days per year.

In continuation with the finding the section above, the respondents were asked when did they start to observe the changes in the above listed indicators. of. The purpose of the question was to know the respondents experience and observations about the change in weather patterns.

As shown in table 5.7, majority of the respondents have observed the changes in CC indicators since 6 to 10 years while the least amount of changes is observed in the category comprised of 20 years and above. Around 21 to 24% of the respondents have observed change in CC indicators since 11 to 20 years ago while 12 to 23% of the respondents fall in the category 1 to 5 years since they observed the changes.

Around 72.7% of the respondents reported that they have observed changes in size of glaciers since 6 to 10 years ago, while 23% of the respondents reported change in the same indicator since 1 to 5 years ago. This means that 96% of the respondents are observing change in glaciers within 10 years' time frame, which is alarming than any other climate change indicator in the study area. Chi-square analysis of the results

shows strong correlation (Cramer's V, 0.315) between the age groups for the aforementioned observed changes.

Likewise, 65% of the respondents have observed change in rainfall pattern since 6 to 10 years ago while 13.4% observed the change since 1 to 5 years ago. The sum of the two categories (78.5%) present the second CC indicator in the vicinity. Chi-square analysis for this indicator shows strong correlation between the age groups (Cramer's V, 0.313), education (Cramer's V, 0.146) and income groups (Cramer's V, 0.182).

To elucidate the results above, Figure 5.8 shows the results of a common question asked during survey combining the effect of all the indicators discussed above. The respondents were asked to compare the current weather¹ with the weather 10 to 30 years ago. The survey results show that majority of the respondents selected that weather has warmed (75.3%) than before while 12.9% of the respondents indicated that the weather is actually cooler now compared to the past. A limited number of respondents (12.9%) didn't know about the change in weather pattern. The purpose to ask the question was to get an overall perception in a nutshell about the changing weather pattern in the study area.

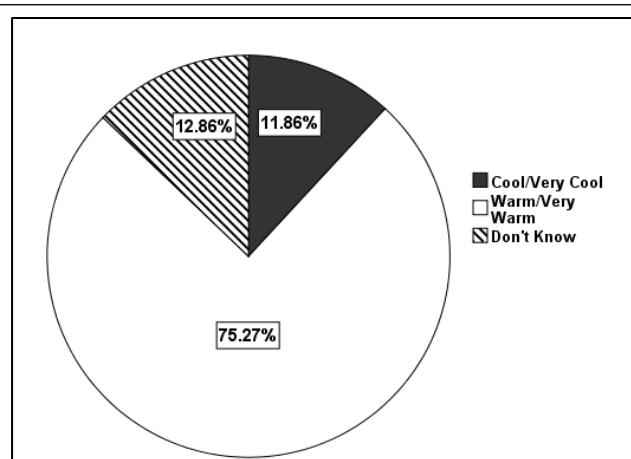


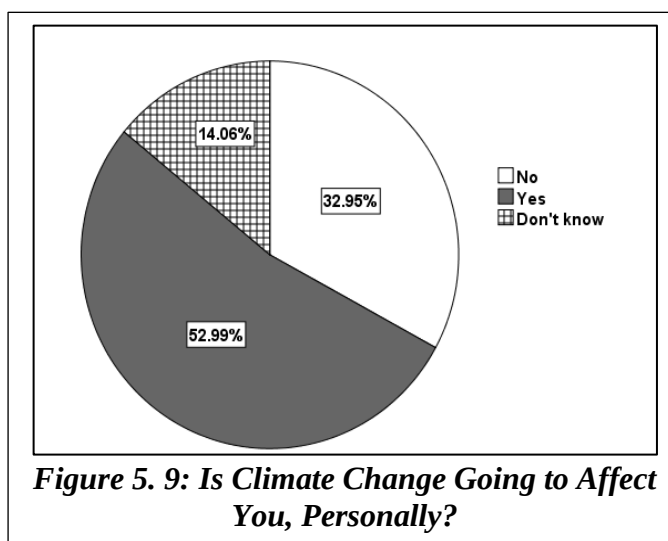
Figure 5. 8: Compare the Current Weather With the Past (10-30 Years)?

Chi-square analysis of the results show that significantly more respondents aged 51 or above (95.8 %***) have specified that the weather is warmed/very warmed compared to the past. Comparatively more respondents aged 21 to 30 (18.4 %***) specified that weather is cooler now compared to the past years. Significantly more respondents with masters/PG (93.3 %*) and Bachelors (90.0 %*) specified that the weather is changed and now it's warmer than before.

¹ Comparison of the weather: Cool, Very Cool, Warm, Very Warm and Don't know. The first four options were grouped for further analysis.

5.7 Climate Change as Personal Threat

To know how the respondents, perceive climate change as a personal threat, in the present or in the near future, respondents were asked about their opinion, the results are shown in Figure 5.9. The results show that majority of the respondents (53%) termed climate change as a threat to their personal lives while 33% of the respondents rejected the opinion as the climate change to be a threat to their personal lives. About 14.1% of the respondents chose “don’t know” as the answer. This shows the concern of the respondents about the climate change, that could their personal lives in any form.



As shown in table in 5.13, as to further expedite the results, respondents were asked about the about the ways climate change will affect them personally. The question was asked to know how much the respondents term climate change as threat to their personal lives. The survey results show that majority of the respondents (29.1% of the total) were concerned about their own and their family health. It can incur that health is the most important factor of livelihoods of the studied communities. The respondents were more concerned about their livelihood resources (23.0%) after the health, therefore the livelihoods got second priority of the respondents. The other common recorded responses were water availability or water scarcity (21.2%), overall family welfare (15.3%), low agricultural productivity (6.5%) and other concerns (4.9%).

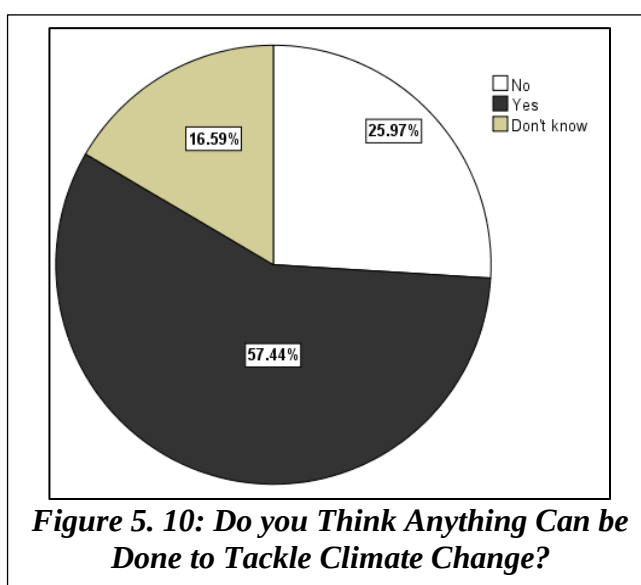
Table 5. 13: Impacts of Climate Change on Personal Lives of the Respondents

Personal effects of CC	N	% of total
Affecting Livelihood	270	23.0
Affecting your health	341	29.1
Affecting Water availability	248	21.2
Overall family welfare	179	15.3
Low Agriculture Productivity	76	6.5
Other	58	4.9
Total	1172	100.0

Statistical analysis of the results indicate that significantly more respondents related to very low income groups are concerned about their livelihoods (51.4%*), and water availability (52.3%**). While more respondents related to low income group are concerned about their health/family health (58.8%*). Conversely more respondents related to very high income group (42.6 %***) and FSc/A-Level (48.6 %*) education are concerned about the overall family welfare. Significantly more middle class respondents are concerned about low agricultural productivity (27.1 %*). Moreover, more respondents with farming (35.6 %****) are concerned about low agricultural productivity.

5.8 Understanding About Tackling Climate Change

As shown in Figure 5.10, the respondents were asked whether they know anything can be done to tackle climate change, about 57.44% of the respondents answered positive, while 16.59% chose that they don't know how to tackle climate change. Around 25% of the respondents didn't know how to take care of the climate change issue. The same



question was asked by Whitmarsh (2005) where two third of the respondents (64.3%)

were affirmative while a significant minority (19%) did not know about tackling climate change.

To further elucidate the results, respondents were asked about the ways or means that can be used to tackle climate change. Table 5.14 shows the results. Majority (34.7%) of the respondents thought that planting more trees is a good way to tackle climate change while the second top response was pollution control (26.0%). The other responses included change in house structure (13.6%), water conservation (9.3%), install air-conditioners (5.6%), Migration (4.3%) and use of renewable energy (3.9%). This is worth mentioning that the survey responses come from general population with a very low literacy rate, yet forestation and pollution control seems convenient to the respondents to confront climate change.

Table 5. 14: Opinions of the Respondents About Tackling Climate Change

Tackling CC	N	Percent
Plant tree/afforestation	450	34.7
Install air conditioners	73	5.6
Change in housing structure	176	13.6
Migration	56	4.3
Transfer from non-renewable to renewable energy	50	3.9
Water conservation in agriculture	121	9.3
Pollution Control	337	26.0
Do Nothing	33	2.5
Total	1296	100.0

5.9 Responsibility of Taking Action Against Climate Change

Table 5.15 shows the opinion of the respondents as to who are responsible to cope with climate change. Majority of the respondents showed their opinion that national government (42.1%) is responsible for taking action against climate change. Provincial government (28%) was selected second that can play a role against climate change while International / Non-Governmental organizations (21.4%) was selected third in this category. A relatively small number of respondents (6.7%) showed their opinion that local community can play a role in action against climate change. The respondents

showed trust and held responsible their elected representatives in action against climate change. Moreover, due to floods of 2010 in district Swat, a large number of international organizations took part in rehabilitation efforts of the flood affected areas therefore respondents have a clear tendency towards role in taking action against climate change in the study area. Government and international organizations rehabilitation efforts after the 2010 floods are shown in Annexure-V.

Table 5. 15: Opinion of the Respondents: Who is Responsible to Take Action Against Climate Change?

Responsible for action against CC	Total (%)	International Organizations (%)	National Government (%)	Provincial Government (%)	Local Community/Individuals (%)	Other (%)
Responses (%)	2168	464	930	608	145	21
Percent (%)	100	21.4	42.9	28.0	6.7	1.0
Cases (%)	207.7	44.4	89.1	58.2	13.9	2.0
Income groups						
Sig.		.000	.688	.000	.424	
Cramer's V		.173	.047	.224	.061	
Very Low Income		61.5	90.9	39.0	12.3	
Low Income		39.0	87.1	56.3	13.5	
Middle Income		36.7	88.4	58.4	12.6	
High Income		44.1	88.8	73.3	13.4	
Very High Income		46.2	90.8	68.5	19.2	
Flood Experience						
Sig.		.000	.000	.000	.001	
Cramer's V		.111	.127	.134	.100	
Respondents experienced flood ^a		47.0	90.7	55.2	12.3	

^a Respondents experienced floods are given in the case study (Annexure-I)

Chi-square analysis indicates that significantly more respondents related to Very Low Income group (61.5 %***) chose international organizations/NGOs responsible for taking action against climate change and there is a significant relationship between all the income groups. National government and local communities showed non-significant ($p > .05$) relationship between the income groups. More respondents related to High Income group (73.3 %***) chose provincial government as having the main responsibility to take action against climate change. Respondents having the flood experience showed significant ($p < .05$) relationship for all the actors responsible for

taking action against climate change, while more respondents chose national (90.7 %***) and provincial (55.2%****) governments responsible for action against climate change issue.

The results are in accordance with studies conducted in other parts of the world. In China and Costa Rica majority of the people have the opinion that government should be responsible for leading actions against climate change (Yu et al., 2013; Vignola et al., 2013) while the people of England regarded international organizations responsible for tackling climate change (Whitmarsh 2005). According to study conducted by Norton & Leaman 2004, most of the Britain people assent that the actions against climate change should be global, rather than national or local.

5.10 Public Understanding About Environmental Changes

As shown in table 5.16, respondents were asked about the observed environmental changes in the study area. The question is multi-response, so more than one answer was expected from the respondents. The survey results show that majority of the respondents have chosen Solid waste increase (60.4%) as the major environmental change. Water pollution is the second major response of the study. The water pollution encompasses contamination of rivers, streams and other water bodies by solid waste and dumping of untreated wastewater in these water bodies. Being no treatment of wastewater in the study area, all the effluents from municipal/domestic areas, industrial units, hotels and restaurants are discharged directly in River Swat (reference). Extreme Weather events (33.7%), loss of biodiversity (28.1%), air pollution (26.3%), and deforestation (25.2%) are other selected environmental changes in the area.

The above results also indicate that environmental pollution comprising air, water and waste pollution constitutes about two third (60.4%) of all the environmental issues in the study area. Chi-square analysis shows that significantly more respondents aged 21 to 30 have observed air pollution (36.6 %***) and water pollution (59 %****) in district Swat. This shows concern of younger generation for the environmental pollution in a system. Significantly more respondents having higher education (graduates/PG) have observed air pollution (77.8 %***) and water pollution (80 %****) while more respondents with FSc/A-Level education (88.5 %****) have observed increase in solid

waste in the study area. Significantly more respondents related to Very Low Income group (53.5 %**) have observed water pollution in the study area.

Table 5. 16: Descriptive Statistics and Chi-Square Analysis of the Observed Environmental Changes in the Study Area

Environmental Changes	Total (%)	Air Pollution (%)	Deforestation (%)	Water Pollution (%)	Increase in Solid Waste (%)	Loss of biodiversity (%)	Extreme weather events (%)	Other (%)
Responses (N)	2133	251	241	461	577	269	322	12
Responses (%)	100.0	11.8	11.3	21.6	27.1	12.6	15.1	.6
Cases (%)	223.1	26.3	25.2	48.2	60.4	28.1	33.7	1.3
Age groups								
Sig.		.000	.599	.000	.141	.018	.087	
Cramer's V		.167	.042	.163	.073	.098	.079	
21-30		36.6	26.3	59.0	62.1	25.4	30.7	
31-40		25.5	21.4	43.5	55.8	23.4	35.1	
41-50		17.8	23.4	41.3	51.4	23.4	29.7	
51 or above		16.9	22.4	33.7	56.0	35.0	24.6	
Education								
Sig.		.000	.000	.000	.000	.003	.000	
Cramer's V		.490	.213	.345	.201	.123	.144	
Primary/Middle		35.9	17.3	51.9	47.7	29.1	26.2	
Matric/O-Level		45.3	21.6	71.0	62.0	22.5	39.9	
FSc/A-Level		57.7	53.8	63.5	88.5	15.4	28.8	
Graduates/PG		77.8	46.7	80.0	77.8	46.7	55.6	
No Education		6.7	21.2	29.9	53.0	24.6	28.9	
Income groups								
Sig.		.305	.153	.003	.502	.000	.140	
Cramer's V		.068	.080	.124	.057	.143	.082	
Very Low Income		24.3	22.2	53.5	60.9	18.4	29.2	
Low Income		23.8	18.8	45.9	53.5	22.0	32.7	
Middle Income		23.3	27.0	45.6	56.3	24.2	35.8	
High Income		20.7	24.5	35.4	52.7	36.2	28.7	
Very High Income		31.3	27.3	36.7	56.3	32.0	23.4	

Water pollution is a common problem in the study area. Most of the settlements near the Swat River dispose the solid and liquid waste directly in to the river. This results in increased level of TS level (Total Solids) of water and fecal contamination and eventually lowering water quality. Some of the streams have high levels of BOD responsible for changes in faunal arrangement of the water bodies. Due to water

pollution in the district, most of the diseases are waterborne in nature (Ahmad et al., 2015).

The second major part of the environmental changes constitute damages to natural ecosystem or loss of natural resources (23.9%) i.e. deforestation and loss of biodiversity. The study area contains various forest and forest species which are under a constant pressure due to cutting of trees by the locals as well as timber mafia. Some of the communities are totally dependent on forest resources for their livelihoods due to poor socio-economic conditions and lack of resources (GoKP, 2015). Both the topics have been explored in the previous sections. Chi-square analysis of the results indicate that more respondents aged 51 or above have experienced and observed the loss of biodiversity (35 %*) in the study area. Significantly more respondents having FSc/A-level education (53.8 %***) have observed deforestation while more Graduates/PG respondents (46.7 %***) have observed loss of biodiversity. More respondents with High Income (36.2 %***) have observed loss of biodiversity. Chi-square analysis shows that more respondents having graduation/PG (55.6 %***) have observed extreme events in the study area.

5.11 Adaptation to Climate Change

Table 5.17 shows the adaptation measures taken by the government, community or the respondents against the climate change vulnerabilities in District Swat. Majority of the respondents (22%) reported that actions have been taken by construction of check dams and protections along River Swat and other tributaries. The other adaptation measures reported are reforestation efforts for planting new trees (19.3%), change in agricultural practices (17.6%), improvement/provision of drinking water supply to the public (13.40%) etc. The adaptation measures are taken to face the real challenges against climate change vulnerabilities and is sometimes critical for survival of a particular community.

Migration of the people is also reported by some of the respondents (6.13%) which shows low level of coping the impacts of climate change in the area. The damaged roads and missing links are being rehabilitated by the government with support from the international community.

Table 5. 17: Adaptation Measures Against Climate Change Vulnerabilities in the Study Area

Adaptation Measures	N	% of Total
Reforestation	355	19.26
Migration	113	6.13
Crops diversification	157	8.52
Changing agricultural practices	325	17.63
Construction of check dams/protection walls	407	22.08
Construction/Improvement of irrigation channels	108	5.86
Improved drainage system/Sanitation	43	2.33
Improvement/Provision of Drinking water supply	247	13.40
Rehabilitation of the road structures	62	3.36
Other measures	26	1.41
Total	1843	100

The adaptation measures taken for the improvement of public water supply infrastructure (13.40%) includes improvement of the spring structures including water distribution, hand pumps with the help of NGOs and improvement/rehabilitation of the water tanks (Annex-III, Table 3 and Annex-V). The adaptation measures taken in the improvement of irrigation infrastructure (5.86%) includes construction of new irrigation channels, improvement of the existing channels, pavement of the channels, installation of tube wells etc. (Annex-III, Table 3 and Annex-V).

The Khyber Pakhtunkhwa Government has initiated a project “Billion Trees Tsunami Afforestation Project”² in the whole province with the objective of planting a billion trees by 2018. The project got international recognition from the Bonn challenge³ of the UN Climate Conference of 2015 held at Paris, France. At the Paris conference, the KP government pledged to restore 384,000 (0.38 million) hectares of degraded land (by reforestation) under its ‘Billion Tree Tsunami’ project with the economic benefit of 121 million USD and climate benefit of 0.04 GtCO₂ sequestered (Khan, 2016). A few snapshots of the Billion Tree Tsunami are shown in Annex-V. The adaptation measures taken against climate change vulnerabilities are better explained in the next section.

² Billion Trees Tsunami Afforestation Project, Forestry Environment and Wildlife Department, Government of Khyber Pakhtunkhwa (Pakistan), <http://103.240.220.71/btt/> [Accessed Nov 03, 2016]

³ Bonn Challenge, at <http://www.bonnchallenge.org/content/pakistan-kpk> [Accessed Nov 03, 2016]

5.11.1 Personal Preferences in Future Adaptation Measures

As shown in Table 5.18, the respondents were asked about their future adaptation measures against climate change. The comprehensive responses are given in Annex-III, Table 4 and summarized in table 5.18. The survey results reveals varying responses. Majority of the respondents (16%) opined that planting more and more is necessary to offset the effect of climate change. The second major response was the provision of safe drinking water (11.9%) for the community in face of climate change. This includes installation of hand pumps for drinking water and improvement in spring structures. This shows the concern of the respondents towards the availability of drinking water. Considerably a large number of respondents (9.6%) reported that they would migrate from their respective area, if climate change threatens their lives. The water conservations in irrigation systems (8.31%) were given importance, for minimizing water losses compared to conventional setup. As discussed earlier, climate change is going to affect the livelihood sources of individuals therefore some of the respondents chose to change their livelihood sources if affected by climate change (6.72%).

Community awareness (7.16%) campaigns can play a vital role in disseminating climate change information to the public. This includes flood emergency awareness, mass awareness about environmental issues and the use of social media such as Facebook, Twitter etc. for awareness (Annex-III, Table 4). Use of energy efficient houses (5%), reducing the use of fossil fuels (4.86%), use of renewable energy (4%) such as Solar energy, Biogas etc), rainwater harvesting, promotion of eco-tourism (3.18%), pollution control (2.74%) and protecting the community forests (2.74%) are commendable adaptation measures resulted in the survey.

Table 5. 18: Personal Preferences in the Future Adaptation Measures Against CC Vulnerabilities in the Study Area

Adaptation Measures	N	% of Total
Energy efficient homes	57	5.04
Community Awareness	81	7.16
Migration	109	9.64
Plantation of trees	182	16.09
Promote Eco-Tourism	36	3.18
Use of Renewable Energy	46	4.07
Reducing the use of fossil fuels	55	4.86
Protecting the community forests	31	2.74
Rainwater harvesting	36	3.18
Assistance from Government	67	5.92
Use of modern agriculture practices	57	5.04
Provision of safe drinking water	134	11.85
Pollution control	31	2.74
Change of livelihood source	76	6.72
Water conservation in irrigation systems	94	8.31
Other measures	39	3.45
Total	1131	100.00

5.11.2 Role of Community Actions in CC Adaptation

The respondents were asked whether they think community actions can play a role in actions against climate change or vice versa. The question was based on Likert scale (strongly agree to strongly disagree). Majority of the respondents (77.2%) were agree (strongly agree/agree) that climate change can be slowed down community measures while 8.7% of the respondents disagreed to this point of view. Some of the respondents were not sure (14.2%) about the role of community actions in climate change adaptation (figure 5.11).

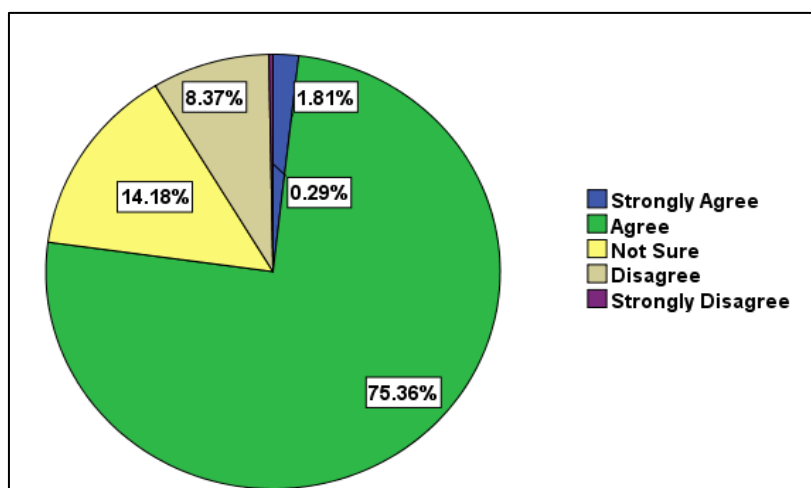


Figure 5. 11: Can CC be Slowed Down by Community Actions?

The interview results showed that some communities have taken actions against climate change vulnerabilities. For instance, some of the respondents reminded that they had collectively improved the spring condition by making enclosures surrounding the spring and extending pipelines for water supply to the community. A respondent replied that (Box 5.5);

Box 5.5: Public Views About Climate Change

“Community based natural resource management (CBNRM) is the easiest way to tackle major environmental problems, so they have worked with different NGOs for solving and environmental community problems”.

Some of the other actions taken by community together are water management, protection of forests, establishing micro-scale hydal power plants and steps to reduce soil erosion. While some of the respondents were of the opinion that they can’t do nothing stating that “*we are nothing in front of nature*”. The role of community in climate change adaptation is imperative. In order to minimize the losses from climate change hazards in the future, community should be equipped by initiating awareness campaigns and trainings so respond quickly and positively (Khan et al., 2012).

5.12 Barriers to CC Adaptation

The respondents were asked about the barriers in adapting to climate change vulnerabilities, a variety of the responses were recorded by from the respondents. The question is multi-response so more than one answer was expected from the respondents. The results are shown in table 5.20 and further elaborated in the following paras.

5.12.1 Lack of Knowledge

The survey highlights that lack of knowledge (18.6%) and illiteracy (10.7%) are the main hurdles in taking measures against the climate change vulnerabilities. Here the lack of knowledge encompasses all the information about change in weather patterns and climate while the illiteracy constitutes, lack of overall education. As discussed previous in section 5.15, the literacy rate of the respondents is quite low which corresponds to low knowledge about climate change vulnerabilities in the study area. The interview results show that most of the respondents were aware how the weather is changing but were unaware about the exact term of climate change. They attributed

climate change to cutting of trees and vehicles pollution contributing to increased temperature of the air.

Table 5. 19: Main Barriers to Adaptation Against Climate Change in the Study Area

Barriers to Adaptation	N	Percent
Lack of knowledge	597	18.6
Lack of access to communication	568	17.7
Population growth	527	16.4
Insufficient cultivatable land	361	11.3
Illiteracy	342	10.7
Lack of proper technology	235	7.3
lack of awareness about CC	187	5.8
Lack of technical knowhow	140	4.4
Corruption	65	2.0
Govt. Incompetence/lack of govt. interest	29	0.9
Land tenure	24	0.7
Low Soil Quality	15	0.5
Poor seeds	14	0.4
Other measures	102	3.2
Total	3206	100.0

5.12.2 Lack of Access to Communication

The second hindrance to climate adaptation in the study is lack of communication (17.7%). The study area lacks basic facilities of communication, which can help to provide with required about climate change. For instance, interview data shows that many respondents showed anger and despise against the unavailability of electricity (most of the area are deprived of electricity, either they are facing severe power shortages, outages or load shedding which is other name of load management). Due to that reasons, respondents expressed that they don't have access to electronic media especially television and internet so they don't have up-to-date knowledge about change in weather patterns and other relevant information.

5.12.3 Population Growth

As shown in Table 5.20, Population growth (16.4%) is likewise a main hurdle in climate change adaptation efforts in district Swat. According the population census 1998,

population of district Swat was 1.26 million (1257602 persons to be exact). While the annual population growth rate lies within 3 to 4% (average annual growth rate during 1981 to 1998 was 3.37%) (GOP, 1999). This coincides roughly to 2283728 persons (2.3 million) in 2016 using web-based human population indicator⁴. With roughly one third population increase in the last 18 years, population increase is directly related to fossil fuels consumption, deforestation and exploitation of natural resources in the study area. The interview results showed that respondents were of the opinion that during the past 30 years, the population increase resulted in damaging the environment, thus contributing to climate change. The damages included cutting of the trees, pressure on water bodies as a result there was increase in solid waste and industrial waste in River Swat. Agriculture land was converted into residential areas even there was constructions in the flood zones (Ahmad et al., 2015). Moreover, more and more animals are reared for the purpose of fulfilling the dietary needs, resulting in to overgrazing. So all these problems of deforestation, overgrazing and terrace farming give way to increased runoff, increased soil erosion, decreased soil fertility and siltation problems in Swat.

5.12.4 Economic Barriers

The economic barriers have a major role among the other barriers to climate in the area. Limited area is available for agriculture as pointed out by 11.3% respondents, which is forcing the farmers for sustenance agriculture. Similarly, the land tenure system is also not farmer friendly as identified by 0.7% respondents. Other problems include soil fertility (0.5%) and poor seeds (0.4%), due to which cannot give attention to climate change adaptation. Most of the district comprise of the mountains, rivers/streams and built-up area, thus leaving a very low space for agricultural lands. Due to low income generating resources, the respondents cannot bear the pressure from the environment or climate change in the study area. Some of the respondent reported that they haven't have access to good quality seeds from the government, therefore cannot get higher yields from their farming lands, pressurizing their economy.

5.12.5 Governance Barriers

Some of the respondents discoursed that lack of governance contributes to the actions against climate change. Corruption in the government system (6.2%) and lack of government interest (2.8%) in the climate change issue are main reported issues.

⁴ <http://www.metamorphosisalpha.com/ias/population.php> [accessed Aug 07, 2016]

Although government have imposed ban on cutting of the forests but yet the cutting continues due to the corruption in the system.

The government system is not participatory in measures against climate change. In most of the upper part of District Swat the access roads and drainage system damaged haven't been rehabilitated by government departments. This aids to the low accessibility of the inhabitants and exposure too many health and food shortage risks in the vicinity.

5.12.6 Social Barriers

Lack of awareness as pointed out by 5.8% respondents is another big problem area to understand and cope with climate change. The lack of awareness about the causal agents of climate change is a big hurdle in the path of adaptive measures as discussed in section 5.3. Moreover, despite the grave situation that Pakistan is exposed to the dire impacts of climate change, the school and college curricula lacks information about climate change, which is why our children and youth don't have any knowledge about the changing mode of climate change.

5.13 Demographic Features of the Study Area

5.13.1 Age

Age is most of the important demographic feature of the study. Certain precautions were taken during the survey. During the questionnaire survey care was taken to interview the household heads and conduct oral interviews from high age respondents. The reasons being to get benefited from their wide knowledge about their surroundings. The results show that the respondents above the 30 years' age make a total of 81.5% of the respondents. The least age group of the study is 21-30 which make only 19.5% of the whole.

Table 5. 20: Demographic Characteristics of the Study Area (n = 1055)

Demographic Characteristics	Number	Percent
Age(years)		
21-30	206	19.5
31-40	375	35.5
41-50	290	27.5
51 or above	184	17.4
Education		
Not having Formal Education	578	54.8
With Formal Education	477	45.2
<i>Primary/Middle</i>	<i>239</i>	<i>50.10</i>
<i>Matric/O-Level</i>	<i>140</i>	<i>29.35</i>
<i>FSc/A-Level</i>	<i>53</i>	<i>11.11</i>
<i>BA/BSc</i>	<i>27</i>	<i>5.66</i>
<i>Graduates/Postgraduates</i>	<i>18</i>	<i>3.77</i>
Income (PKR)		
Up to 10000	191	18.24
10000-20000	321	30.66
20000-30000	216	20.63
30000-40000	189	18.05
> 40000	130	12.42
Household's size		
Up to 5	35	3.3
6-10	547	51.8
11-15	290	27.5
16 and above	183	17.3
Average = 11.62 persons, SD = 5.121		
Livelihood sources		
Farming/Agriculture	453	42.9
Tourism	174	16.5
Fisheries	84	8.0
Livestock	61	5.8
Forest Resources	56	5.3
Medicinal Plants	17	1.6
Government service	75	7.1
Business	88	8.3
Other	47	4.5

5.13.2 Education

The study revealed that more than half of the respondents (54.8%) have no formal education. The situation is alarming but this is a distressing issue of the developing

countries. Literacy rate in the study area is quite low as evident from table 5.20. According to the population census 1998, the literacy ratio (10 years and above) in the district is 28.75% (Male 43.16%, Female 13.45%). This shows striking resemblance with the results from our study which consists of male literacy only. Although it is expected that since 1998 there could be positive change in the literacy rate of district Swat but our sample consists of more than 80% of respondents aged more than 30 years of age, which means that if there could have an increase in the literacy rate since the last census, it is more likely that within this age group, literacy rate would be the same as depicted in census report 1998 (DCR, 1998).

When analyzed for the educated respondents among the total sampled respondents, primary education makes the highest proportion with 50.1% of the total educated or qualified respondents while the Matric/O-Level makes the second largest fraction and Masters makes 3.4% of the educated respondents. When analyzed within the age groups, age group 31-40 were found to be the most educated (39.6%) while the 51 or above aged respondents were the least educated (7.5%).

5.13.3 Household's Size

The average household's size of the survey respondents is calculated as 11.62 persons. A major proportion (51.8%) of the respondents had a household size of 6 to 8 persons while 17.3% of them have household size of 11 to 15 persons. The main reason behind the high households' size is joint family system of the study area where all the family including parents, grandparents, sons, daughters, children and grandchildren lives in the same house constituting a big family size. The socio-economic reason is one of the basic motives behind such a large family, where the businesses and income sources are inherited from the parents and thus this keeps the family intact with most of the family involves in the same income generating activity.

5.13.4 Income

Table 5.20 shows the income level of the respondents in the study area. The income per month (PKR) has been converted to income categories for the ease of further analysis. The data shows that 49% of the respondents belong to either Very Low or Low income groups while 20.6% of the respondents belong to middle class.

5.13.5 Livelihood Sources

The major proportion (42.9%) of the surveyed respondents belong to agriculture/horticulture based livelihoods while tourism (16.5%) is the second major reported livelihood source. The other livelihood sources of the respondents are fisheries (8%), livestock (5.8%), forest resources (5.3%), medicinal plants (1.6%), government employees (7.1%) and business (8.3%).

RESULTS AND DISCUSSION (PART-II)

CLIMATE VULNERABILITY TO THE LIVELIHOODS SOURCES

This section of the results chapter deals with the impacts and vulnerabilities of climate change to the various livelihood sources of the study area. These includes agriculture/horticulture, tourism and fisheries. Hundreds and thousands of families and individuals are dependent on these livelihoods for sustenance. This part of the chapter draw results from the questionnaire survey conducted for each livelihood source, oral interviews and focus group discussions.

5.14 Agriculture

5.14.1 General Attributes of Agriculture in the Study Area

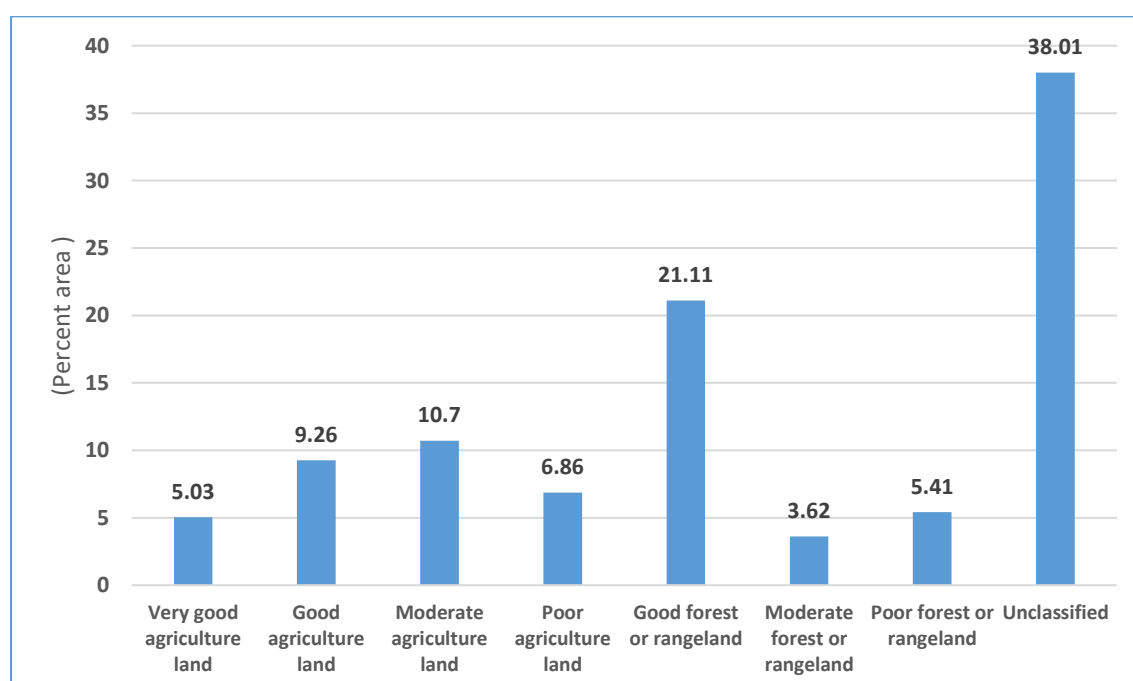
The land holdings structure of the respondents shows that average landholdings is 20 kanals ranging from a minimum of 2 kanals (.25 ares)) to a maximum of 135 kanals (16.87 acres). Around half of the respondents (50.5%) have 10 kanals or less of land holdings while 7.8% have 30 kanals or more. Land ownership of the respondents show that majority (88.6%) of the respondents own lands while 11.4% of the farmers either rented or borrowed the farming lands.

With respect to the farming land quality, a major portion of 86.2% of the respondents reported their land to be either good or very good while a mere 13.8% of the respondents/farmers reported their land quality to be bad (Table 5.21). According to land classification of the study area conducted by Nafees (2008) 14.29% of the total area is either very good or good agriculture land, 10.7% is moderate agriculture land and 10.4% is poor agriculture land. The rest of the area is designated to forest land and unclassified as shown in figure 5.12

Table 5. 21: Land quality, Ownership and Irrigation Type Within the Surveyed Respondents (n = 333)

Agricultural attributes	N	Percent
Land ownership		
Possessing (Owned)	295	88.6
Renting	36	10.8
Borrowing	2	0.6
Land quality		
Good	235	70.6%
Very Good	52	15.6%
Bad	46	13.8%
Irrigation Type		
Tube well	24	7.2%
Rain-fed	17	5.1%
River/canal/stream	292	87.7%

According to the respondents three types of irrigation system are practiced in the study area; tube wells (7.2%), river/streams (87.7%) and rain-fed (5.1%). The most practiced irrigation type by the farmers is drawing water directly from the river/streams or using canal system originated from these streams in the study area.



Source: Nafees, 2008

Figure 5. 12: Land Capability Classes in District Swat

The major crops grown in the study area are shown in figure 5.13. The main crops grown included wheat (27.6% of the respondents), Maize (16.4% of the respondents), and rice (11.9%) while the vegetables grown in the study are included onion (18.1%), tomato (7.5%), peas (other), okra (other) and Garlic (other). The study area is also famous for its fruit production namely Peach (7.1%), persimmon, apples (other), and pear (other) etc.

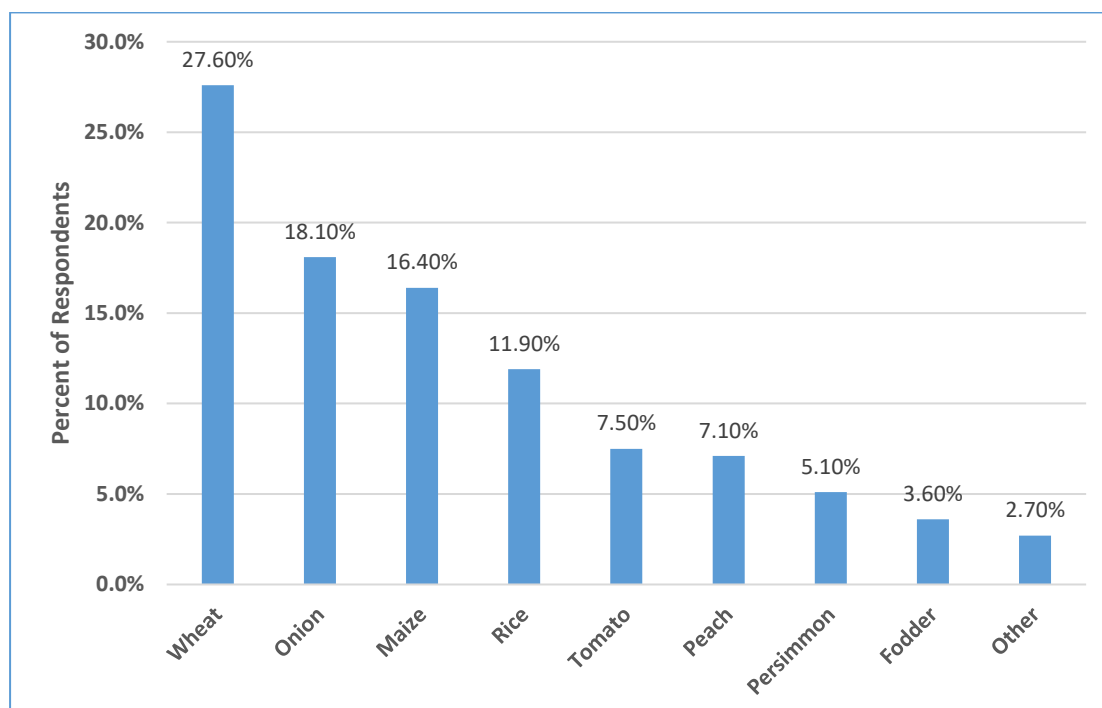


Figure 5. 13: Major Types of Crops Produced by the Survey Respondents (n = 333)

5.14.2 Crop Production Affected by Natural Disasters

The results indicate that natural disasters have affected large areas of growing crops at the moment. More than half ($n = 173$, 52%) of the respondents reported that they received damages to their crop production/horticulture and the farming lands as the result of natural disasters. Among these respondents, more than 80% of the respondents/farmers reported that they had received damages to 60% of their farming lands or less than that (Figure 5.14). The rest of the respondents have received more than 60% damages to crop production/horticulture in the last 10 years. The mean affected crop production/horticulture due to natural disasters was found to be 38.5% (SD $\pm$ 21.223) with minimum of 5% and maximum of 90% (Annex-III, Table 5).

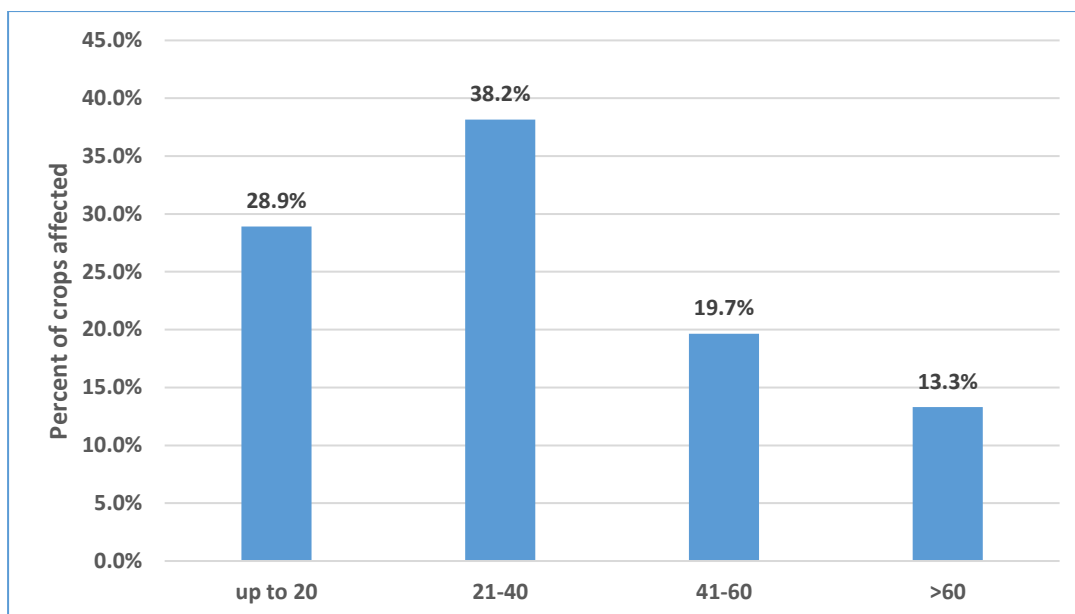


Figure 5. 14: Percentage of the Crop Production Affected Due to Natural Disasters in the Past 10 Years

The interview results are in agreement with the questionnaire survey where respondents declared huge losses of due to natural disasters in the last 10 years.

The respondents were asked that whether their land area/farming area changed in the past 10 years, the response can be visualized in figure 5.15. About 15% of the respondents have reported that their farming area reduced or much reduced by 15% over the couple of years.

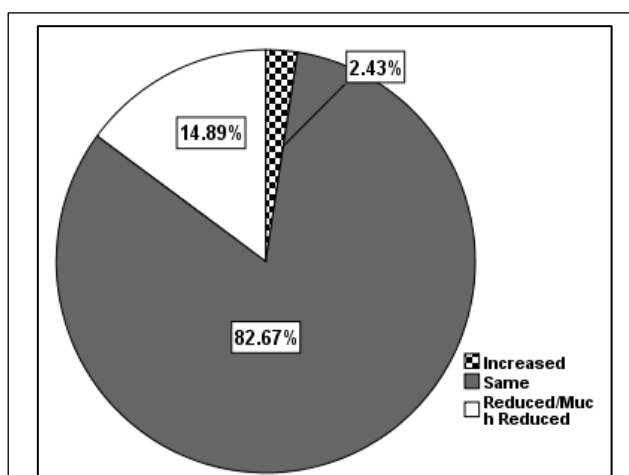


Figure 5. 15: Change in the Farming Land Area Over the Past 10 Years

In the next step, respondents were asked about the reasons behind the reduction in farming areas, 63.3% of the respondents reported that they lost their lands due to flooding while 16.3% of the respondents reported drought to be the main reason (Annex-II).

5.14.3 Limiting Factors for Agriculture

Table 5.22 shows the main issues farmers are facing affecting the crop production in district Swat. The question contained multiple responses, so the respondents could choose more than one option. The survey results showed that most of the respondents (20.6 %) chose lack of modern agricultural machinery as the major problem responsible for reduced crop production in their respective areas. The second major problem chosen by the respondents was lack of good variety of seeds (17.3 %). The other problems included lack of good irrigation practices (16.8 %) and lack of finance 15.2% %).

The weather related issues responsible for reduced crop production chosen by the respondents included erratic rainfall/droughts (12.2 % of the respondents), loss of land (8.2 %), bad weather (7.3 %) and high rainfall (2.4 %). The categories that got less than 20 responses were excluded from the analysis.

Table 5. 22: Major Problems Responsible for the Reduction of Crop Production in the Study Area

<i>Problems</i>	<i>N</i>	<i>% of respondents</i>
Lack of modern techniques	174	20.6
Lack of good variety seeds	146	17.3
Lack of good irrigation practices	142	16.8
Lack of finance	128	15.2
Erratic rainfall/Droughts	103	12.2
Loss of land	69	8.2
Bad Weather	62	7.3
High rainfall	20	2.4
Total	844	100.0

The interview data shows that farmers were of the opinion that due to small farming areas, they can't practice the modern techniques. Some of them still don't rely on fertilizers and pesticides which reduces their crop production. Some of the farmers reported that they were provided with bad variety of seeds by the government last year which resulted in low yields. They were requesting government to provide them good quality of seeds for better crop production.

According to the respondents, the occurrences of droughts have increased, therefore crop yields are reduced. One of the farmer replied that, “*This year seems to be drought*”. A farmer in UC Totanu Banda replied that maize crop has been delayed due to low rainfall that is about 20 to 25 late and moreover, the yield has been decreased by 40%.

5.14.4 Severity of Weather Related Hazards

A list of various weather related natural hazards were enquired from the respondents and their impacts on the crop production. The results are given in table 5.23;

The survey analysis shows that among the given weather related hazards, flooding is ranked the top by the farmers/respondents with a mean score of 3.77. Droughts received the second rank among the natural hazards with a mean score of 3.46 due to its importance for the crop production. Low/no rainfall scored a mean score of 3.08 among the severity of weather related hazards. The absence of rainfall give rise to the drought condition.

Table 5. 23: Severity of Weather Related Hazards on the Crop Production/Farming of District Swat

<i>Natural Hazards</i>	<i>N</i>	<i>Not Severe (%)</i>	<i>Least Severe (%)</i>	<i>Moderate Severe (%)</i>	<i>Severe (%)</i>	<i>Very Severe (%)</i>	<i>Mean Score</i>	<i>Std. Deviation</i>	<i>Rank</i>
Floods	333	7.8	9.6	20.4	34.2	27.9	3.77	1.205	1
Droughts	331	4.5	17.5	26.3	30.5	21.1	3.46	1.139	2
Low/No Rainfall	333	8.7	25.5	28.8	22.8	14.1	3.08	1.181	3
Storms	333	43.2	20.7	18.6	12.3	5.1	2.25	1.246	4
Warm Wave	333	64.6	14.7	15.9	4.8	-	1.61	.920	5
Land Slide	333	77.8	8.7	11.4	2.1	-	1.38	.769	6
Cold Wave	333	84.7	6.3	7.5	1.5	-	1.26	.658	7

Note: The question was based on 5 point Likert type scale (from Not Severe to Very Severe).

5.14.5 Adaptation Measures in Agriculture

As shown in table 5.24, respondents were asked about the adaptation measures adapted against climate change vulnerabilities in agriculture sector, various responses were recorded. Most of the farmers indicated that they have changed crop variety (22.3 %)

to adapt to the changes in climate. A major part of the respondents adopted water conservation techniques (20.5%) due to the effects of climate change. A considerable number of respondents selected improved seed varieties (20.0 %) as an adaptation measure to climate change while 14.1 % of the respondents have chosen that they irrigated more. The other adaptation measures include finding another job (5.3%), adopting soil conservation techniques (4.8%), leasing out land (3.3%), reduction of the number of livestock (2.7%), migration (2.4%), rainwater harvesting (2.3%) and other adaptation measures (2.2%).

Table 5. 24: Adaptation Measures Adapted by Respondents in Response to Climate Change

Adaptation Measures	N	% of respondents
Change crop variety	201	22.3
Adopting water conservation techniques	185	20.5
Improved seed varieties	180	20.0
Irrigate more	127	14.1
Find another job	48	5.3
Adopting soil conservation techniques	43	4.8
Leasing out land	30	3.3
Reducing the number of livestock	24	2.7
Migration	22	2.4
Rainwater harvesting	21	2.3
Other measures	20	2.2
Total	901	100.0

Note: Responses less than 20 have been excluded from the results

The interview results showed that farmers had started using improved seed varieties for better yield as some of the respondents had experienced low production due to lower quality of seed in the past. Due to damage of fertile soils, some of the respondents stated that they were using soil conservation techniques to adapt to the situation. Some of the respondents stated that they had built protection walls around the fields to stop erosion or cutting of their lands. Especially it became concern after the floods which washed away a lot of agricultural lands.

The community based adaptation measures in agricultural sector are explicitly given in section 5.11. In another question, respondents were asked about the assistance they need from the government in fighting against climate change vulnerabilities in the study area. It was revealed that the main requirement they had from the government was better variety of seeds (50.8% of the respondents). As discussed before, the respondents were unhappy about the government attitude towards the provision of low quality seeds to the farmers, which made their livelihoods at stake. Due to low economic condition of the farmers, 26.0% of the respondents required agricultural loans to continue their agricultural practices. Some of the respondents (21.5%) were interested in jobs. They were pessimistic about the agricultural activities, so that they wanted their offspring to have a change their livelihood sources and get a government job with a steady pay.

5.14.6 Use of Sustainable Agriculture Techniques

As shown in figure 5.16, a major portion of the famers use compost manure for crop production. Crop rotation is used by 20.9% of the respondents while 12.10 % of the respondents practiced terrace farming in their fields. The terrace farming is important in terms of maximizing surface area, minimize soil erosion and runoff.

The use of sustainable agriculture provides high crop yields without damaging the natural systems and resources that yield depends on. The sustainable agriculture techniques are employed to get the key goals of pest control, weed control, erosion control, disease control and high soil quality (Norman et al., 1997). The above indicated measures are good form of adaptation to climate vulnerabilities without compromising on the soil and environmental quality.

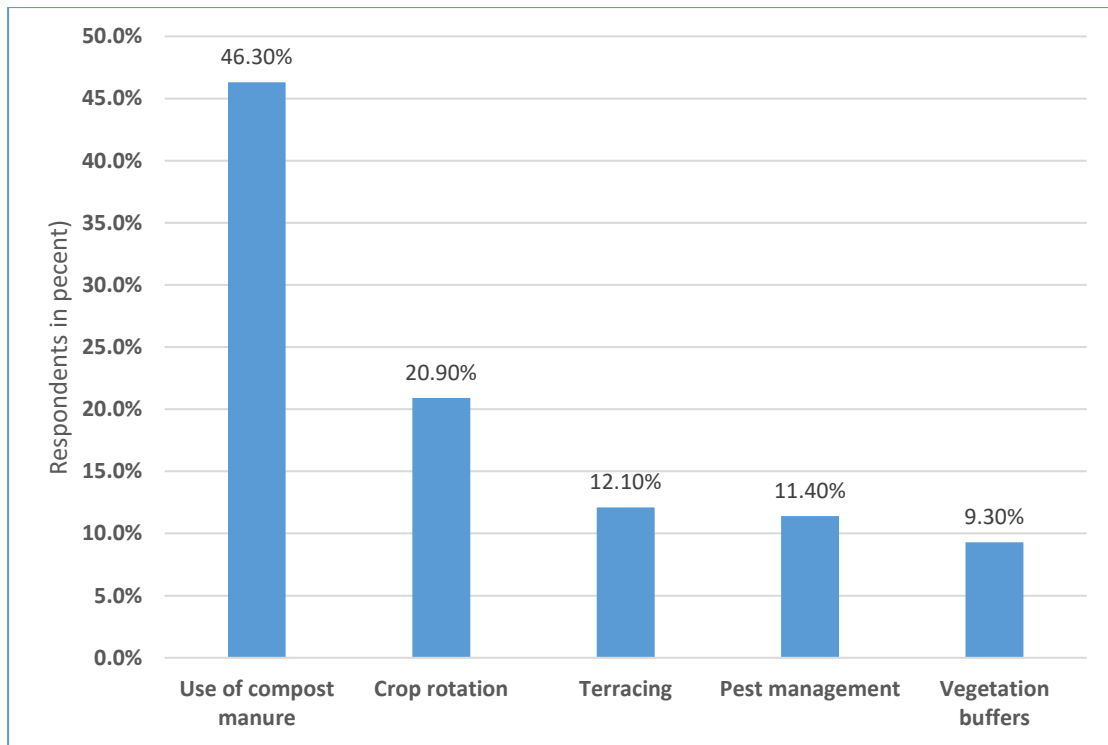


Figure 5. 16: Use of Sustainable Agriculture Techniques by The Farmers in the Study Area

5.15 Tourism

The valley features many great attractions for the tourist which provides livelihood source to many inhabitants of the valley. Swat Valley is known for its beautiful lush green mountains and swift rivers around the world. Tourism industry is well established in the district. There are currently 850 hotels and restaurants operational accommodating 15000 people working directly as employees and owners of these establishments while 25000 more people are attached to other related businesses. The scenic natural beauty and rich cultural Gandhara civilization/relics offers an important place for local and international tourists to visit the Swat district (District Disaster Management Plan 2015-2020; Ali et al., 2013).

Table 5.25 gives a picture of the respondents' relationship to the tourism industry in the study area. Most of the respondents are directly related to the tourism industry, with about 40% of the respondents in the hotels and restaurant businesses, 22.5% in the transportation and 32.4% in other related businesses such as grocery and general stores etc.

Table 5. 25: Relationship of Respondents to the Tourism/Eco-Tourism Industry in District Swat

Relation to tourism	N	% of Respondents
Hotel business	26	15.0
Restaurant	43	24.9
Transportation	39	22.5
Tourist Guide	9	5.2
Other Businesses	56	32.4
Total	173	100.0

Swat valley is famous for its pristine beauty and natural attractions for the tourists. The respondents were asked about the tourist attractions in their respective areas as shown in figure 5.17. The main attraction of the area is streams as pointed out by 216% of the respondents followed by springs (18.5%), Beautiful landscapes (10.9 %), Lakes (8.8%) and forests 5.8%). The other tourist attractions of the area include hiking and camping (5.3%), Wilderness (4.3 %), Wildlife (4.2%) and glaciers (3.4%).

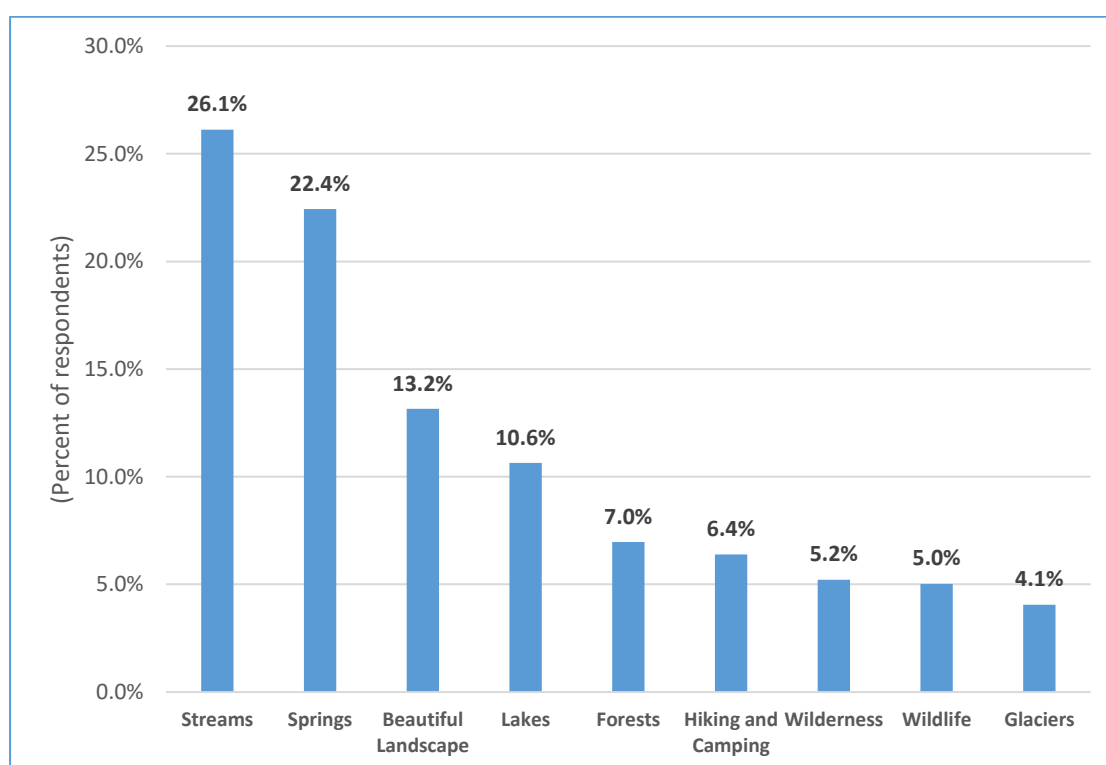


Figure 5. 17: Main Tourist Attractions in the Study Area

5.15.1 Climate Hazards to Tourism

As shown in table 5.26, the respondents were asked about the climatic hazards to the tourism industry of District Swat, majority of the respondents were of the opinion that floods (19.1% of the respondents) is the main climate change hazard to tourism sector in the study area followed by deforestation (13.8% of the respondents) and loss of glaciers (12.5%). The other hazards related to climate change affecting tourism in district Swat are road erosion (11.1%), extreme weather conditions (9.3%), Landslides (8.2%), increased forest fire (6.8%), increase in temperature (6.8%), loss of biodiversity (5.2%), loss of scenic beauty (3.8%) and quality of River Swat (3.5%).

Table 5. 26: Climate Change Hazards to Tourism Industry in District Swat

CC hazards	N	Percent
Floods	136	19.1
Deforestation	98	13.8
Loss of Glaciers	89	12.5
Road erosion	79	11.1
Extreme weather conditions	66	9.3
Landslides	58	8.2
Increased forest fire	48	6.8
Increase in Temperature	48	6.8
Loss of bio-diversity	37	5.2
Loss of scenic beauty	27	3.8
Quality of River Swat	25	3.5
Total	711	100.0

The Swat valley is famous for its eco-tourism potential and this sector remained as backbone of the local economy as tourism is one of the main livelihood sources of district Swat (Khan et al., 2010).

To quantify, how much will the Climate change negatively influence tourism sector in District Swat, respondents were asked about the effect of climate change on the tourism.

The results as shown in figure 5.18 indicate that 85.5% of the respondents regarded that climate change is going to affect the tourism sector in Swat district while a mere 14.5% of the respondents rejected the impression that CC would be any harm to tourism sector in the study area.

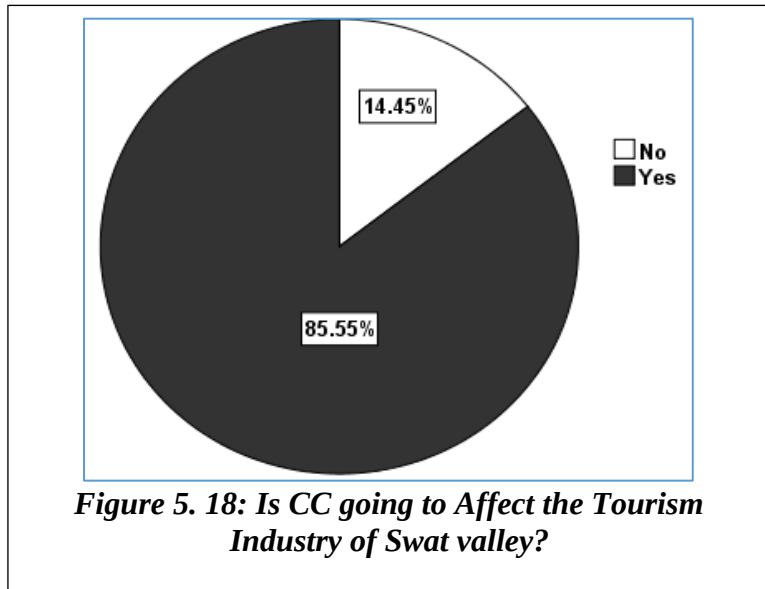


Figure 5. 18: Is CC going to Affect the Tourism Industry of Swat valley?

5.15.2 Severity of Weather Related Hazards

As shown in Table 5.27, respondents were asked about the severity of

natural hazards exerted on the tourism sector of district Swat. Unsurprisingly, the flooding as a natural hazard was ranked first with 3.69 mean score by the respondents while cold wave is ranked 2nd with mean score of 2.68. The other natural hazards include landslides with mean score of 2.56, low/decrease in snowfall with mean score of 2.28, storm (2.08), quality of river water (1.77), warm/heat wave (1.59) and low/no rainfall (1.05).

Table 5. 271: Severity of Weather Related Hazards Related to the Tourism Sector of Swat

Natural Hazards	N	Not Severe (%)	Least Severe (%)	Moderate Severe (%)	Severe (%)	Very Severe (%)	Mean Score	Std. Deviation	Rank
Flood	144	14.6	8.3	7.6	31.9	37.5	3.69	1.421	1
Cold wave	142	28.4	21.3	16.3	22.0	12.1	2.68	1.401	2
Landslide	144	35.4	11.8	18.8	29.2	4.9	2.56	1.357	3
Decrease in Snowfall	144	35.4	26.4	19.4	12.5	6.3	2.28	1.243	4
Storm	140	41.0	23.6	22.9	12.5	NA	2.08	1.072	5
Quality of River Water	141	56.7	17.7	17.0	8.5	NA	1.77	1.017	6
Heat wave	141	58.9	23.4	17.7	NA	NA	1.59	.775	7
Low/no rainfall	141	97.1	.7	2.1	NA	NA	1.05	.302	8

About 70% of the respondents reported that floods are the most potent of all the weather related hazards when combined severe or very severe. A large number of infrastructure such as hotels, restaurants, bridges, houses, roads, architectural sites and recreational spots had been damaged by the floods in district Swat (Annex-III, Table 10). These damages costed thousands of livelihoods in the tourism sector. About 88% of the respondents were affirmative that the floods have affected tourism activities in the district (Annex-III, Table 9).

Landslides are also common at the flood affected areas. According to the respondents after the floods and heavy rainfall of 2010, many roads were washed away by floods and roads were blocked by landslides, which occurred from the loosened mountain structures. These landslides are still very common on Kalam road, where the roads are still damaged and the hills running along the roads results in landslides (Buneri, 2016). This results in the transportation problems for residents and tourists (Khan, 2016).

5.15.3 Factors Influencing Tourism

Table 5.28 shows the factors negatively influencing tourism in the study area. The locals attached to the tourism sector in the area reported were certain about the decrease in number of tourists (39.4%) while 31.7% of the respondents viewed that climate change as affecting their livelihoods. The other responses included damage to natural (17.8%) and built environment (11.2%).

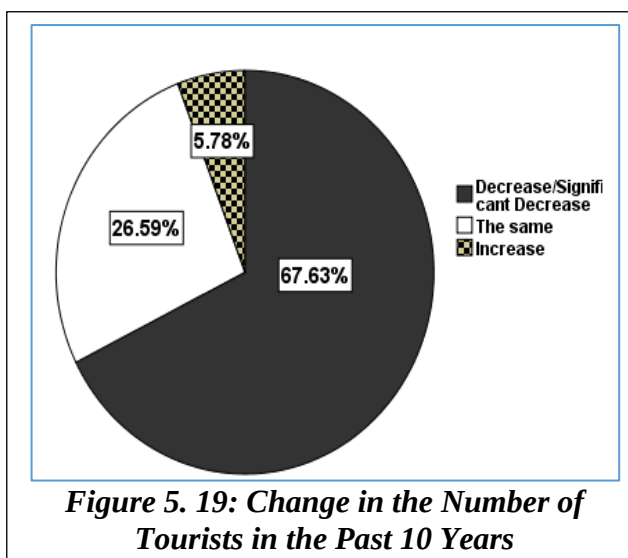
Table 5. 28: Factors Influencing Tourism Sector in District Swat

<i>Factors influencing tourism</i>	<i>N</i>	<i>Percent</i>
<i>Decrease in number of tourists</i>	102	39.4
<i>Affecting livelihoods</i>	82	31.7
<i>Damage to natural environment</i>	46	17.8
<i>Damage to built environment</i>	29	11.2
<i>Total</i>	259	100.0

The above table indicates that decrease in number of tourists has a direct effect on the livelihoods of the individuals working in the sector. To verify that, respondents were asked that whether climate change is a concern for their businesses or livelihoods, 97%

of the respondents were affirmative that climate change is a personal threat to their livelihoods (Annex-III, Table 11).

To evaluate if climate change has any effect on the number of tourist visiting the study area, respondents were asked whether they have observed any change in the number of tourists in the last 10 years, the results indicated as shown in figure 5.19 that majority of the respondents (66.7%) were of the opinion that the number of tourist are either decreased or significantly decreased during that period. Some of the respondents (26.6%) reported that the number of the tourist is the same as before whereas a small number (5.78%) of respondents reported a slight increase in tourists' number.



As shown in table 5.29 when asked about the main causes behind the decrease or significant decrease in the number of tourists in the study area, flooding in the river Swat 31.2% of the respondents) was reported as the main culprit behind the decrease in the number of tourist in the study area.

Table 5. 29: Main Reason for the Change (Decrease or Significant Decrease) in the Number of Tourists in the Study Area

<i>Reasons</i>	<i>N</i>	<i>% of respondents</i>
Flooding in River Swat	103	31.2
Damages to Access roads	86	26.1
Increase in Temperature	59	17.9
Security concerns	47	14.2
Lack of Govt. Interest	35	10.6
Total	330	100.0

Note: Responses less than 20 have been omitted from the results. The question is multi response, therefore the total number of responses is exceeding 100%.

The second reported reason was damages to access roads (26.2%) followed by increase in temperature (17.9%), security concerns (14.2%) and lack of government interest (10.6%). The above results show that flooding is main reason behind the decrease in the number of tourists. As discussed earlier, floods bring havoc to the whole district damaging infrastructure and tourism hotspots in the area. The detailed damages of floods and its relationship to climate change is well documented in the previous sections.

5.15.4 Adaptation Measures in Tourism Sector

Table 5.30 explains the adaptive measures taken by the government and other taken locally. After the flooding event of 2010, government is being busy in the rehabilitation of the damaged infrastructure such as road networks, water supply system and sewerage system. Efforts have been made to construct safety walls and embankments around the River Swat. Apart from that, the tourism department is set to promote tourism in the Swat valley by taking efforts for the promotion of tourism such as Kalam cultural festival and promotional advertisement on the media.

The flooding of 2010 rendered a major blow to the people dependent on the tourism by damaging their hotels, restaurants, and other local businesses. As local adaptive measures, people are making efforts to rekindle their livelihoods sources in the valley. Table sheds light on the adaptive measures taken by the locals of the district Swat. The damaged hotels and restaurants are being restored and they are providing better services to the tourist visiting the valley. Small hydal power plants have been established by the locals, in the areas where government is still unable to provide/restore power. Social media such as Facebook is proving best tool for the promotion of local businesses and attraction of tourists to the valley.

Table 5. 30: Government and Locally Adaptive Measures Against CC Vulnerabilities in Tourism Sector

Government Adaptive Measures	N
Advertisement on media by tourism department (including social media)	8
Construction of Roads	20
Embankment of River Swat	22
Kalam cultural festival for tourism promotion	26
Government is not interested in the promotion of tourism	5
Rehabilitation of the damaged infrastructure	10
Locally Adaptive Measures	
Advertising on social media (e.g. Facebook)	3
Construction of hotels and cabins	12
rehabilitation of springs	4
Inviting people to visit Swat (Self Promotion)	8
Provide guidance and facilitation to tourists	37
Small hydal plants	10
Rehabilitation of hotels, Restaurants and local businesses	24
Promotion of peace and awareness	5
Establishment of Fish farms for visitors	3

5.16 Fisheries

Fisheries is one of the important livelihood sources of District Swat. With the global climate change, there is growing concern over the consequences of climate change for fisheries production and the state of marine ecosystems (Allison et al., 2009). There are various factors affecting fishery sector such as fishing mortality, pollution, loss of habitat and disturbance. climate change is an additional pressure (Brander, 2010). Climate change is going to affect the supply and quality of freshwater resources by increasing water temperatures, increased pollutants toxicity and lowering dissolved oxygen levels (Chu et al., 2005; Ficke et al., 2007).

The River Swat originates at Kalam with the confluence of Ushu and Utror Rivers and flow for about 160 km across the valley up to Busaq. The length of River Swat is about

250 km from Kalam to its confluence with Kabul River near Charsadda. A large number of small and large and tributaries join river Swat as it flows downstream. From its origin to the end, about 50 species of freshwater species have been recorded in River Swat (Hasan et al., 2013; Yousafzai et al., 2013). The major edible fish species of River Swat are given in Table 5.31.

Table 5. 31: Major Fresh Water Fish Species of River Swat

S. no.	Local name	Zoological name
1	Mahasheer	Barbus Putiutura Tarp pititora
2	Swati	Shizothorax Palgiostomus
3	Thalk	Shizothorax spp
4	Chunr	Shixothorax esocnus
5	Marmahai	Mestacembelus armatus
6	Katasarary	Channa punctutus
7	Degai	Gara gotyla
8	Singi	Triplophysa naziri (loaches)
10	Braitai	Triplophysa chori
11	Braitai	Triplophysa alipidata
12	Gulabi	Glyptothorax stoki

Source: Nafees et al., (2012)

The results for the current study are derived from questionnaire survey and interviews from respondents related to fisheries. As shown in table 5.32, 73% of the respondents reported that they catch the fish from River/Streams while 20.8% of the respondents catch from ponds. 6.3% of the respondents catch the fish from other sources. The survey data shows that 26.8% of the respondents utilize the capture personally while 71.8% of them use them for commercial purposes (Annex-III, Table 12).

Table 5. 32: Sources of Respondents' Fish Catch

Source of fish	N	% (Total)	% of Respondents
River	70	72.9	100.0
Pond	20	20.8	28.6
Others	6	6.3	8.6
Total	96	100.0	137.1

5.16.1 Causes of Decrease in Fish Production

Table 5.33 shows the limiting factors of fishery production in the study area. The results reveal that 27.7% of the respondents' termed over fishing as main cause of decrease in fisheries in the study area. The second most limiting factor reported by the respondents

is flooding in rivers (22.3%). The other limiting factors in the study area are water pollution (15.6%), fishing in breeding season (13.8%) and change in water temperature (11.6%).

Table 5. 33: Limiting Factors for the Fishery Production in the Study Area

Limiting Factors	N	Percent
Use of illegal fishing techniques	17	7.6
Water Pollution	35	15.6
Change in the water temperature	26	11.6
Flooding in rivers	50	22.3
Fishing in breeding season	31	13.8
Over fishing in rivers	62	27.7
Others	3	1.3
Total	224	100

The other limiting factor of fishery production in district Swat is the water pollution in River Swat (Khaliq, 2016). Huge quantities of solid waste are dumped in to the River affecting the marine biota. Poor quality of Swat River water is responsible for the depletion of oxygen in the water, affecting fisheries and other riverine biota. Water pollution is caused due to flooding in River Swat after heavy rainfall, along with some other major factors including dumping of industrial wastewater and municipal solid waste in the river (Izharullah, 2016; Akhtar et al., 2014).

Some of the respondents (37.1%) reported change in water temperature as a limiting factor to the fish production in the River Swat. It is studied that climate change will affect hydrologic and thermal regimes of rivers, having a direct impact on freshwater ecosystems and human water use (Van Vliet et al., 2013). The interview results showed that most of the people catch fish indiscriminately in every without knowing the breeding season of the fish species, which results in declining the population of various species. A respondent from union council Kalam reported that “due to illegal fishing/over fishing the number of trout fish has decreased in the River Swat, furthermore the floods of 2010 resulted in a decline in the trout population in Swat River. If the water quality of the river is not good, then the fish could not survive. It makes them dead”. Some of the respondents reported that used of illegal and inhumane fishing techniques such as current (using portable generators) and dynamites are one of the limiting factors of fishes in the study area. Ishaq et al., (2014) reported that due to using illegal fishing techniques some important fish species such as *Schizothorax*

esocinus, *Tor macrolepis*, *Cyprinus carpio* have become endangered in the River Swat. A major incident of overfishing occurred during the floods, putting a tremendous pressure on fish population in River Swat. It is reported that in some fish hotspot areas, either the fish stock had died or caught by local population (Khan et al., 2010).

According to interview results, during the 80s, the then governor Khyber Pakhtunkhwa put ban on fishing. During that time, fishery department was not allowed to issue licenses to the local community. As a result, local community started illegal means of fishing in the Swat River. Among these pesticides, stream diversion, usage of dynamite was common.

5.16.2 Severity of Weather Related Hazards

When calculated the natural hazards in terms of hazard severity (1 being not severe and 5 very severe), the floods scored highest among the severity of related hazards with mean score of 4.20 (SD $\pm$ 0.710) while the Quality of river water scored second with mean score of 2.99 (SD $\pm$ 0.802). low/no rainfall, landslides, warm wave, cold wave. Storms/cyclone scored 2.69, 2.11, 1.37, 1.34 and 1.00 respectively. The results are given in Table 5.34.

Table 5. 34: Severity of Weather Related Hazards Related to the Fisheries Sector of District Swat

Natural Hazards	Not Severe (%)	Least Severe (%)	Moderate Severe (%)	Severe (%)	Very Severe (%)	Mean Score	SD	Rank
Flood	NA	NA	16.9	46.5	36.6	4.20	0.710	1
Quality of River Water/water pollution	NA	5.6	15.5	53.5	25.4	2.99	0.802	2
Low/No Rainfall	12.7	39.4	21.1	19.7	7.0	2.69	1.141	3
Landslide	19.7	60.6	8.5	11.3	NA	2.11	0.854	4
Warm Wave	63.4	36.6	NA	NA	NA	1.37	0.485	5
Cold Wave	85.9	14.1	NA	NA	NA	1.14	0.350	6
Storms/Cyclone	100.0	NA	NA	NA	NA	1.00	0.000	7

Around 83% of the respondents termed floods as severe or very severe among the other natural hazards while 79% of the respondents showed the same severity rating for the quality of river water. More individuals were concerned about the quality of river water than the absence of rainfall (26.7% collectively for severe and very severe). Around

20% of the respondents termed landslides to be moderately or severe for the fisheries in the study area.

The interview results showed that deteriorating river quality because of floods or landslide can result in low fish catch compared to the decrease in rainfall. Respondents from the trout hatcheries and fish ponds reported that during the floods of 2010 in River Swat they faced great damages. Either the floods wiped out all the farms or damaged a great chunk of it. Majority of the respondents interviewed stated that floods affect the fishery production negatively.

5.16.3 Adaptation Measures in Fishery Sector

Due to the limiting factors for the fishery production discussed above, a number of adaptation measures have been adapted by the individuals related to fisheries sector. The interview results indicated that respondents were well aware of the worsening situation of fishery in the study area.

A few of the individuals stated that they use nets and rods for fishing instead of illegal fishing techniques such as the use of current and dynamite. Some of the respondents practiced not to fish in the breeding season while some of them indicated that they use to catch big fishes and leave the small ones. The breeding season is important for the progression of fish population, therefore sensible respondents adhered to that notion. Some of them started other jobs due to damages received after the floods of 2010. Fisheries department of Khyber Pakhtunkhwa province issues licenses for fish hunting, therefore some of the respondents reported that they have acquired fishing licenses from the fisheries department. While some of the respondents revealed that they most fish at night to catch maximum fishes.

The adaptation measures related to flooding in River Swat such as construction of check dams and embankment of River Swat by building protection walls as discussed in Table 5.17 are associated to the protection of fisheries sector in the study area. After the floods of 2010 government of Pakistan is involved in rehabilitation activities but due to far flung and remote areas, the efforts haven't been completed yet.

5.17 Climate Vulnerability and Capacity Assessment

5.17.1 Changes in Climatic Indicators

The public observation about climate change were recorded during the FGDs, interviews and the PRA tools (Table 5.35). The results reveal that the general climate of the area has changed considerably compared to the past 10/20 years and the respondents are of the opinion that mean annual temperature and seasonal temperatures have changed. The elders recalled that the winters used to be more severe and summers mild but now the winters are not severe anymore and the summers have got warmer than before. Moreover, the number of winter days have decreased and the summers months have extended. One of the respondent stated that *“the temperature is quite increased in district Swat and now there is no difference between the (temperature of) Swat and plain areas anymore”*. Likewise, the rainfall pattern in both the seasons have changed. According to the respondents the long wet spells of the winters have decreased while the monsoons are more erratic causing flash floods and riverine floods in the area.

Table 5. 35: Public Observations About the Changing Climate and Related Vulnerabilities in the Study Area

Indicators	Public Perceptions
Temperature	Mean temperature of the area is changed. Most of the respondents from the interview data are of the opinion that mean annual temperature and seasonal temperatures have changed. As a result, the summers have gotten warmer and winters less cold compared to the past 10-30 years ago.
Rainfall variability	Rainfall pattern is changed in the area. The rainfall amount is decreased in both winter and summer seasons and a wide uncertainty about the rainfall has resulted over time.
Snowfall	There is a decline in the snowfall amount in the study area
Soil Erosion	Soil erosion has increased due to increasing flood events.
Flooding	Floods have increased in the area compared to past records. The major flood event of 2010 has resulted in major human and economic losses.
Landslides	In direct link to the floods, the landslides happen in the study area.

Summer Days	There is an increase in the number of summer days since the past decade. Climate change has affected the length of summer months and cold months. More hot days are observed in the study area compared to the past 10/20 years.
Winter Days	The number of winter days decreased. Moreover, the intensity of the winter has also decreased.
Extreme Weather Events	Extreme weather events such as floods, droughts, extreme heat or heat waves have increased since the last decade. Now more flash floods and high intensity cyclones are experienced compared to before.
Early Springs	The springs arrive soon now. With change in the average yearly temperatures and extending summers, the springs are experienced in 1 st half of February compared to its arrival in march 10/20 years ago.

The above findings are consistent with the empirical studies and historical climatic data as shown as section 5.1. An increase in the mean annual, mean maximum and mean minimum temperatures as well as in the mean annual precipitation is observed for 31 years' historical data.

5.17.2 Major Hazards to Livelihoods Resources

During the *climate vulnerability and capacity assessment* process, a vulnerability matrix of the study area was prepared. The incidents of floods have increased in the area. The participants identified floods, droughts, water pollution, cold waves, storms, landslides, heat waves and vector borne diseases as major hazards. The major livelihood resources listed were agricultural crops, livestock, forest resources, fisheries and tourism. The hazards were scored against each livelihood resource with significant impact on that resource. The most vulnerable hazards according to the analysis were floods, droughts

Table 5. 36: Vulnerability Matrix of the Study Area

Livelihood resources	Floods	Droughts/dry spells	Quality of Water/Water Pollution	Storms/Cyclones	Landslide	Warm wave/heat wave	Cold Wave	Vector borne diseases	Rank
Rice	3	3	0	2	1	1	2	0	II
Wheat	3	3	0	3	1	1	2	0	I
Maize	3	3	0	2	1	1	1	0	III
Vegetables	3	3	0	2	1	1	1	0	V
Fruit orchards	3	3	0	3	1	1	1	0	II
Livestock (fodder and grazing)	3	2	1	0	1	2	0	0	V
Poultry farming	0	0	0	0	1	2	2	3	VI
Forest Resources (collection of NTFPs and Medicinal Plants)	2	3	0	1	1	1	1	0	VIII
Fisheries	3	0	2	0	2	0	0	0	VII
Tourism	3	0	1	2	3	0	2	0	V
Total Score	26 (I)	17 (II)	4 (VI)	15 (III)	13 (IV)	10 (V)	10 (V)	3 (VII)	

Scores: significant impact =3, medium impact = 2, low impact = 1 and no impact = 0

The major hazard to the livelihood resources are ranked in Table 5.36. The major livelihood resources identified and ranked by the respondents were wheat, rice, fruit orchards, livestock, poultry farming among the others. Climate change has badly impacted the agriculture sector in the area. Change in weather pattern, especially the rainfalls have impacted the productivity. Due to this reason, water shortages and erratic rainfalls have increased the irrigation requirements for the crops. Agriculture is one of the most affected sectors of the study area. The data from the PRA sessions with farmers and other community members showed that floods have badly damaged the standing and washed away fertile soils. Wheat was termed the most vulnerable livelihood resource within the agriculture sector, most susceptible to floods, droughts, storms, landslides, heat waves. The available literature and historical climatic records are consistent with the vulnerability of these resources to natural hazards. Most of these hazards are descriptively discussed in the previous sections. Table 5.37 lists the coping strategies adopted by the local communities against climate vulnerabilities

Table 5. 37: Adaptation Measures and Coping Strategies in District Swat

Climate indicators	Impacts on livelihood sources	Adaptation measures	Potential Future Risks
Increase in Temperature	Increased irrigation requirements for crops, Negative effects on crops and horticulture Increase mortality rate in poultry	Energy efficient housing structures,	Livelihood insecurity
Rainfall variability	Arising of drought condition, lower agricultural productivity, food scarcity, Problems with natural grazing lands and fodder availability, Drying of springs	Installation of tube wells or pressure pumps on River Swat/other streams in the respective areas, Delay in sowing different fruits and crops Purchasing fodder from the market, Manually fetching water from far flung springs especially women on their heads.	Livelihood insecurity, Increased expenses on livestock rearing
Extreme Weather Conditions	Increased riverine and flash flood occurrences Damaging agricultural lands, Increased soil erosion washing away fertile soils Cyclones with rise in temperatures destroying the crops	Stream/River embankments Plantation along the fields No coping strategy	Livelihood insecurity, negative impact on tourism Decreased in the fertile soils/lands Food insecurity
Warmer winters and less snowfall	Increased human diseases Increased livestock diseases	Hospitalization Vaccination	Decreased household welfare Increased output cost and less income generation

RESULTS AND DISCUSSION (PART-III)

REVIEW OF CLIMATE CHANGE POLICIES OF PAKISTAN

This section discusses the laws and regulations related to climate change and other environmental matters in Pakistan, regionally and nationally. In the following paras, an attempt has been made to summarize the existing public policies related to climate change and other environmental issues. Moreover, it sheds light on the efforts undertaken by the government to initiate in response to different emerging environmental issues in line with the international efforts. In the end policy recommendation are underpinned, extracted from the local knowledge using questionnaire and interview surveys as well as expert opinion method.

The Federal Environment Ministry was established in Pakistan in 1975 as a follow up to Stockholm Declaration of 1972. The Ministry was responsible for promulgation of the environmental Protection Ordinance of Pakistan in 1983. It was the first comprehensive legislation prepared in the country. The main objective of Ordinance 1983 was to establish institutions i.e. to establish Federal and Provincial Environmental Protection agencies and Pakistan Environmental Protection Council (PEPC). As a result, in 1983, Pakistan Environmental Agency and PEPC were established while in 1987 Provincial Protection Agencies were established (Naureen, 2009; Nadeem & Hameed, 2008; Saeed et al., 2012).

Pakistan has shown determination by contributing to the efforts of international community related to climate change and actively participated in intergovernmental negotiations and world summits to address global environmental issues. So far Pakistan has ratified 14 major multilateral environmental agreements (MEAs) namely UNFCCC, Desertification convention (UNCCD), the convention on Biological Diversity (CBD), Kyoto Protocol, Conventions on chemicals and hazard wastes among the others (Khan & Munawar., 2011).

The country has enacted legislation and established institutional mechanisms to execute the commitments made at MEAs and to protect the environmental and natural resources of the country (Khan & Munawar., 2011). Pakistan participated in the Earth Summit

held at Rio-De Janeiro in 1992, hence becoming party to a number of international protocols and conventions. As a result, this commitment amplified the environmental progression in the country. Another attempt was made in 1992 when National Conservation Strategy (NCS) was formulated based on the World Conservation Strategy (WCS) by International Union for the Conservation of Nature in 1980. The National Conservation strategy has served as the de facto environmental policy of Pakistan for some time. The NCS was important in addressing the environmental issues of Pakistan that were aggravating the overall environmental horizon of the country, and also suggested actions for sustainable utilization of natural resources (Naureen, 2009). In the next year, 1993, Environmental Quality Standards (NEQs) were designed chalking out various standard parameters for varying levels of gaseous emissions and liquid effluents. The NEQs were approved by Pakistan Environmental Protection Committee (PEPC) in the very first meeting held on May 10, 1993. The National Environmental Quality Standards was revised by environmental standards committee (ESC) and approved by PEPC on Dec 18, 1999 which become effective from August 8, 2000. The Pakistan Environmental Protection Act was enacted on December 06, 1997 to provide for the protection, conservation, rehabilitation and improvement of environment, for the prevention and control of pollution, and promotion of sustainable development. Pakistan Environmental Protection Act (PEPA) was enacted in 1997 which provided legal basis for the establishment of Pakistan Environmental Protection Council (PEPC), which is the high level policy forum and strengthening of other environmental institutions. A list of environmental efforts is given in Table 5.34 (Khan & Munawar., 2011).

Under the commitment of UNFCCC and Kyoto Protocol, Pakistan has carried out multiple climate related studies such as the UNEP country study on adaptation, National Economic and Environmental Development Study and First National Communication on Climate Change. In order to advance the policy framework related to climate change, Task Force on Climate Change (TFCC) was established in 2008 under the umbrella of Planning Commission of Pakistan. The Task Force report on climate change by Planning Commission (Feb 2010) and formulation of National Climate Change Policy by the ministry of environment (now called division of climate change) are two of the major milestones in the history of climate change efforts on the issue from the government of Pakistan (GoP, 2012; Khan & Munawar., 2011).

Some of the important climate change efforts in the form of policies and regulations are elaborated in Annex-II.

5.18 Policy Recommendations

The following recommendations are made to the policy makers to be incorporated in climate change and disaster risk reduction policies;

5.18.1 Institutional Measures

- a. The role of environmental institutions should be enhanced at the provincial level and should be extended to the district level.
- b. After devolution plan according to the 18th amendment, climate change is a provincial subject. Policies and acts related to the subject matter should be formulated and enacted on the provincial level. Provincial EPA (Environmental Protection Agency) should actively take part in the formulation of rules and regulation regarding climate change vulnerabilities.
- c. There is a lack of interest in the public representatives in climate change related issues. The local government and newly elected members of the local government system should be encouraged to take part in the policy making process.
- d. International organizations should be encouraged in order to better plan for the climate change mitigation and adaptation measures.

5.18.2 Protection of Natural Resources

- a. Forest cover should be increased to the international standards of 25% in the whole province. Government should take steps to stop deforestation and the timber mafia by implementation of regulations and fines. Moreover, steps should be taken to improve forest management and conservation of biodiversity. The billion tree tsunami project of the provincial government should be implemented in its true letter and spirit.
- b. Government should exploit rainwater harvesting for agricultural purposes, using water storage reservoirs.
- c. Development of innovative farm production practices should be by the government, including the provision of good variety seeds and fertilizers, as well as irrigation techniques.

5.18.3 Pollution Control

- a. Solid waste dumpsites are main emitters of methane gas. As a result of biodegradation, the organic fraction of solid waste is converted in to methane and goes to the atmosphere unaccounted. With the increase in population, generation of waste increases and hence ultimately the production of methane gas increases. Policy intervention is necessary to address the problem in the first place. Solid waste should not be discarded in open and a proper land fill sites should be identified with full methane recovery option. This option is green and it would result in revenue generation also.
- b. Organic fraction of the waste can be used in the biogas production through the process of anaerobic digestion. It can be done at households, community and a general public biogas generator unit. Apart from that various other “Waste to Energy” projects can be initiated at the community and municipality level. Incineration provides a good opportunity for waste reduction and valuable energy generation. The idea is already being taken up positively by various municipalities of the country.
- c. Use of plastic bags should be discouraged or minimized. These bags clog the drainage system which results in over flooding in the rainy season.
- d. Wastes from municipalities and industries and dumped in River Swat posing negative effect on fisheries and other riverine biota. Those waste dumping should be banned by the government and rules related to water pollution should be enacted.

5.18.4 Alternative Energy Sources

- a. The government should take solid step in providing the locals alternative fuel sources as to minimize their dependency on forest resources. Natural gas should be provided to the people to stop deforestation in the mountainous regions of Pakistan. Moreover, CNG for vehicles should be promoted to minimize air pollution.
- b. Measures should be taken to produce hydel power by constructing multiple small Dams/Power plants on River Swat and related Khwars (streams or tributaries of River Swat), to compensate for the power shortages in the district. Other sources of renewable energy should also be exploited for power

production, in order to reduce dependency on fossil fuels and forest resources in the study area.

5.18.5 Water Conservation

- a. The provincial government is keen in establishing Water and Sanitation Companies in the province. Water and Sanitation Services Peshawar is a successful step towards the revolution in the municipal services delivery in Peshawar. Similar structures like WSSP is planned and under the process of development in other divisional Headquarter cities of Khyber Pakhtunkhwa. Those companies should be able to provide clean safe drinking to the consumers. Moreover, the tube wells and water supply system effected due to floods should be reclaimed in district Swat.
- b. Problems related to water scarcity should be addressed on priority basis in the remote areas of the country. The policy measures related to water sector management should be enhanced keeping in view the needs of agriculture, disasters, power resources, glaciers monitoring and national economy (Khan & Mahmood-ul-Hasan, 2016).
- c. City drainage systems should be broadened to accommodate storm water or storm water drainage system should be introduced in the cities. Due to the low capacity of the existing sewage/drainage system, the drains over floods eventually causing huge losses due to flooding.

5.18.6 Inventory of the Greenhouse Gas Emissions

A proper record and monitoring of the GHGs from the following should be kept;

- a. Increasing agricultural practices
- b. Vehicular emissions; particularly the substandard and old engines which are responsible for most of the emissions. Fines should be imposed on vehicles not meeting the standards (like the VETS model).
- c. Industrial stake emissions should be kept under a strict surveillance and those exceeding the limits should be fined heavily and banned accordingly or the licenses cancelled. On the contrary there should be a reward system also. Those who meeting the standards should be rewarded accordingly.
- d. The concept of carbon credits should be introduced in to various sectors and the stakeholders should be guided accordingly.

- e. Greenhouse Gases inventory should be carried out biannually or a proper timeline agreed upon. The exercise will help in prioritizing the adaptive and migratory policies and will also be a good influence on the international efforts in combating climate change.
- f. Maintenance and government check on the vehicles to control their exhausts.

5.18.7 Flood Control Measures

- a. Flood control measures should be made part of all the developmental activities of the government including flood plain protection using river embankment and raising dykes, awareness among the public about floods, introduction of early warning system etc. the flood policies of the country should be revived. While constructing dams and barrages, the long term flood management should be given priority along with the other priorities of irrigation and power generation by the water managers (Mustafa & Wrathall, 2011).
- b. Encroachments in the flood plains should be discouraged by the government and regulations related to encroachments in the flood plains should be enacted with force. These encroachment results in huge human and infrastructure losses in flooding.
- c. Improving technological responses by setting in and implementation of early warning systems about the head extremes, droughts and flooding to enhance disaster preparedness.
- d. The road network affected by flooding and other natural hazards should be fixed to minimize the traveling time and speed up transportation. That will have a positive effect on the environment with less greenhouse gas emissions from transportation sector.

5.18.8 Capacity Building and Awareness

- a. The climate change issue and related hazards should be part of the curricula, in schools and colleges to raise awareness among the children and youth of the country.
- b. Capacity building sessions should be conducted by government and NGOs through workshops, trainings and symposia targeting local elders, local representatives, religious leaders and politicians in order to equip them about climate change and related hazards of their respective area.

- c. The capacity building programs should be extended to the public especially those livelihoods depend on the natural resources.
- d. The public should be made aware about the importance of forests, negative effects of deforestation and how to take care of these forests using individual as well as communal measures.
- e. Energy efficiency at individual level by change in life styles should be practiced.
- f. Energy efficient homes with less dependence on non-renewable energy should be developed as part of the climate change mitigation should be adopted.

5.18.9 Community Participation

The local community should be actively involved in the climate change adaptation measures. That's because locals of a particular area carry a wide range of indigenous knowledge about the weather, environment and cultural norms of the respective areas. Community based organizations (CBOs) should be established, equipped and encouraged to help protect environment and natural resources, raise awareness among the public about the environmental and climate change related issues in the community. The local communities and stakeholders should be empowered so that they participate actively in CC vulnerability assessment and implementation of adaptation measures.

5.18.10 Establishment of Climate Change Unit

A climate change unit should be established provincially which will be responsible for carrying out various activities. The unit will gather information from the other relevant departments and structures. Progress made through provincial departments of vehicular emission testing stations (VETS) will be shared with the climate change units. The unit will struggle in formulating the climate change mitigation and adaptation measures for the provinces in coordination with all the relevant stakeholders.

CHAPTER VI

CONCLUSION AND RECOMMENDATIONS

This chapter discusses the findings of the current study and offer feasible recommendations for the policy and decision makers. The key findings of the study are summarized in the text following;

6.1 Public Perceptions and Understandings of Climate Change

Climate change is a reality and happening in the study area. The survey results present ample evidence to materialize this prerogative. Majority of the respondents are aware of the change in weather patterns and recognize that climate has changed. Increase in temperature, change in rainfall patterns or erratic rainfalls, extreme weather events, changes in biodiversity and melting of ice caps are the main ways to recognize the changes in climate. The trend analysis of 31-years temperature and rainfall data indicate increase in the maximum, minimum and mean annual temperatures while significant decrease in rainfall for mean annual and four seasons of the year.

The study revealed that different causes are responsible for climate change. Deforestation, natural causes and fossil fuels burning are the main reported causes of climate change. The population increase has put pressure on the already limited forest resources and has increased the consumption and combustion of fossil fuels. Among the other environmental changes, Increase in Solid waste, water pollution and air pollution are the most significant changes revealed by the study. The various pollution sources are contributing to climate change and damaging the riverine ecosystem.

Climate change impacts in the study area include changes in glacier sizes, erratic rainfalls, flooding, droughts, extreme weather events. The results based on community observations reveal increase in temperature, floods, droughts and a decrease in size of glaciers, amount of snowfall, rainfall and the number of winter days over the past decades. For most of the part, the results indicate that public has been observing changes in the given climate parameters since the last two decades. The observations of the community about the indicators of climate change are consistent with the 31-years analyzed temperature and rainfall trends.

Community gatherings, friends and family, education institutions are modes of information dissemination about climate change in the study area. The role of media including television, radio, newspapers and internet regarding the subject is still limited but despite that evidently the changes in weather patterns are not so hard to notice. Climate change has been termed threat to personal lives in terms of livelihood loss, health risks, water availability and low agricultural productivity. The national government, provincial government and international institutions (NGOs) are held responsible for taking actions against climate change. The role of local community in action against climate change is also made part of these endeavors.

The understanding of public perceptions about climate variability and their attitude and beliefs towards the climate vulnerabilities can provide directions to government for the formulation of policies, regulation, guidelines and adaptation strategies (Kabir et al., 2016). Education is the most influential factor that could lead to better understanding of CC and its impacts on the communities. School, college and university based interventions could be explored to increase peoples' knowledge about CC and necessary adaptation measures at community level (Kabir et al., 2016). Therefore, the provincial government should take steps to include the climate change topic in various levels of curricula, to equip the students as future planners for better decision making and awareness.

6.2 Natural Hazards

The study revealed various impacts of climate change in district Swat included but not limited to flooding, dry spells, diseases, change in biodiversity and increase in extreme weather events among the others impacts. The flood of 2010 and other subsequent occurrences afterwards in District Swat aims for urgency in the study area. The floods are responsible for compromising lives of hundreds and thousands of individuals living in the area. The floods are responsible for washing out agriculture lands, standing crops, horticulture, tourism, fisheries and other livelihood sources. Moreover, infrastructure and public properties worth billions of dollars have been damaged by the floods. Shortage of water resources have been reported in the study. The main reasons include low rainfall, decline of water table and low recharge of the springs.

The 2010 flood was a disaster but it can be used strategically to build better infrastructure and systems and address the challenging social and physical factors that contributed to this disaster in the first place. Climate change should be taken a serious threat, because the anomalous meteorological events are getting frequent. In that regards, vulnerability reduction is the best protection against the future threats, as well as adaptation to these events (Mustafa & Wrathall, 2011).

The government has not prepared flood hazard mapping in the study area yet (Atta-ur-Rahman et al., 2016). The lack of land use planning also contributed to the vast damages of floods in district Swat. To minimize the flood losses and flood intensity, land use should be controlled. It is necessary to apply zoning laws in the flood plain for proper management and control of unauthorized land use in the future (Khan et al., 2012). It is crucial to undertake floodplain mapping, hydrological modelling and zoning along the Swat River with respect to climate change scenario and to measure the flood peaks using future projections (Atta-ur-Rahman et al., 2016).

The government should equip the local governments of the area by providing required resources for efficient flood mitigation and proper management without the interference of the political figures. Moreover, the local government should be equipped with the early flood forecasting system for effective flood warning dissemination (Khan et al., 2015).

6.3 Deforestation

Deforestation is on the rise in the study area. This practice should be stopped by government and measures should be taken to streamline the forestry extension services by making the local community as stakeholders in the protection efforts of these resources. They should be provided with necessary education and awareness for the sustainable utilization of forest resources and strategic forest management. Apart from that, government should take steps for supplying alternative fuel sources to minimize the rate of deforestation (Ali et al., 2006). To get to the international standards of 25% forest cover, CBOs should be enacted and mobilized to protect the forests and incentivize with the communities with best results.

The biodiversity of district is largely affected by the human intervention, and proper measures should be taken to control the devastation. The solutions could include

awareness among the community, education, provision of basic needs, new rules and regulations for the local populations (Ali et al., 2016).

6.4 Adaptation Measures

Adaptation measures against the climate change vulnerabilities include construction of check dams and protection walls, reforestation, improvement in the drinking water supply and drainage systems and rehabilitation of the road structures. As the result of flooding the study area, climate induced migration as a mitigation measure was also reported in the study area. This reveals that a fraction of population has been forced from their homes due to climate change vulnerability. Community based measures can play an important role in climate adaptation efforts. Apart from the government and community level, individual level measures are the need of the day to combat the negative impacts of climate. This could start from changing the life styles, minimize energy use in houses and private entities, planting trees and preserving the forests, minimize the use of vehicles to limit the use of fossil fuels and greenhouse gas emissions etc.

The main barriers to climate adaptation in the study area included lack of education, lack of access to communication, population growth, insufficient cultivatable land, lack of proper technology, lack of technical know-how and government incompetence among the other reasons. Government should take steps to maximize the literacy rate in the public, to raise awareness about environmental and climatic issues. With growing population, the future land use planning for urban and rural areas should be prioritized by the government in the form of sector master plans in the form of mid-term and long term plans. These plans should cover the areas of transportation, land use, environment, climate change, water and sanitation, natural resources etc. Some of these sector master plans are under development stage by the provincial government but it is needed that these master plans include the planning for natural hazards due to climate change.

6.5 Climate Vulnerability to Livelihood Sources

The impacts of climate change on livelihood sources namely agriculture, tourism and fisheries were studied. The results indicate that climate change is widely affecting all the livelihood sources endangering lives of hundreds of individuals in district Swat.

6.5.1 Agriculture

The floods devastated agriculture sector by destroying crops and washing out fertile soils. The floods washed away 150000 acres of land in district Swat (Khaliq, 2011a). The land holdings of the farmers are on average low due to the low availability of agricultural lands in the area. More than half of the respondents had received damage to agriculture/horticulture. Lack of modern techniques, lack of good variety seeds, low rainfall, floods and lack of good irrigation practices are some of the factors responsible for the reduction of crop production. Among the weather related hazards to agriculture sector, floods scored high in terms of hazard severity. The other weather hazards ranked accordingly are droughts, low/no rainfall, storms, warm wave, landslides and cold wave accordingly. The adaptation measures in the agricultural sector included changing crop variety, water conservation techniques (Khan & Mahmood-ul-Hasan, 2016), improved seed varieties, improvement in the irrigational infrastructure, soil conservation and rainwater harvesting.

Use of sustainable agriculture techniques is also a form of adaptation to the climate vulnerability by applying crop rotation, soil enrichment and pest management techniques in the fields. Government assistance is needed in the agriculture sector to carry out the crop production sustainably. Moreover, raising awareness about the use of modern technology among the farmer community is also needed, so that they can better plan for their crops and make informed decisions. The government should also extend the weather forecasting to the public, so that they can benefit from the advance prediction in crop harvests.

6.5.2 Tourism

Tourism sector is one of the most affected sector in district Swat. A lot of individuals are attached to the tourism sector for their sustenance. The flooding badly affected hotels, picnic spots, hotels and restaurants, suffering thousands of individuals related to this sector. The other natural hazards to this industry includes deforestation, loss of glaciers, loss of biodiversity, extreme weather conditions, landslides, increased forest fire and increased temperature among the others. The results indicated that majority of the individuals are concerned about their livelihoods as the climate change is going to affect tourism industry in district Swat by reducing the number of tourist visiting to the area. The severity of weather related hazards shows that flooding is the most severe of

all the hazards. The other hazards according to their ranks are cold wave, landslides, decrease in snowfall, storms, quality of river water, heat waves and low/no rainfall. The climate adaptation in tourism sector includes rehabilitation of the infrastructure (roads, bridges, tourist picnic spots etc.), embankment of River Swat, rehabilitation of hotels and media campaign from the tourism department. Government has started Kalam cultural festival for promotion of peace and eco-tourism in the study area. Social media such as Facebook is proving a best tool for the promotion of local businesses and attraction of tourist to the valley.

Field visits to the study area indicated various problems to the tourism sector. The government is still unable to rehabilitate the damaged infrastructure in the upper reaches of district Swat such as Makyal, Kalam, Ushu and Utror. The damaged roads in the area is restricting the tourist movement to the area thus by affecting the whole tourism sector. The government should take solid steps in rehabilitating the damaged infrastructure such as roads, bridges etc. the steps will not only improve the lives of the inhabitants but will help in the promotion of eco-tourism in the district.

6.5.3 Fisheries

Fisheries is one of the important livelihood sources of the study area. The River Swat which extends to a length of 250 Km is home to more than 50 freshwater fish species. The limiting factors for fishery production in the study area includes overfishing, flooding in River Swat, water pollution, fishing in breeding, change in water temperature and use of illegal fishing techniques. The flooding event of 2010 in River Swat damaged a number of fish ponds and private hatcheries. Severity of the weather related hazards revealed that like the other livelihood sources, floods are major severe hazard to the fisheries sector of district Swat. The other severely ranked weather hazards are water pollution, low/no rainfall, landslides, warm wave, and cold wave accordingly. The adaptation measures include ban on illegal fishing techniques, issuance of fishing licenses by the fisheries department and ban on fishing in the breeding season.

Water pollution in Swat River and its tributaries is a main threat to the aquatic fauna of these waters and should be a prime concern of the Khyber Pakhtunkhwa Fisheries Department. A wide variety of fish species thrive in this ecosystem, some of which is

threatened due to multitude of problems. Government should impose penalties on illegal fishing and take steps for the conservation of various threatened fish species. Moreover, further research is needed to identify the causative factors that are limiting the fish population.

6.6 Policy Measures

The review of various policies, rules and regulations regarding climate change and environment points out in the direction that there is no specified policies or other regulations for climate change provincially. As ministry of environment falls under the provincial government after the devolution plan of 18th amendment, the rules and regulations of the subject matter is the sole responsibility of the provincial departments.

These policy recommendations can be a part of future climate change policies, laws, rules and regulations in Khyber Pakhtunkhwa as well as federally. National Climate Change Policy can be adopted for the province with changes to the geographic context and vulnerability of various sectors to climate change.

The government of KP should focus on the issue of climate change and establish a separate institution, specified for climate change affairs kept under the ministry of Forestry, Environment and Wildlife Department. The department should be responsible for taking care of the CO₂ limits, impacts of climate change and adaption/mitigation to CC in the whole province.

6.7 Further research

The current study opens new venues for further research as extension to this study regarding the impacts of climate change on various livelihood sources including the ones covered under this thesis as well as socio-economic changes and the role of institutions in the wake of these changes. Some of the recommendations for further research is given under.

1. The current research was focused on the general impacts of climate change on the livelihoods and does not specifically target various livelihood sources, further research should extend in-depth studies concerning every livelihood should be conducted.

2. The scope of this research is micro-scale, only focused on the residents of District Swat. It is recommended that research of the same nature and objectives should be conducted for the whole province, Country and other districts.
3. Due to the general nature of the study, this research was unable to find specific details related to the agriculture sector in the study area, such as the impacts of climate change on various crops, yields and change in timeline of these crops.
4. A large portion of the farming community produces rice in their agricultural fields. Rice paddies are known for the release of heavy amounts of methane gas (CH₄), therefore it is suggested that studies focused on finding the amount of methane gas released from these rice paddies and its contribution to climate change in District Swat should be carried out.
5. The role of deforestation should be expedited by studying the linkages between cutting forests and increasing temperatures in the study area. The study can also determine the increased runoff, soil erosion and floods due to deforestation.
6. The current study provides a baseline for future researches related to public understanding about climate change. Therefore, it is recommended that comparative studies for different locations should be carried out.

REFERENCES

1. Abbas, Z. (2009). Climate change, poverty and environmental crisis in the disaster prone areas of Pakistan: Community-based approach. *Oxfam Policy and Practice: Climate Change and Resilience*, 5(3), 1-96.
2. Adger, W. N. (2006). Vulnerability. *Global environmental change*, 16(3), 268-281.
3. Adnan, M., Tariq, A., & Shinwari, Z. K. (2015). Effects of human proximity and nomadic grazing on the diversity of medicinal plants in temperate Hindukush. *Pak. J. Bot*, 47(1), 149-157.
4. Ahmad, H., Öztürk, M., Ahmad, W., & Khan, S. M. (2015). Status of Natural Resources in the Uplands of the Swat Valley Pakistan. In *Climate Change Impacts on High-Altitude Ecosystems* (pp. 49-98). Springer International Publishing.
5. Ahmad, I., Ambreen, R., Sultan, S., Qasim, S., & Saeed, A. (2013). The Temperature Anomalies at Decadal Scale in Pakistan: a case study of march (1950s-2000s). *J. Sc. & Tech.Univ. Peshawar*, 37(2),17-23.
6. Ahmad, S. S., Abbasi, Q., Jabeen, R., & Shah, M. T. (2012). Decline of conifer forest cover in Pakistan: a GIS approach. *Pak. J. Bot*, 44(2), 511-514.
7. Ahmad, S. S., Sherazi, A., & Shah, M. T. A. (2010). A preliminary study on climate change causing decline in forest cover area in District Chakwal, Pakistan. *Pak. J. Bot*, 42(6), 3967-3970.
8. Akerlof, K., Maibach, E. W., Fitzgerald, D., Cedenro, A. Y., & Neuman, A. (2013). Do people “personally experience” global warming, and if so how, and does it matter? *Global Environmental Change*, 23(1), 81-91.
9. Akhtar, N., & Pathan, A. J. (2014). Exploring the Avian Fauna of Swat, Khyber Pakhtunkhwa, Pakistan. *British Journal of Poultry Sciences*, 3(1), 20-26.
10. Akhtar, N., Khan, S., & Saeed, K. (2014). Exploring the Fish Fauna of River Swat, Khyber Pakhtunkhwa, Pakistan. *World Journal of Fish and Marine Sciences*, 6(2), 190-194.
11. Ali, K. (2015). A comparative assessment of climate change effect on some of the important tree species of Hindu-Kush Himalayas, using predictive

- modelling techniques. *International Journal of Advanced Research*, 3(5), 1230-1240.
12. Ali, K., Ahmad, H., Khan, N., & Jury, S. (2014b). Future of *Abies pindrow* in Swat district, northern Pakistan. *Journal of forestry research*, 25(1), 211-214.
 13. Ali, K., Khan, N., & Inayat-ur-Rahman. (2013). Understanding the Ethno-cultural domain of the Swat Valley, Northern Pakistan. *International Journal of Advanced Research*, 1(8), 223-239.
 14. Ali, K., Khan, N., Rahman, I., Begum, H. A., Jury, S., & Ahmad, H. (2016). Use of multiple Phytoecological indices and multivariate approaches in the Hinduk-ush ranges of Pakistan. *S. Asian J. Life Sci*, 4(2), 40-50.
 15. Ali, K., Rahman, I. U., & Khan, N. (2014a) Climate change and the fate of *Picea smithiana* in Swat District, Northern Pakistan. *Int.J.Curr.Res.Aca.Rev*, 1: 58-65.
 16. Ali, T., Shahbaz, B., & Suleri, A. (2006). Analysis of myths and realities of deforestation in Northwest Pakistan: implications for forestry extension. *International Journal of Agriculture and Biology*, 8(1), 107-110.
 17. Allison, E. H., Perry, A. L., Badjeck, M. C., Neil Adger, W., Brown, K., Conway, D., ... & Dulvy, N. K. (2009). Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and fisheries*, 10(2), 173-196.
 18. Araújo, M. B., & Rahbek, C. (2006). How does climate change affect biodiversity? *Science*, 313(5792), 1396-1397.
 19. Asian Development Bank. (2010). Pakistan Floods 2010: preliminary damage and need assessment. Islamabad, Pakistan; 2010.
<http://www.adb.org/sites/default/files/linked-documents/44372-01-pak-oth-02.pdf> [May 14, 2016]
 20. Atta-ur-Rehman., & Khan, A. N. (2011). Analysis of flood causes and associated socio-economic damages in the Hindukush region. *Natural hazards*, 59(3), 1239-1260. DOI 10.1007/s11069-011-9830-8
 21. Bajracharya, S. R., & Shrestha, B. (2011). The Status of Glaciers in the Hindu Kush-Himalayan Region. Kathmandu: ICIMOD.
 22. Bajracharya, S. R., Maharjan, S. B., Shrestha, F., Guo, W., Liu, S., Immerzeel, W., & Shrestha, B. (2015). The glaciers of the Hindu Kush Himalayas: current status and observed changes from the 1980s to 2010. *International Journal of Water Resources Development*, 31(2), 161-173.

23. Bangash, S. (2012). Socio-Economic Conditions of Post-Conflict Swat: A Critical Appraisal. *Tigah, a Journal of Peace and Development*, FATA Research Centre, Islamabad. 2, 66-79.
24. Barnett, J., & Adger, W. N. (2007). Climate change, human security and violent conflict. *Political geography*, 26(6), 639-655.
25. Bazinni, F., (2013). Atlas of natural resources evaluation in swat valley, Khyber Pakhtunkhwa, Islamic republic of Pakistan. Italian Development Cooperation, Ministry of Foreign Affairs. <http://goo.gl/Tp7Y41> [February 29, 2016]
26. Berkes, F., & Jolly, D. (2002). Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. *Conservation ecology*, 5(2), 18.
27. Bohensky, E. L., Kirono, D. G. C., Butler, J. R. A., Rochester, W., Habibi, P., Handayani, T., & Yanuartati, Y. (2015). Climate knowledge cultures: Stakeholder perspectives on change and adaptation in Nusa Tenggara Barat, Indonesia. *Climate Risk Management*.
28. Bord, R. J., Fisher, A., & O'Connor, R. E. (1998). Public perceptions of global warming: United States and international perspectives. *Climate Research*, 11(1), 75-84.
29. Bord, R. J., O'Connor, R. E., & Fisher, A. (2000). In what sense does the public need to understand global climate change? *Public Understanding of Science*, 9(3), 205-218.
30. Bowley, A. L. (1925). Measurement of the precision attained in sampling. Cambridge University Press.
31. Brander, K. (2010). Impacts of climate change on fisheries. *Journal of Marine Systems*, 79(3), 389-402.
32. Bronstert, A., 2003, Floods and climate change: interactions and impacts: Risk Analysis, v. 23(3), p. 545-557.
33. Broomell, S.B., Budescu, D.V., Por, H.-H., 2015. Personal experience with climate change predicts intentions to act. *Global Environ. Change* 32, 67–73.
34. Buner, N. (2016, July 11). Tourists irked over dilapidated Kalam road. The Nation. Retrieved from <http://nation.com.pk/>
35. Capstick S, Whitmarsh L, Poortinga W, et al. (2015) International trends in public perceptions of climate change over the past quarter century. *Wiley Interdiscip Rev Clim Chang* 6:35–61. doi:[10.1002/wcc.321](https://doi.org/10.1002/wcc.321)

36. Chaudhry, Q. U. Z., Mahmood, A., Rasul, G., & Afzaal, M. (2009). Climate change indicators of Pakistan. *Pakistan Meteorological Department, Islamabad. Technical Report No. PMD-22/2009*, 1-43.
37. Chu, C., Mandrak, N. E., & Minns, C. K. (2005). Potential impacts of climate change on the distributions of several common and rare freshwater fishes in Canada. *Diversity and Distributions*, 11(4), 299-310.
38. Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A., & Sheikh, A. (2011). The case study approach. *BMC medical research methodology*, 11(1), 1.
39. Dahri, Z. H., Ahmad, B., Leach, J. H., & Ahmad, S. (2011). Satellite-based snowcover distribution and associated snowmelt runoff modeling in Swat River Basin of Pakistan. *Proceedings of the Pakistan Academy of Sciences*, 48(1), 19-32.
40. Daniel, H; Farooqi, H; Birtel, S; and Warner, K. (2011). Flood and Displacement in Rural Sindh: People's Perception. Workshop of the ZiF-Research Group "Communicating Disaster" Center for Interdisciplinary Research, Bielefeld, Germany (16-17 May, 2011).
41. Daze, A., Ambrose, K., & Ehrhart, C. (2009). Climate vulnerability and capacity analysis handbook. Care International.
42. de Jalón, S. G., Iglesias, A., Quiroga, S., & Bardají, I. (2013). Exploring public support for climate change adaptation policies in the Mediterranean region: a case study in Southern Spain. *Environmental Science & Policy*, 29, 1-11.
43. DeBono, R., Vincenti, K., & Calleja, N. (2012). Risk communication: climate change as a human-health threat, a survey of public perceptions in Malta. *The European Journal of Public Health*, 22(1), 144-149.
44. Deng, M., Qin, D., & Zhang, H. (2012). Public perceptions of climate and cryosphere change in typical arid inland river areas of China: Facts, impacts and selections of adaptation measures. *Quaternary international*, 282, 48-57.
45. Dessler, A. E. (2012). *Introduction to Modern Climate Change* (First South Asian edition ed.). New Delhi, India: Cambridge University Press.
46. Divisional Profile (2014). Divisional Profile of Kalam Forest Division. Kalam Forest Division Swat KP, Pakistan.
47. Dube, T., & Phiri, K. (2013). Rural livelihoods under stress: the impact of climate change on livelihoods in South Western Zimbabwe. Dube, T. & Phiri, K.(2013), *Rural livelihoods under stress: The impact of climate change on*

- livelihoods in South Western Zimbabwe, American International Journal of Contemporary Research*, 3(5), 11-25.
48. Ebi, K. L., & Semenza, J. C. (2008). Community-based adaptation to the health impacts of climate change. *American journal of preventive medicine*, 35(5), 501-507.
 49. Eisenhardt, K. M. (1989). Building theories from case study research. *The Academy of Management Review*, 14, 532-550.
 50. Elasha, B. O., Elhassan, N. G., Ahmed, H., & Zakieldin, S. (2005). Sustainable livelihood approach for assessing community resilience to climate change: case studies from Sudan. *Assessments of Impacts and Adaptations to Climate Change (AIACC) Working Paper*, 17.
 51. Enete, A. A., Madu, I. I., Mojekwu, J. C., Onyekuru, A. N., Onwubuya, E. A., & Eze, F. (2011). Indigenous Agricultural Adaptation to Climate Change: Study of Southeast Nigeria.
 52. Farooqi, A. B., Khan, A. H., & Mir, H. (2005). Climate change perspective in Pakistan. *Pakistan J. Meteorol*, 2(3):11-21.
 53. Ficke, A. D., Myrick, C. A., & Hansen, L. J. (2007). Potential impacts of global climate change on freshwater fisheries. *Reviews in Fish Biology and Fisheries*, 17(4), 581-613.
 54. Firdous, I. (2016, 28 February). Climate study points to disasters in Malakand, Hazara. The Express Tribune, <http://tribune.com.pk/>
 55. Füssel, H. M., & Klein, R. J. (2006). Climate change vulnerability assessments: an evolution of conceptual thinking. *Climatic change*, 75(3), 301-329.
 56. Gadiwala, M. S., & Burke, F. (2013). Climate Change and Precipitation in Pakistan-A Meteorological Prospect. *Int. j. econ. environ. geol. Vol:4(2)* 10-15.
 57. Gao, J., Li, Y., Fu, J., Zhu, Y., & Ding, P. (2015). Environmental impact of sustainable environment policy: A case study from Jiuzhaigou Nature Reserve, China.
 58. GCISC (2016). Climate Change Related Concerns and Vulnerability of Pakistan. Global Change Impact Studies Centre Islamabad, Pakistan, <http://www.gcisc.org/pak-gcisc.aspx>. Accessed [January 3, 2017].
 59. Gentle, P., Maraseni, T. N. (2012). Climate change, poverty and livelihoods: adaptation practices by rural mountain communities in Nepal. *Environmental Science & Policy*, 21, 24-34.

60. Githeko, A. K., Lindsay, S. W., Confalonieri, U. E., & Patz, J. A. (2000). Climate change and vector-borne diseases: a regional analysis. *Bulletin of the World Health Organization*, 78(9), 1136-1147.
61. Government of Khyber Pakhtunkhwa. (2015). Khyber Pakhtunkhwa Wildlife and Biodiversity (Protection, Preservation, Conservation and Management) Act, 2015.
62. Government of Khyber Pakhtunkhwa. (2016). Development Statistics of Khyber Pakhtunkhwa 2016. Bureau of Statistics, Planning & Development Department Government of Khyber Pakhtunkhwa.
63. Government of Pakistan, 2013. Framework for implementation of Climate Change (2014-2030). Government of Pakistan, Climate Change Division, Islamabad Pakistan (Nov 2013), <http://goo.gl/j0X5Zy> [August 31, 2016]
64. Government of Pakistan. (1997). Pakistan Environmental Protection Act. Government of Pakistan Ministry of Climate Change. www.environment.gov.pk/act-rules/envprotact1997.pdf [11 August, 2016]
65. Government of Pakistan. (2005). National Environmental Policy. Government of Pakistan Ministry of Climate Change. www.environment.gov.pk/NEP/Policy.pdf [21 February, 2016]
66. Government of Pakistan. (2006). Clean Development Mechanism (CDM), National Operational Strategy. Government of Pakistan Ministry of Climate Change. www.environment.gov.pk/NEP/PakCDM-NatOpelStrgy.pdf [22 February, 2016]
67. Government of Pakistan. (2012). National Climate Change Policy. Government of Pakistan Ministry of Climate Change. www.lead.org.pk/cc/attachments/Resource_Center/NAP/pakistan.pdf [21 January 2016]
68. Government of Khyber Pakhtunkhwa. (2016). Billion Trees Tsunami Afforestation Project. Peshawar (Pakistan): Forestry Environment and Wildlife Department, <http://103.240.220.71/btt/> [Accessed November 13 2016]
69. Government of Pakistan. (1999). Biodiversity Action Plan Pakistan. Ministry of Environment, Islamabad.
70. Government of Pakistan. (1999). District Census Report of Swat. Islamabad: Statistics Division, Population Census Organization.

71. Government of Pakistan. (2010). Task Force on Climate Change: Final Report, Islamabad: Planning Commission.
72. Government of Pakistan. (2015c). Pakistan National Biodiversity Strategy and Action Plan. Minister for Climate Change, Islamabad.
73. Grimm, P. (2010). Pretesting a questionnaire. *Wiley International Encyclopedia of Marketing*.
74. Hamayun, M., Khan, S. A., Sohn, E. Y., & Lee, I. J. (2006). Folk medicinal knowledge and conservation status of some economically valued medicinal plants of District Swat, Pakistan. *Lyonia*, 11(2), 101-113.
75. Haq, S. M. A., & Ahmed, K. J. (2017). Does the perception of climate change vary with the socio-demographic dimensions? A study on vulnerable populations in Bangladesh. *Natural Hazards*, 1-27.
76. Haque, M. A., Yamamoto, S. S., Malik, A. A., & Sauerborn, R. (2012). Households' perception of climate change and human health risks: a community perspective. *Environ Health*, 11(1), 1.
77. Hartter, J., Stampone, M. D., Ryan, S. J., Kirner, K., Chapman, C. A., & Goldman, A. (2012). Patterns and perceptions of climate change in a biodiversity conservation hotspot. *PLoS One*, 7(2), e32408.
78. Hasan, Z., Ahmad, I., Yousuf, M., & Khan, J. (2013). Fish Biodiversity of River Swat. *Pakistan Journal of Zoology*, 45(283-289).
79. Honjo, K. (1996). R&D for technology to solve global warming. *Journal of materials processing technology*, 59(3), 218-220.
80. Houghton, J. T., Ding, Y., Griggs, D. J., Noguer, M., van der Linden, P. J., Dai, X., Maskell, K. and Johnson, C. A. (eds.): 2001, *Climate Change 2001: The Scientific Basis. Contribution of Working Group 1 to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, UK, and N.Y., USA.
81. Houze Jr, R. A., Rasmussen, K. L., Medina, S., Brodzik, S. R., & Romatschke, U. (2011). Anomalous atmospheric events leading to the summer 2010 floods in Pakistan. *Bulletin of the American Meteorological Society*, 92(3), 291.
82. Howe, P. D., & Leiserowitz, A. (2013). Who remembers a hot summer or a cold winter? The asymmetric effect of beliefs about global warming on perceptions of local climate conditions in the US. *Global environmental change*, 23(6), 1488-1500.

83. Huda, M. N. (2013). Understanding indigenous people's perception on climate change and climatic hazards: a case study of Chakma indigenous communities in Rangamati Sadar Upazila of Rangamati District, Bangladesh. *Natural Hazards*, 65(3), 2147-2159.
84. Hussain, I., Spöck, G., Pilz, J., & Yu, H. L. (2010). Spatio-temporal interpolation of precipitation during monsoon periods in Pakistan. *Advances in water resources*, 33(8), 880-886.
85. Hussain, S. S., & Mudasser, M. (2007). Prospects for wheat production under changing climate in mountain areas of Pakistan—An econometric analysis. *Agricultural Systems*, 94(2), 494-501.
86. IISD (2003). Combining disaster risk reduction, natural resource management and climate change adaptation in a new approach to the reduction of vulnerability and poverty. The International Institute for Sustainable Development, https://www.iisd.org/pdf/2003/natres_livelihoods_cc.pdf.
87. Inam-ur-Rehman., & Viaro, A. (2002). Swat: An Afghan society in Pakistan: Urbanisation and change in a Tribal Environment, City Press Karachi, pp 145.
88. IPCC 2007. IPCC fourth assessment report. Asia: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, 2009.
89. IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
90. Iqbal, M. A., Penas, A., Cano-Ortiz, A., Kersebaum, K. C., Herrero, L., & del Río, S. (2016). Analysis of recent changes in maximum and minimum temperatures in Pakistan. *Atmospheric Research*, 168, 234-249.
91. Ishaq, M., Khan, S., Khan, J., Akhtar, N., & Saeed, K. (2014). Study on Ichthyofaunal Biodiversity of River Swat. *World Journal of Fish and Marine Sciences*, 6(4), 313-318.

92. Islam, M. M., Sallu, S., Hubacek, K., & Paavola, J. (2014). Limits and barriers to adaptation to climate variability and change in Bangladeshi coastal fishing communities. *Marine Policy*, 43, 208-216.
93. IUCN (2016). IUCN Red List of Threatened Species. Version 2016-3. <http://www.iucnredlist.org/> [December 15, 2016]
94. IUCN Pakistan (2009). Policy Gap Analysis. IUCN Pakistan, Islamabad, Pakistan. 56 pp.
95. IUCN Pakistan. (2009a). Climate Change Disaster Management in Pakistan, IUCN Pakistan, Islamabad, Pakistan.
96. IUCN Pakistan. (2009b). Climate Change Vulnerabilities in Agriculture in Pakistan, IUCN Pakistan, Islamabad, Pakistan.
97. Izhar Ullah. (2016, August 10). Concern. Solid Waste in Swat River threatens aquatic life. The Express Tribune. Retrieved from <http://tribune.com.pk/>
98. Jabeen, N., Saleem, A., Anwaar, S., & Hussain, Z. (2015). *Berberis lycium* Royle (Royle, 1837): A threatened medicinal plant and Its biological activities. *EC Agriculture*, 1(2), 100-108.
99. Janjua, P. Z., Samad, G., Khan, N. U., & Nasir, M. (2010). Impact of Climate Change on Wheat Production: A Case Study of Pakistan [with Comments]. *The Pakistan Development Review*, 799-822.
100. Jeswani, H. K., Wehrmeyer, W., & Mulugetta, Y. (2008). How warm is the corporate response to climate change? Evidence from Pakistan and the UK. *Business Strategy and the Environment*, 17(1), 46-60.
101. Jin, C. (2008). Biodiversity dynamics of freshwater wetland ecosystems affected by secondary salinisation and seasonal hydrology variation: a model-based study. *Hydrobiologia*, 598(1), 257-270.
102. Jurt, C., Burga, M. D., Vicuña, L., Huggel, C., & Orlove, B. (2015). Local perceptions in climate change debates: insights from case studies in the Alps and the Andes. *Climatic Change*, 133(3), 511-523.
103. Kabir, M. I., Rahman, M. B., Smith, W., Lusha, M. A. F., Azim, S., & Milton, A. H. (2016). Knowledge and perception about climate change and human health: findings from a baseline survey among vulnerable communities in Bangladesh. *BMC public health*, 16:266
104. Khaliq, F. (2011a, January 10). Devastation: Call for revival of Swat agriculture. The Express Tribune. Retrieved from <http://tribune.com.pk/>

105. Khaliq, F. (2011b, January 12). Reviving tourism: Aid rekindles hope among Swat hoteliers. The Express Tribune. Retrieved from <http://tribune.com.pk/>
106. Khaliq, F. (2016, May 31). Pollution affects aquatic life in Swat River. Dawn. Retrieved from <http://www.dawn.com/>
107. Khan, A. N., Ali, A., Ali, Z., & Qasim, S. (2015). Methodological Framework for Flood Risk Assessment. *J. Sc. & Tech. Univ. Peshawar*, 39 (1), 23-35.
108. Khan, A. N., Ghauri, B. M., Jilani, R., & Rahman, S. (2009). Climate Change: Emissions and Sinks of greenhouse gases in Pakistan. In *Proceedings of the Symposium on Changing Environmental Pattern and its impact with Special Focus on Pakistan*.
109. Khan, A. N., khan, S. N., & Ali, A. (2012). Analysis of damages caused by flood-2010 in district Peshawar. *J. Sc. & Tech., Univ. Peshawar*, 36 (1&2), 11-16.
110. Khan, A. N., Khan, S. N., & Tayyab, M. (2014). Appraisal of Flood Mitigation Practices in Timergara City District Dir Lower, Pakistan. *J. Sc. & Tech. Univ. Peshawar*, 2014, 38(2), 1-11.
111. Khan, A., Khan, M., Ayaz, Said A., Ali Z., Khan, H., Ahmad, N., & Garstang, R. (2010). Rapid Assessment of Flood Impact on the Environment in Selected Affected Areas of Pakistan. Pakistan Wetlands Programme and UNDP Pakistan. Pp 35
112. Khan, F.K; Munawar, S. (2011). Institutional Arrangements for Climate Change in Pakistan. Sustainable Development Policy Institute, Islamabad. pp.1-19. Project report series # 19, July 2011, <https://www.sdpi.org/publications/files/project%20report%2019.pdf> [August 31, 2016]
113. Khan, J. A. (2011). Changing climatic patterns and their impacts with special focus on Pakistan. In *Symposium on "Changing environmental pattern and its impact with special focus on Pakistan (Vol. 23)*.
114. Khan, M. S., Shah, W., Hussain, A., Naz, A., & Masaud, S. (2015a). Predicting The Present Growing Stock for The Next Ten Years Keeping in View the Dependency of Local Community in Karaker Forest Swat. *J. Sc. & Tech. Univ. Peshawar*, 39 (1), 37-55.

115. Khan, M. T., Hashim, S., Ayub, S., Jan, A., & Marwat, K. B. (2015). A Case Study of Ethnobotany and Biodiversity Conservation from Tehsil Barawal, Upper Dir, Khyber Pakhtunkhwa, Pakistan. *Pak. J. Bot.*, 47, 7-13.
116. Khan, N., Ali, F., Ali, K., & Shaukat, S. (2015b). Composition, structure and regeneration dynamics of *Olea ferruginea* Royle forests from Hindukush range of Pakistan. *Journal of Mountain Science*, 12(3), 647-658.
117. Khan, R.S. (2016, May 14). Pakistan's "Billion Tree Tsunami" gains momentum. Dawn. Retrieved from <http://www.dawn.com/>
118. Khan, S. (2016, June 8). Govt again fails to construct Kalam Road. The Express Tribune. Retrieved from <http://tribune.com.pk/>
119. Khan, S. R., & Khan, S. R. (2009). Assessing poverty–deforestation links: Evidence from Swat, Pakistan. *Ecological Economics*, 68(10), 2607-2618.
120. Khan, S., & Mahmood-ul-Hasan. (2016). Climate Change Impacts and Adaptation to Flow of Swat River and Glaciers in Hindu Kush Ranges, Swat District, Pakistan (2003-2013). *Int. j. econ. environ. geol. Vol:7(1)* 24-35.
121. Kreft S, Eckstein D, Dorsch L, Fischer L (2015) Global Climate Risk Index 2016: Who Suffers Most from Extreme Weather Events? Weather-related Loss Events in 2014 and 1995 to 2014. German watch 1-31. www.germanwatch.org/en/crri. Accessed Jan 2017
122. Kruseman, G., & Pellegrini, L. (2013). Institutions and forest management in the Swat region of Pakistan. *Nature's Wealth: The Economics of Ecosystem Services and Poverty*, pp.234-258.
123. Leary, N., Adejuwon, J., Barros, V., Batimaa, P., Biagini, B., Burton, I., ... & Dougherty, B. (2007). A stitch in time: lessons for climate change adaptation from the AIACC project. *Washington, DC, AIACC*.
124. Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic change*, 77(1-2), 45-72.
125. Leiserowitz, A. A. (2005). American risk perceptions: Is climate change dangerous? *Risk analysis*, 25(6), 1433-1442.
126. Liu, Z., Smith, W. J., & Safi, A. S. (2014). Rancher and farmer perceptions of climate change in Nevada, USA. *Climatic change*, 122(1-2), 313-327.
127. Lorenzoni, I., & Pidgeon, N. F. (2006). Public views on climate change: European and USA perspectives. *Climatic change*, 77(1), 73-95.

128. Lorenzoni, I., Nicholson-Cole, S., & Whitmarsh, L. (2007). Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global environmental change*, 17(3), 445-459.
129. Lyimo, J. G., & Kangalawe, R. Y. (2010). Vulnerability and Adaptive Strategies to the Impact of Climate Change and Variability. The Case of Rural Households in Semiarid Tanzania. *Environmental Economics*, 1(2), 88-96.
130. Majid, A., Ahmad, H., Saqib, Z., Ali, H., & Alam, J. (2015). Conservation Status Assessment of *Meconopsis aculeata* Royle; a Threatened Endemic of Pakistan and Kashmir. *Pakistan Journal of Botany*, 47, 1-5.
131. Malik, M. I., & Ahmad, F. (2014). Flood Inundation Mapping and Risk Zoning of the Swat River Pakistan using HEC-RAS Model. *Lasbela. Uni. J. Sci., Tech., vol.3, pp. 45-52, 2014.*
132. Marquart-Pyatt, S. T., Shwom, R. L., Dietz, T., Dunlap, R. E., Kaplowitz, S. A., McCright, A. M., & Zahran, S. (2011). Understanding public opinion on climate change: a call for research. *Environment: Science and Policy for Sustainable Development*, 53(4), 38-42.
133. Martens, W. J. M., Jetten, T. H., Rotmans, J., & Niessen, L. W. (1995). Climate change and vector-borne diseases: a global modelling perspective. *Global environmental change*, 5(3), 195-209.
134. Maryam, A., Khan, S., Khan, M. A., Khan, K., Rabbi, F & Ali, S. (2014). The Perception of Local Community about the Effects of Climate Change in Upper Swat, Khyber Pakhtunkhwa, Pakistan. *J Earth Sci Clim Change* 5: 183. doi:10.4172/2157-7617.1000183
135. Masood, M., Arshad, M., Asif, S., & Chaudhari, S. K. (2014). *Viola canescens*: Herbal wealth to be conserved. *Journal of Botany*, 2014, 1-6.
136. McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J., White, K.S. (Eds.), 2001. *Climate Change 2001: Impacts, Adaptation and Vulnerability*. Cambridge University Press, Cambridge.
137. McElhinney, H. (2011). Six Months into the Floods: Resetting Pakistan's priorities through reconstruction (Vol. 144). Oxfam. <https://www.oxfam.org/sites/www.oxfam.org/files/bp144-resetting-pakistans-priorities-6month-260111-en.pdf>. [Accessed January 23, 2017]

138. McMichael, A. J., & Kovats, R. S. (2000). Climate change and climate variability: adaptations to reduce adverse health impacts. *Environmental Monitoring and Assessment*, 61(1), 49-64.
139. Meehl, G. A., Thomas, K., Easterling, D. R., & Changnon, S. (2000). An introduction to trends in extreme weather and climate events: observations, socioeconomic impacts, terrestrial ecological impacts, and model projections. *Bulletin of the American Meteorological Society*, 81(3), 413.
140. Metzger, M. J., & Schröter, D. (2006). Towards a spatially explicit and quantitative vulnerability assessment of environmental change in Europe. *Regional Environmental Change*, 6(4), 201-216.
141. Mirza, M. M. Q. (2003). Climate change and extreme weather events: can developing countries adapt?. *Climate policy*, 3(3), 233-248.
142. Miller-Kuckelberg, K. (2012). Climate change and its impact on the livelihood of farmers and agricultural workers in Ghana. *Accra: Friedrich Ebert Stiftung*.
143. Moghariya, D. P., & Smardon, R. C. (2014). Rural perspectives of climate change: A study from Saurashtra and Kutch of Western India. *Public Understanding of Science*, 23(6), 660-677.
144. Mustafa, D., & Wrathall, D. (2011). Indus basin floods of 2010: Souring of a Faustian bargain?. *Water Alternatives*, 4(1), 72.
145. Myers, T. A., Maibach, E. W., Roser-Renouf, C., Akerlof, K., & Leiserowitz, A. A. (2013). The relationship between personal experience and belief in the reality of global warming. *Nature Climate Change*, 3(4), 343-347.
146. Nadeem, O., & Hameed, R. (2008). Evaluation of environmental impact assessment system in Pakistan. *Environmental Impact Assessment Review*, 28(8), 562-571.
147. Nafees, M., Jan, M. R., Khan, H., & Ali, A. (2008). Status of soil texture and required associated soil conservation measure of River Swat catchments area, NWFP, Pakistan. *Sarhad Journal of Agriculture*, 24(2), 251-259.
148. Naheed, G., & Rasul, G. (2011). Investigation of rainfall variability for Pakistan. *Pak J Meteorol* (14), 53-62.
149. Naureen, M. (2009). Development of environmental institutions and laws in Pakistan. *Pakistan Journal of History and Culture*, 30(1), 93-112.
150. Nayava, J. L. (1980). Rainfall in Nepal. *Himalayan Review*, 12, 1-18.

151. Niles, M. T., & Mueller, N. D. (2016). Farmer perceptions of climate change: Associations with observed temperature and precipitation trends, irrigation, and climate beliefs. *Global Environmental Change*, 39, 133-142.
152. Norman, D., Janke, R., Freyenberger, S., Schurle, B., & Kok, H. (1997). Defining and implementing sustainable agriculture. *Kansas Sustainable Agriculture Series, Paper, 1*.
153. Norton, A., & Leaman, J. (2004). The day after tomorrow: Public opinion on climate change. *MORI Social Research Institute, London*.
154. Omitoyin, S. A., & Tosan, F. B. (2012). Potential Impacts of Climate Change on Livelihood and Food Security of Artisanal Fisherfolks in Lagos State, Nigeria. *Journal of Agricultural Science*, 4(9), 20.
155. Oremo, F. O. (2013). *Small-scale Farmers' Perceptions and Adaptation Measures to Climate Change in Kitui County, Kenya* (Doctoral dissertation, University of Nairobi,).
156. Panda, A. (2016). Exploring climate change perceptions, rainfall trends and perceived barriers to adaptation in a drought affected region in India. *Natural Hazards*, 84(2), 777-796.
157. Panhwar, N. A. (2011). *The Indus Flood 2010; Perspectives, Issues and Strategies*. Centre for Environment & Development.
158. PDMA. (2015). District Disaster Management Plan (2015-2020) District Swat, Khyber Pakhtunkhwa. District Disaster Management Unit (DDMU), Provincial Disaster Management Authority, Khyber Pakhtunkhwa. Retrieved from <http://www.pdma.gov.pk/>
159. PDMA. (2015a). Overview of Natural Disasters 2015 Impact, Response and Managing Risks. Provincial Disaster Management Authority, Government of Khyber Pakhtunkhwa. <http://www.pdma.gov.pk/> [Nov 22, 2016]
160. PDMA. (2015b). Chitral Floods 2015: Recovery Needs Assessment and Action framework. Provincial Disaster Management Authority, Government of Khyber Pakhtunkhwa. <http://www.pdma.gov.pk/> [Nov 22, 2016]
161. Pellegrini, L. (2011). The Rule of the Jungle in Pakistan: A Case Study on Corruption and Forest Management in Swat Swat. In *Corruption, Development and the Environment* (pp. 121-147). Springer Netherlands.

162. Petheram, L., Zander, K. K., Campbell, B. M., High, C., & Stacey, N. (2010). 'Strange changes': Indigenous perspectives of climate change and adaptation in NE Arnhem Land (Australia). *Global Environmental Change*, 20(4), 681-692.
163. PPAF, 2015. Developmental Profile of *District Swat*, Situation Analysis & Baseline Surveys for Poverty Reduction through Rural *Development* in KPK, FATA & Baluchistan. Pakistan Poverty Alleviation Fund (PPAF). <http://ppr.org.pk/PDF/District%20Profile%20Swat.pdf> [February 29, 2016]
164. Qasim, M., Hubacek, K., & Termansen, M. (2013). Underlying and proximate driving causes of land use change in district Swat, Pakistan. *Land Use Policy*, 34, 146-157.
165. Qasim, S., Khan, A. N., Shrestha, R. P., & Qasim, M. (2015). Risk perception of the people in the flood prone Khyber Pukhthunkhwa province of Pakistan. *International Journal of Disaster Risk Reduction*, 14, 373-378.
166. Rahman, A., Khan, A.N., Collins, A.E., & Qazi, F. (2011). Causes and extent of environmental impacts of landslide hazard in the Himalayan region: a case study of Murree, Pakistan. *Nat Hazards* 57(2):413–434.
167. Rahman, G., & Shaw, R. (2017). Flood Disasters and Land Use Planning in Swat Valley, Eastern Hindu Kush. In *Land Use Management in Disaster Risk Reduction* (pp. 179-195). Springer Japan. DOI 10.1007/978-4-431-56442-3_10
168. Rahman, M. A., & Rahman, S. (2015). Natural and traditional defense mechanisms to reduce climate risks in coastal zones of Bangladesh. *Weather and Climate Extremes*, 7, 84-95.
169. Rasul, G., Azfal, M., Zahid, M., & Bukhari, S. A. A. (2012). Climate Change in Pakistan Focused on Sindh Province. Pakistan Meteorological Department Report.
170. Raygorodetsky, G. (2011). Why traditional knowledge holds the key to climate change. United Nations University. <http://unu.edu/publications/articles/why-traditional-knowledge-holds-the-key-to-climate-change.html> [December 11, 2016].
171. Rennie, J. K., & Singh, N. C. (1996). *Participatory research for sustainable livelihoods: a guidebook for field projects*. Winnipeg, Canada: IISD.
172. Rosenzweig, C., Iglesias, A., Yang, X. B., Epstein, P. R., & Chivian, E. (2001). Climate change and extreme weather events; implications for food production, plant diseases, and pests. *Global change & human health*, 2(2), 90-104.

173. Roser, D., Huggel, C., Ohndorf, M., & Wallimann-Helmer, I. (2015). Advancing the interdisciplinary dialogue on climate justice. *Climatic Change*, 133(3), 349-359.
174. Sabir, M. A. (2002). Evaluation of Surface Water Resources and Sediment Load in Indus and Swat Kohistan North Pakistan (Doctoral Dissertation Unpublished). Retrieved from Pakistan Research Repository-Higher Education Commission, Islamabad. www.prr.hec.gov.pk/Thesis/2541H.pdf [February 29, 2016]
175. Saeed, R., Sattar, A., Iqbal, Z., Imran, M., & Nadeem, R. (2012). Environmental impact assessment (EIA): an overlooked instrument for sustainable development in Pakistan. *Environmental monitoring and assessment*, 184(4), 1909-1919.
176. Sajjad, A., Hussain, A., Wahab, U., Adnan, S., Ali, S., Ahmad, Z., & Ali, A. (2015). Application of remote sensing and GIS in forest cover change in Tehsil Barawal, District Dir, Pakistan. *American Journal of Plant Sciences*, 6(9), 1501.
177. Salma, S., Rehman, S., Shah, M. A., & Badshah, S. (2010). Temperature trends in different Climatic Zones of Pakistan. *Journal of Science and Technology*, 34(1).59-72
178. Salma. (2011). Climate change and variability trends in Pakistan and its environmental effects. Department of Environmental Sciences, university of Peshawar. PhD thesis
179. Sarkar, S., & Padaria, R. N. (2010). Farmers' awareness and risk perception about climate change in coastal ecosystem of West Bengal. *Indian Research Journal of Extension Education*, 10(2), 32-43.
180. Schellenhuber, H. J., Cramer, W., Nakicenovic, N., Wigley, T., & Yohe, G. (2006) Avoiding dangerous climate change; Cambridge: Cambridge University Press.
181. Schneider, S., Sarukhan, J., Adejuwan, J., Azar, C., Baethgen, W., & Hope, C. (2001). Overview of impacts, adaptation, and vulnerability to climate change. In *Climate change 2001: Impacts, adaptation, and vulnerability*; McCarthy, J. J.; Canziani, O. F.; Leary, N. A.; Dokken, D. J.; White, K. S.; Cambridge: Cambridge University Press, pp 75–104.
182. Sekaran, U. (2003). Research Methods for Business: "A skill building approach". New York, US: John Wiley and Sons. Inc.

183. Semenza, J. C. (2007). Case studies: improving the macrosocial environment. In *Macrosocial determinants of population health* (pp. 463-484). Springer New York.
184. Semenza, J. C., Hall, D. E., Wilson, D. J., Bontempo, B. D., Sailor, D. J., & George, L. A. (2008). Public perception of climate change: voluntary mitigation and barriers to behavior change. *American journal of preventive medicine*, 35(5), 479-487.
185. Shah, M., & Hussain, F. (2012). Conservation assessment of plant resources of chakesar valley, district Shangla, KPK, Pakistan. *Pakistan Journal of Botany*, 44, 179-186.
186. Shahbaz, B., Ali, T., & Suleri, A. Q. (2007). A critical analysis of forest policies of Pakistan: implications for sustainable livelihoods. *Mitigation and Adaptation Strategies for Global Change*, 12(4), 441-453.
187. Shahbaz, Babar; Geiser, Urs; Suleri, & Abid, Q. (2013). Forests, livelihoods and power relations in North-West Pakistan: Introduction, insights gained and challenges ahead. In: Shahbaz, Babar; Geiser, Urs; Suleri, Abid Q. Forests, livelihoods and power relations in North-West Pakistan. Lahore (Pakistan): Sang-e-Meel Publications, 11-34.
188. Shakoor, U., Saboor, A., Ali, I., & Mohsin, A. Q. (2011). Impact of climate change on agriculture: empirical evidence from arid region. *Pak. J. Agri. Sci*, 48(4), 327-333.
189. Sher, H., Ahmad, A., Eleyemeni, M., Fazl-i-Hadi, S., & Sher, H. (2010). Impact of nomadic grazing on medicinal plants diversity in Miandam, Swat-Pakistan (Preliminary results). *International Journal of Biodiversity and Conservation*, 2(6), 146-154.
190. Simatele, D., Binns, T., & Simatele, M. (2012). Sustaining livelihoods under a changing climate: the case of urban agriculture in Lusaka, Zambia. *Journal of Environmental Planning and Management*, 55(9), 1175-1191.
191. Smit, B., Pilifosova, O., Burton, I., Challenger, B., Huq, S., Klein, R., & Yohe, G. (2001). 'Adaptation to climate change in the context of sustainable development and equity.' In J. McCarthy, O. Canziani, N. Leary, D. Dokken, and K. White (eds), *Climate Change 2001: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Third Assessment

- Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.
192. Spence, A., Poortinga, W., Butler, C., Pidgeon, N.F., 2011. Perceptions of climate change and willingness to save energy related to flood experience. *Nat. Clim. Change* 1, 46–49.
 193. Suleri, A. Q. (2002). The state of forests in Pakistan through a pressure-state-response framework. Sustainable Development Policy Institute.
 194. Tariq, S., Ahmad, M., & Mahmood, I. (2014). Climate change impacts on Chitral-Kabul trans-boundary rivers, Northern Pakistan - 29th Himalaya-Karakoram-Tibet Workshop, Lucca, Italy, September 2-4, 2014).
 195. UN General Assembly. (2015). Transforming our world: The 2030 agenda for Sustainable Development. <https://sustainabledevelopment.un.org/content/documents/7891Transforming%20Our%20World.pdf>. Accessed [03 February 2016].
 196. Van Vliet, M. T., Franssen, W. H., Yearsley, J. R., Ludwig, F., Haddeland, I., Lettenmaier, D. P., & Kabat, P. (2013). Global river discharge and water temperature under climate change. *Global Environmental Change*, 23(2), 450-464.
 197. Vignola, R., Klinsky, S., Tam, J., & McDaniels, T. (2013). Public perception, knowledge and policy support for mitigation and adaption to climate change in Costa Rica: comparisons with North American and European studies. *Mitigation and Adaptation Strategies for Global Change*, 18(3), 303-323.
 198. VijayaVenkataRaman, S., Iniyan, S., & Goic, R. (2012). A review of climate change, mitigation and adaptation. *Renewable and Sustainable Energy Reviews*, 16(1), 878-897.
 199. Vogt, N., Pinedo-Vasquez, M., Brondízio, E. S., Rabelo, F. G., Fernandes, K., Almeida, O., ... & Dou, Y. (2016). Local ecological knowledge and incremental adaptation to changing flood patterns in the Amazon delta. *Sustainability Science*, 1-13.
 200. Wardekker, J. A., Petersen, A. C., & van Der Sluijs, J. P. (2009). Ethics and public perception of climate change: Exploring the Christian voices in the US public debate. *Global Environmental Change*, 19(4), 512-521.

201. Whitmarsh, L. (2008). Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. *Journal of risk research*, 11(3), 351-374.
202. Whitmarsh, L. E (2005). A study of public understanding of and response to climate change in the South of England. Unpublished Ph.D. thesis, University of Bath. www.esds.ac.uk/doc/5345%5Cmrdoc%5Cpdf%5C5345thesis.pdf [03 March, 2016]
203. Willis, K. J., & Bhagwat, S. A. (2009). Biodiversity and climate change. *Science*, 326(5954), 806-807.
204. Wolf, J., & Moser, S. C. (2011). Individual understandings, perceptions, and engagement with climate change: insights from in-depth studies across the world. *Wiley Interdisciplinary Reviews: Climate Change*, 2(4), 547-569.
205. Wuensch, K. L. (2011). Chi-Square Tests. In M. Lovric (Ed.), *International Encyclopedia of Statistical Science* (pp. 252–253). inbook, Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-04898-2_173.
206. Yin, R. K. 1984. Case Study Research: Design and Methods, Beverly Hills, CA, Sage Publications.
207. Yousafzai, A. M., Khan, W., & Hasan, Z. (2013). Fresh records on water quality and ichthyodiversity of River Swat at Charsadda, Khyber Pakhtunkhwa. *Pak J Zool*, 45(6), 1727-1734.
208. Yu, H., Wang, B., Zhang, Y. J., Wang, S., & Wei, Y. M. (2013). Public perception of climate change in China: results from the questionnaire survey. *Natural hazards*, 69(1), 459-472.
209. Yu, W., Yang, Y., Savitsky, A., Alford, D., Brown, C., Wescoat, J., Debowicz, D., & Robinson, S. (2013). *Indus basin of Pakistan: impacts of climate risks on water and agriculture*. Directions in development; countries and regions. Washington DC; World Bank. <http://documents.worldbank.org/curated/en/650851468288636753/Indus-basin-of-Pakistan-impacts-of-climate-risks-on-water-and-agriculture>.
210. Ziervogel, G., Bharwani, S., & Downing, T. E. (2006). Adapting to climate variability: pumpkins, people and policy. In *Natural resources forum* (Vol. 30, No. 4, pp. 294-305). Blackwell Publishing Ltd.

ANNEXTURES

Annexure-I Case study: Causes and Damages of 2010 flooding in District Swat

Abstract

Flooding is the most devastating natural hazard of Pakistan. Since the inception, the country has faced with multiple flood event costing thousands of lives and billions of losses in infrastructure. The situation has gotten worse since the past decade when the country was struck by enormous flooding of 2010 which shook the economy and has not been recovered since. This paper uses primary and secondary sources in gathering the data regarding damages of flooding incurred by the inhabitants of district Swat. The findings reveal that a huge proportion of the respondents have experienced floods in the past 10 year while around half of the respondents have received damages of some kind. The research recommends that government should restore the damaged infrastructure and associated livelihoods.

1. Introduction

Flooding is the most frequently occurring and most devastating natural hazard in Pakistan. Of all population who are affected by natural hazards, 90% are subjected to flooding (Tariq & van de Giesen, 2012). Due to excessive rainfall in the months of July to September 2010, Pakistan experienced unprecedented flooding in the whole country that affected about 20 million people and brought a death toll of 1800 people. The flooding event was recorded as one of the worst since 1929. Moreover, the flash floods caused great damages to the infrastructure affecting entire villages, urban centers, homes, crops and agriculture lands. The direct damages by the floods were calculated to US\$ 6.5 billion while the indirect costs were calculated to be US\$ 3.6 billion. The main sectors that were affected during the flooding were agriculture, livestock and fisheries costed US\$ 5.0 billion (Asian Development Bank, 2010; Tariq & van de Giesen, 2012;). It is anticipated that more incidents of similar nature will occur the coming decades. Moreover, variability in the monsoon pattern will increase chances of droughts in the future, thus affecting the food availability in Pakistan (IUCN, 2009a). Pakistan is vulnerable to the climate change induced hazards including floods, droughts, water shortages, shifts in weather patterns, loss of biodiversity and melting of glaciers (Government of Pakistan, 2010). There have been 67 reported flooding events in Pakistan occurring since 1900 with a clustering of 52 events of various severity in the last 30–40 years. Around eight of these events that occurred between 1950 to 2010 were

also accompanied with huge losses of life and property (Webster et al., 2011; Atta-ur-Rahman & Khan, 2011). According to available official statistics, about 8000 people lost their lives and economical losses amounted to approximately \$10 billion between independence in 1947 and the 2010 flooding (Baig, 2008). Likewise, the events of droughts recorded during 2000-2002 and fourteen cyclones recoded during 1971-2001 caused hoax and momentous damages (Asian Development Bank, 2010).

The change in the rainfall patterns and increase in precipitation during monsoon seasons is a clear indication of changing climate in the country. The future scenarios conducted for Pakistan points towards increase in the rainfall events over the north-west region instead of north-west. Due to the reason Indus and Kabul Rivers will be more vulnerable to flooding events in the future (Asian Development Bank, 2010). The 2010 flooding was triggered by a number of events. Due to low rainfall and severe drought in 2009, the vegetation cover was sparser in 2010. The region is mountainous with steep valleys and ridges. Moreover, severe deforestation in the region may have accelerated the runoff after heavy rainfall through the steep valleys during the months of July and August (Webster et al., 2011).

This research is based on the case study of district Swat (Pakistan). The area is selected because the impacts of climate change are more evident in the mountainous areas compared to the plain areas. The study area fits to this description as the climate of the area is already changing and might get worse in the future. The study area was one of the most affected areas as a result of historic floods of the recent history.

2. Material and Methods

This paper is part of a larger survey conducted to understand the public perceptions of climate change and related impacts on various livelihood sources on in district Swat. A total of 1066 respondents were surveyed using questionnaire techniques in nine tehsils of district Swat through stratified allocation method of sampling. Moreover 100 interviews were conducted targeting key informants and expert opinions. Apart from primary data, secondary data from Pakistan Meteorological department, irrigation department and available literature in the form of research reports were utilized

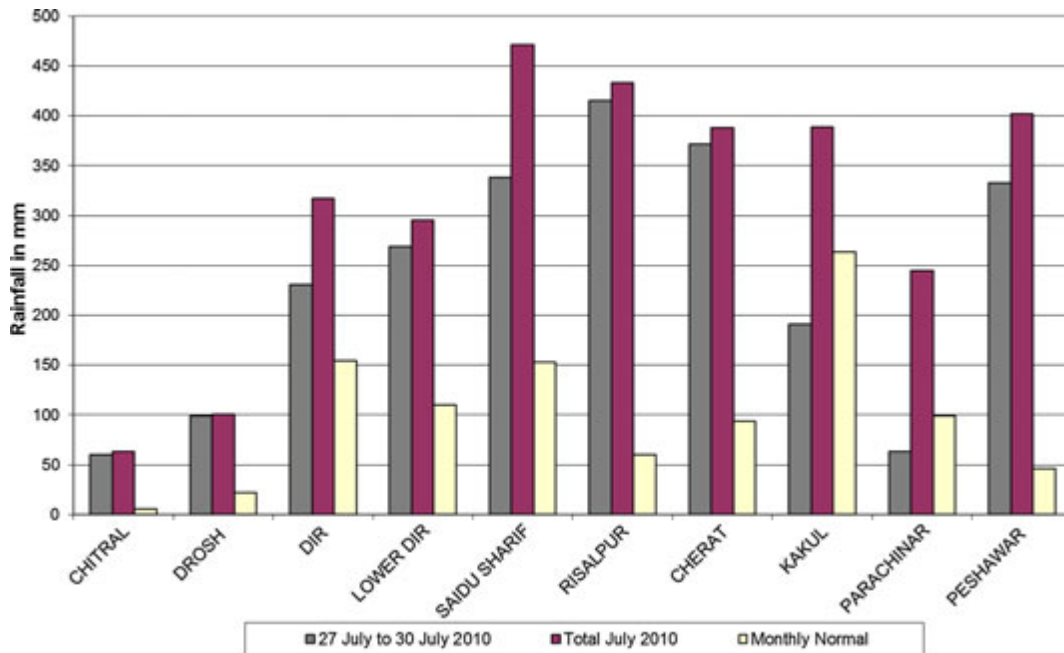
3. Results

3.1 Causes of Flooding

A variety of factors were responsible for triggering the events that lead to devastating floods of 2010 in the study area. Some of them are discussed here. In the pre flood time, heavy snowfall was recorded at Kalam, Dir and Malam Jaba met observatories in the months of January and February of 2010, which subsequently contributed in the floods through heavy melting in June and July. Moreover, the months of June and July are among the hottest months in the region, which acted as a driving force behind the melting of snow (Atta-ur-Rahman & Khan,2013). Monsoon is the major source responsible for most of the rainfalls in the months of July to September in Pakistan. Originating from Bay of Bengal, it moves north-west before reaching Pakistan while in 2010, the course of monsoon rainfall was a somehow different from the usual flow process and moved towards north west to central part of India. At the same high speed cyclone, *Phet* entered Pakistan from south and joined with the usual monsoon track. The moisture laden winds from both the monsoons and *Phet* were responsible for heavy and prolonged rainfall over the north and north western mountains of Pakistan (Atta-ur-Rahman & Khan,2013). The region experienced a huge anomaly of rainfall, that lasted four days starting from July 27 to July 30, 2010. All the meteorological stations recorded rainfall above than normal. According to the water discharge statistics of WAPDA, the river discharge in 2010 showed highest among recorded data. The maximum recorded discharge of Swat River at Amandara gauging station was 5663 Cumecs in 2010 floods and 175,546 Cusecs at Khawazakhela gauging station on July 29, 2010 (PDMA, 2015) while the discharge at Munda headwork's reached 8495 Cumecs on July 29, 2010 which uprooted the Munda headwork's due to the heavy influx (Atta-ur-Rahman & Khan,2013; Asian Development Bank, 2010).

Figures 5.13 and 5.14 shows the comparative discharge of River Swat at Khwazakhela gauge station for the months of July and August through the years 2005 to 2013. The data shows the average monthly discharge for both the months reached its historical highest reading in 2010 with 26891 cusecs for July and 18570 cusecs for August. The data is not sufficient to draw future projections (according to Salma, 2011 river discharge records of 30 to 50 years are required for assessing trends) but it provides ample explanation for event under reference and shows the severity of the flood.

As discussed before due to heavy deforestation in the catchment area, the fluvial processes of all the river systems have been affected seriously. There is a close link between the loss of forest cover and floods because during the past two decades, the forest resources have cruelly and indiscriminately destroyed (Kruseman & Pellegrini, 2013; Atta-ur-Rahman & Khan,2013). A detailed description of the causes and statistics about deforestation is given in the section 5.4.



Source: Atta-ur-Rahman & Khan,2013

Figure 1: The Four-Day Wet Spell for Selected Met Observatories that Caused Floods in Khyber Pakhtunkhwa

Due to the above mentioned reasons, and especially the four-day wet spell over the catchments of almost all the river in Pakistan, the flood originated. In KP province Swat, Panjkora and Kabul Rivers explicitly experienced high flood discharges during its course (Atta-ur-Rahman & Khan,2013).

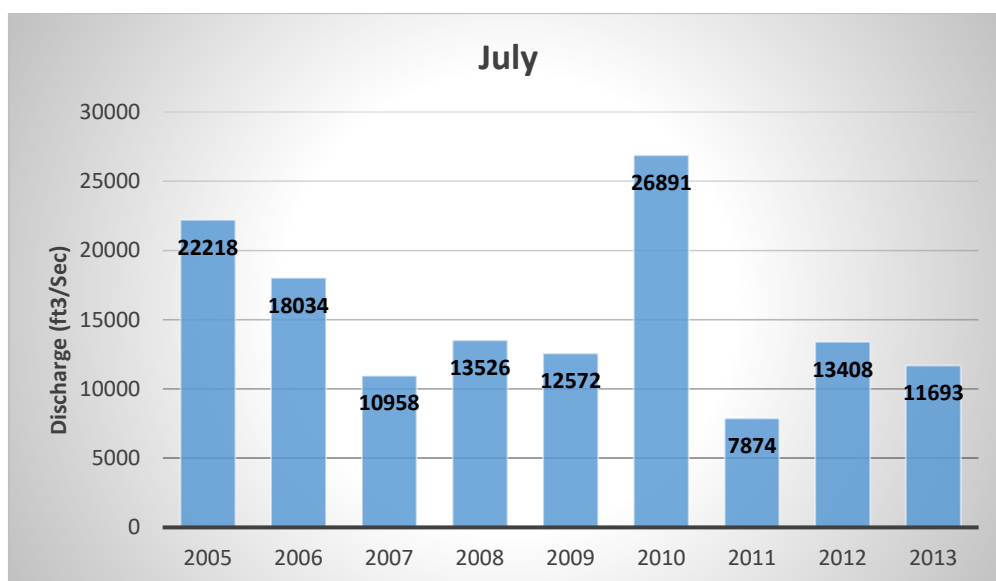


Figure 2: Average Monthly Discharge for July (2005-2013) at Khawazakhela Gauging Station, District Swat

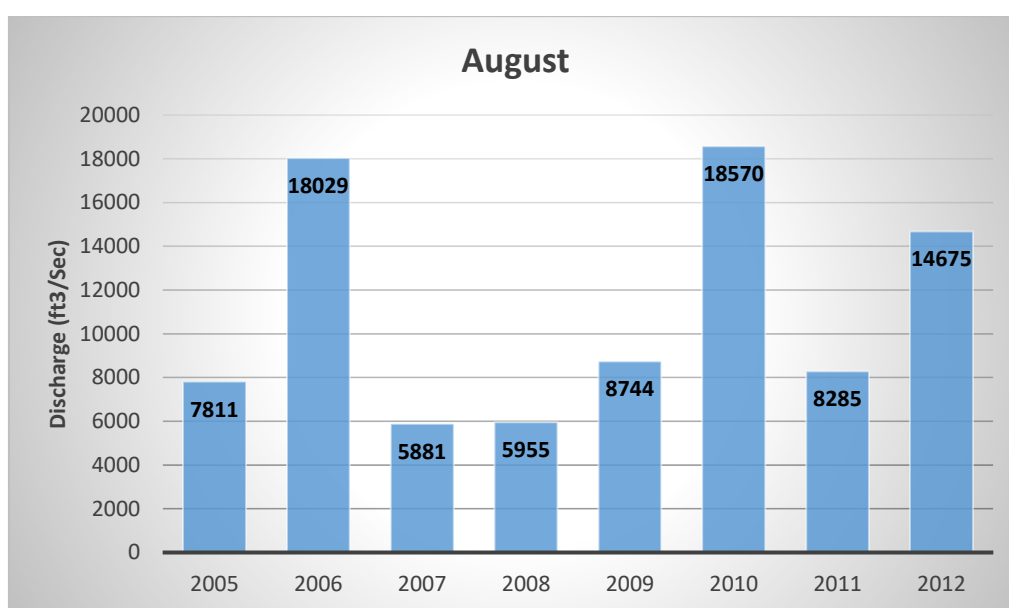


Figure 3: Average Monthly Discharge for August (2005-2012) at Khawazakhela Gauging Station, District Swat

3.2 Flood Damages in the Study Area

As shown in Table 5.17, respondents were asked about the damages received as a result of flooding, land/agriculture (76.7%) was reported to be the major sector affected by the floods. The second major sector affected by the floods was houses (10.5%). Businesses (6.2%), other damages (4.3%) and Human lives (2.4%, 11 cases) were among the other damages causes by floods in district Swat. The no of respondents who

received damages (44.26%) due to floods are slightly lower (38.06% lower) than the respondents who have experienced floods (82.32%) as shown in the figure. It is evident that not all the respondents who have experienced floods have actually received any damage as a result.

The most affected households belonged to the Union Councils namely Kalam (14.6%), Ghaligay (9.4%), Islampur (7.7%), Utror (7.1%), Udigram (6.6%) and Kala Kalay (5.6%). The damages include collectively all the life, houses, agriculture lands, businesses and other damages received by the households in the study area (Annexure-III, Table 1).

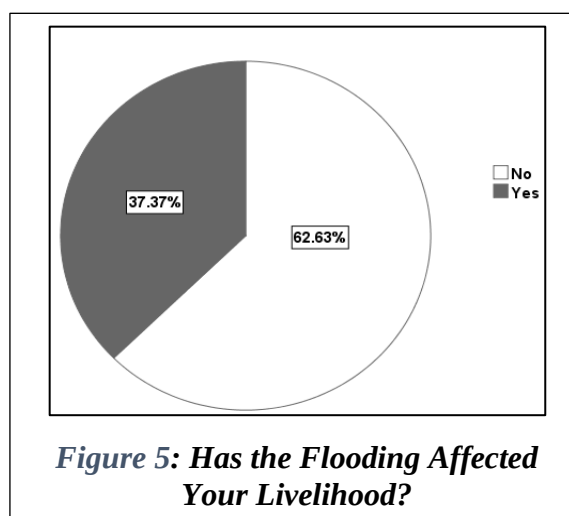
Table 5.17: Floods Damages Received by the Respondents/Households in the Study Area

Flood damages	Responses	
	N*	Percent
Human Life	11	2.4
House	49	10.5
Land/agriculture	358	76.7
Business	29	6.2
Other	20	4.3
Total	467	100.0

* The total number of responses are less than the total sample because of the missing values

3.3 Impact of Flooding on Livelihood Sources

As shown in figure 5.15 respondents were asked about the effect of flood on their livelihood sources, about 37.37% of the respondents responded that their livelihoods been affected from the floods. The most affected livelihood source from the survey results are discussed in the following text;



3.3.1 Agriculture

The reason behind this is the flooding devastation received by the farmers as a result of the recent flooding in district Swat. The floods and their related damages has been described in the sections before. The 2010 floods in district brought a great devastation to agricultural lands, irrigation system, water supply and drainage system, and roads infrastructure etc.

One of the interviewee was irritated about the government steps taken about the damages caused by floods. “8Kanals (01acre) of my agriculture land was swept away by floods, government promised assistance but I have still received nothing and more saddening is that I don’t have that land anymore, completely washed away!” According to Panhwar (2011), the floods swept away the coniferous forests and top fertile soil, which cannot be replenished over the coming decades. The loss of forest cover and soil directly affected many animals and avian species, either washed away with the flood or forced to relocate.

The agriculture sector is one of the badly affected entity in district Swat. The survey results are consistent with the damages reported by other researches. The monsoon floods of 2010 quadrupled the troubles of farmers as 60 per cent of farming land, or 150,000 of 250,000 acres of land was washed away by the floods in district Swat (Khaliq, 2011a).

3.3.2 Tourism

The floods of 2010 damaged the infrastructure and road fabric of the district, negatively affecting the tourism sector in the valley. Due to the floods, the tourism hotspots including Fiza Ghat, Madyan, Bahrrain and Kalam were severely affected (Khan et al., 2010). The Taliban insurgency and monsoon floods badly affected tourism causing heavy financial losses to the hotel industry in Swat valley and other scenic spots. About 107 hotels are being destroyed by the floods in District Swat (Khaliq, 2011b). Collectively more than 800 hotels have been affected in the valley depriving thousands of peoples of their livelihoods (Khaliq, 2011b). According to the preliminary damage and needs assessment survey conducted by Asian Development Bank (2010), 320 hotels existed in district Swat (baseline data acquired from USAID), 70 hotels were completely damaged due to 2010 floods. A respondent expressed his loss that ““I lost half of my hotel building due to 2010 flooding in River

Swat (the hotel is situated along the bank of River Swat)”. Many of these instances are available where people lost their jobs and assets.

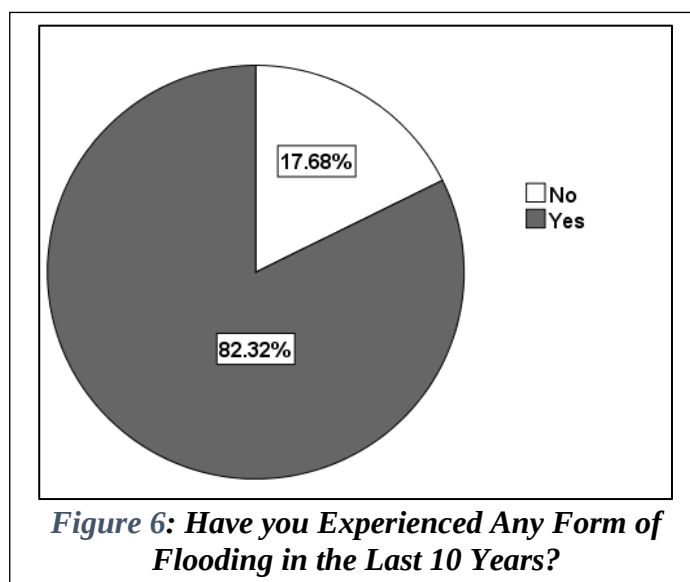
3.3.3 Fisheries

The floods destroyed the fisheries sector in the district by damaging the habitats in River Swat and private fish farms as reported by respondents. Floods are one of the major limiting factor for the fishery industry in district Swat. The 2010 flooding event destroyed fishery sector causing large scale mortalities of fish in River Swat and its tributaries. A total of 26 trout and 17 carp fish farms in both public and private sectors were destroyed while the trout hatchery of Madyan city was completely damaged while Mahsheer fish hatchery near Chakdara was partially damaged (Khan et al., 2010; ADB, 2010).

Floods effect the riverine ecosystem from microorganism to fish. Young fish tends to suffer more from the floods when the timing of high water flows coincides with the delicate life stage of fish (Godlewska et al., 2003). Moreover, the floods have the ability to change the group structure of fishes in rivers (Akhtar et al., 2014).

3.4 Floods experience

Figure 5.11 shows the results when respondents were asked whether they had experienced any form of flood in the past 10 years. The results as shown in figure shows that majority of the respondents (82.32%) have experienced flooding in their life time.



Chi-square analysis indicates that more respondents aged 51 or above (91.3 %***) have experienced flooding in the past years. Significantly more respondents belonging to Very High Income group (92.2 %***) have experienced flooding in the past years in

District Swat. The interview results gathered during the study are in accordance with the questionnaire survey.

Conclusion

The flooding event of 2010 was one of the greatest river disasters in modern history, which affected more than 14 million people in Pakistan. Although, the extreme rainfall between the months of July and September 2010 is the main contributing factor to this disaster, but on the other hand human interventions in the river systems over the years made this disaster a catastrophe (Gaurav et al., 2011). According to Asian Development Bank (2010), the total direct and indirect losses caused by floods accounted for PKR 885 billion while the cost of reconstruction and rehabilitation needed was estimated from PKR 578 to PKR 758 billion. The National Disaster Management Authority (NDMA) estimated that 78 districts affected due to floods covered over 100,000 Km². The affected population reached 20 million people with 1980 reported deaths and 2946 injured.

After the floods, government of Pakistan and international organizations collectively contributed to the rehabilitation efforts of the flood damages in district Swat. Although infrastructure in various effected areas have been restored, yet there is much still to do. Tourism sector is still not fully functional fully because of the dilapidated road infrastructure in the upper part of the district. It is, therefore recommended that government should prioritize the effected livelihoods of the study area by extending their support to the affected communities.

References

- Akhtar, N., & Pathan, A. J. (2014). Exploring the Avian Fauna of Swat, Khyber Pakhtunkhwa, Pakistan. *British Journal of Poultry Sciences*, 3(1), 20-26.
- Asian Development Bank. (2010). Pakistan Floods 2010: preliminary damage and need assessment. Islamabad, Pakistan; 2010. <http://www.adb.org/sites/default/files/linked-documents/44372-01-pak-oth-02.pdf> [May 14, 2016]
- Atta-ur-Rehman., & Khan, A. N. (2011). Analysis of flood causes and associated socio-economic damages in the Hindukush region. *Natural hazards*, 59(3), 1239-1260. DOI 10.1007/s11069-011-9830-8.
- Atta-ur-Rehman., & Khan, A. N. (2013). Analysis of 2010-flood causes, nature and magnitude in the Khyber Pakhtunkhwa, Pakistan. *Natural hazards*, 66(2), 887-904.

Baig, M.A., 2008. Floods and flood plains in Pakistan. In: 20th International Congress on Irrigation and Drainage, Lahore, Pakistan.

Gaurav, K., Sinha, R., & Panda, P. K. (2011). The Indus flood of 2010 in Pakistan: a perspective analysis using remote sensing data. *Natural hazards*, 59(3), 1815-1826.

Godlewska, M., Mazurkiewicz-Boroń, G., Pocięcha, A., Wilk-Woźniak, E., & Jelonek, M. (2003). Effects of flood on the functioning of the Dobczyce reservoir ecosystem. *Hydrobiologia*, 504(1-3), 305-313.

Government of Pakistan. (2010). Task Force on Climate Change: Final Report, Islamabad: Planning Commission.

IUCN Pakistan. (2009a). Climate Change Disaster Management in Pakistan, IUCN Pakistan, Islamabad, Pakistan.

Khaliq, F. (2011a, January 10). Devastation: Call for revival of Swat agriculture. The Express Tribune. Retrieved from <http://tribune.com.pk/>

Khaliq, F. (2011b, January 12). Reviving tourism: Aid rekindles hope among Swat hoteliers. The Express Tribune. Retrieved from <http://tribune.com.pk/>

Khan, A., Khan, M., Ayaz, Said A., Ali Z., Khan, H., Ahmad, N., & Garstang, R. (2010). Rapid Assessment of Flood Impact on the Environment in Selected Affected Areas of Pakistan. Pakistan Wetlands Programme and UNDP Pakistan. Pp 35

Kruseman, G., & Pellegrini, L. (2013). Institutions and forest management in the Swat region of Pakistan. *Nature's Wealth: The Economics of Ecosystem Services and Poverty*, pp.234-258.

Panhwar, N. A. (2011). *The Indus Flood 2010*; Perspectives, Issues and Strategies. Centre for Environment & Development.

Tariq, M. A. U. R., & van de Giesen, N. (2012). Floods and flood management in Pakistan. *Physics and Chemistry of the Earth, Parts A/B/C*, 47, 11-20.

Webster, P. J., Toma, V. E., & Kim, H. M. (2011). Were the 2010 Pakistan floods predictable?. *Geophysical research letters*, 38, L04806, doi:[10.1029/2010GL046346](https://doi.org/10.1029/2010GL046346)

Annexure-II: Review of the Climate Change Policies and Regulations

1. National Climate Change Policy 2012

The National Climate Policy came in to existence in September 2012 formulated by Division of Climate change (Then called Ministry of climate change). The policy provides adaptation measures for a number of sectors which includes water resources, agriculture and livestock, human health, forestry, biodiversity and other vulnerable ecosystem i.e. mountain areas, rangeland and pastures, Arid and Hyper Arid areas, Coastal and Marine Ecosystems and wetlands. The policy also sheds light on the climate change mitigation for Energy, Energy Efficiency and Energy Conservation, Transport, Town Planning, Industries, Carbon Sequestration and Forestry. Although Pakistan rectified UNFCCC in 1994, yet it took almost 2 decades to formulate a policy (Jeswani, 2008).

A task force on the climatic change was set up by the planning commission of Pakistan in Oct 2008 with a view to take stock of the country situation of climatic change and also to contribute formulation of climatic change policies. The main objectives of climatic change policy of Pakistan were to assist government by suggesting measures against climate change vulnerabilities for sustained economic growth, to contribute international efforts in climate change adaptation and mitigation measures, to ensure water security, food security and energy security in the face of multiple climate change related impacts on various sectors, to increase overall forest cover of the country from 5 percent to 25 percent and to facilitate the government in making effective use of the opportunities available internationally e.g. through Clean Development Mechanism (CDM), Adaptation Fund, Global Environmental Facility (GEF) etc., for technology transfer, capacity building and financial support in line with the country needs for climate change adaptation and mitigation.

Although Pakistan is a low emitter of GHGs but like any other developing it needs large supplies of energy to fuel its economy. At the same, it is felt that the country should do whatever it can to bring down the emission and contribute to the international efforts against climate change. The policy in line with its objectives underpins various steps to achieve the objectives without compromising the socio-economic development and energy security of the country. The detailed measures against the climate change

vulnerabilities can be retrieved from the *National Climate Change Policy* document (GoP, 2012).

2. Pakistan Environmental Protection Act, 1997

The national assembly of Pakistan passed the Pakistan environmental protection act (PEPA) 1997 on 3rd September 1997 and received the assent of the president on 3rd Dec 1997. The act repealed the Pakistan environmental protection ordinance, 1983. The act provided the framework for implementation of NCS, establishment of provincial sustainable development funds, protection and conservation of species, conservation of renewable resources, establishment of environmental tribunals and appointment of environmental magistrates, initial environmental examination (IEE), and Environmental Impact Assessment (EIA).

3. National Environmental Policy 2005

As Pakistan is facing a variety of environmental issues including fresh water pollution, air pollution, absence of waste management, loss of biodiversity, deforestation and climate induced hazards, ministry of Environment (now ministry of Climate Change) issued a policy called “National Environmental Policy 2005”. The policy provides directions about the various cross-sectorial environmental issues and pin out the causes of environmental degradation and meeting international treaties.

According to the National Environmental Policy government may take various steps for effectively addressing the challenges stemmed by climate change. This includes framing and implementation of climate change policies and actions plans, establishment of National Clean Development Mechanism (CDM) Authority, development and implementation of framework policies for the practical management of CDM process, to encourage the adoption of ozone friendly technologies and to terminate gradually the ozone depleting agents in line with the international agreements.

The national environmental policy proved quite helpful in addressing various environmental and climate change issues. The continuation of the same policy resulted in Climate Change Policy in 2012 (GoP, 2012), which is now a fundamental document in the climate change efforts of Pakistan. (GoP, 2005).

4. National Operational Strategy for CDM, 2006

In order to establish a Designated National Authority (DNA) for Clean Development Mechanism (CDM), a national operational strategy was developed to fulfill the requirements of the authority. The DNA was established under the ministry of climate change (then ministry of environment) to efficiently manage the CDM process in Pakistan in line with the national sustainable development goals. Furthermore, the prime minister's committee on climate change will act as a guiding instrument for DNA constituting National CDM steering committee, CDM secretariat and technical committees for waste management, energy efficiency or renewable energy and agriculture, forestry and livestock.

According to the strategy the projects allowed for CDM process will include multidirectional energy projects, land use planning and forestry conservation, livestock, agriculture practices, solid waste management including landfills and recycling projects, transportation projects and industrial processes. The strategy also pins down the process for project approval right from submission to approval stage (GoP, 2006).

CDM Cell: The CDM cell was setup in August 2005 under the ministry of environment, and became operational in 2006, following the approval of national operational strategy for CDM by the prime minister of Pakistan. The cell is responsible for tasking all the CDM related activities ranging from the provision of technical to policy support, CDM strategy implementation, undertaking awareness campaigns, CDM project review for approval of grants by DNA as well as rendering input to technical matters related to clean development mechanism in the country (Khan & Munawar., 2011).

5. Framework for Implementation of CC Policy

Climate change is no longer an obscure peril for Pakistani masses, since we are already feeling the heat of climate change disaster and impacts across the region. Since the past couple of years, the country is experiencing devastating floods with far reaching economic costs and human losses. It is estimated that only the flooding of the year 2010 caused economic losses of more than US 9.6 billion dollars.

The framework document is a follow-up to the National Climate Change Policy of Pakistan, with the aim of keeping in view the anticipated threats from climate change to various sectors of the country. Like the climate change policy, this document focuses on the adaptation measures of the climate change vulnerabilities on various sectors such

as agriculture, water, forestry, coastal regions, health, biodiversity and vulnerable ecosystems of the country. Although the country shares a small proportion of GHGs but yet, being a member of the global community, its feels to extending the role as a responsible member by combating climate change through mitigations efforts in various sectors like forestry, energy, transport, agriculture, livestock, industries and urban planning.

6. List of Environmental Regulations in Pakistan

The following table (5.34) provides a list of environmental and climate change related national and provincial rules and regulations promulgated by the government of Pakistan.

Table 5.2: National and Provincial Environmental Rules and Regulations of Pakistan

S. No	Rules and Regulations	Year of Promulgation
1	Pakistan Environmental Protection Ordinance	1983
2	National Conservation Strategy	1992
3	Sarhad (KP) Conservation Strategy	1996
4	Pakistan Environmental Protection Act	1997
5	Pakistan Environmental Protection Policy	2005
6	National Sanitation Policy	2005
7	National Climate Change Policy	2012
8	National Disaster Risk Management Policy	2012
9	Khyber Pakhtunkhwa Drinking Water Policy	2015
10	Khyber Pakhtunkhwa Sanitation Policy (Draft)	2012
11	National Environmental Quality Standards Rules	2001
12	Environmental Samples Rules	2001
13	Provincial Sustainable Development Fund Board (Procedure) Rules	2001
14	Pak-EPA (Review of IEE/EIA) Regulation	2000
15	National Biosafety Rules	2005
16	Hospital Waste Management Rules	2005

17	Hazardous Substances Rules	2002
18	National Operational Strategy for CDM	2006
19	National Conservation Policy	2006
20	National Renewable Energy Policy	2006
21	Policy for Development of Renewable Energy for Power Generation	2006
22	National Forest Policy (Draft)	2015

Annexure-III: Descriptive and Chi-Square Analysis

Table 1: Union Council Wise Flood Damages Received by the Respondents in the Study Area

Union Councils	Flood Damages					Total	Total (%)
	Damage Received: Life	Damage Received: House	Damage Received: Land/agriculture	Damage Received: Business	Other		
Ghaligay	2	0	41	0	1	44	9.4
Shamozai	0	0	7	0	2	9	1.9
Islampur	0	8	16	0	12	36	7.7
Udigram	0	0	31	0	0	31	6.6
Rahim Abad	0	0	9	0	0	9	1.9
Bara Banda	0	1	14	0	2	17	3.6
Totanu Banda	0	0	2	1	1	4	0.9
Kala Kalay	0	0	26	0	0	26	5.6
Deolai	0	0	1	0	0	1	0.2
Charbagh	0	0	9	0	1	10	2.1
Shawar	0	0	25	0	0	25	5.4
Bara Thana	0	0	19	0	0	19	4.1
Gowalairaj	0	1	20	0	0	21	4.5
Miandam	0	0	6	0	0	6	1.3
Khawazakhela	0	1	4	0	1	6	1.3
Fatehpur	0	0	20	0	0	20	4.3
Bahrain	4	1	12	3	0	20	4.3
Mankyal	1	9	15	1	0	26	5.6
Chuprial	0	0	14	0	0	14	3.0
Asharay	0	0	12	0	0	12	2.6
Sakhra	0	0	10	0	0	10	2.1
Kalam	2	19	24	23	0	68	14.6
Utror	2	9	21	1	0	33	7.1
Total	11	49	358	29	20	467	100.0

Table 2: Literacy Rate of The Respondents in Different Union Councils of the Study Area

Union Councils	Literacy		Total
	No	Yes	
Ghaligay	44	11	55
Shamozai	33	20	53
Islampur	16	35	51
Udigram	34	6	40
Rahim Abad	33	8	41
Manglawar	30	13	43
Bara Banda	31	18	49
Totanu Banda	19	10	29
Kala Kalay	35	18	53
Deolai	24	15	39
Kishwara	20	16	36
Charbagh	29	22	51
Shawar	29	14	43
Bara Thana	10	31	41
Gowalairaj	27	16	43
Miandam	11	18	29
Khawazakhela	22	28	50
Fatehpur	15	31	46
Bahrain	18	21	39
Mankyal	8	18	26
Chuprial	18	30	48
Asharay	7	20	27
Sakhra	24	23	47
Kalam	22	24	46
Utror	8	13	21
Total	567	479	1046

Table 3: Adaptation Measures Against CC Vulnerabilities in the Study Area

Locally Adaptive Measures	N	% of Total
Change in irrigation system	11	0.6
construction of new irrigation channels	6	0.3
Establishment of micro hydal power plant	12	0.7
Hand pumps for water provision (including that from NGOs)	184	10.0
Improve irrigation channels	73	4.0
improve road structures after floods	16	0.9
Improve spring structure (including pipeline for water supply)	27	1.5
Improvement of the irrigation channels (and pavements of channels)	10	0.5
Improvement in water supply system (including water tanks)	36	2.0
Plantation (including plantation from government; Tsunami project, fruit trees planting)	355	19.3
River embankment (River Swat included)	407	22.1
Tube wells for irrigation	8	0.4
Improvement of drainage system	43	2.3
Community water management for crops	14	0.8
Construction of road links	46	2.5
Migration	113	6.1
Crops diversification	157	8.5
Changing agricultural practices	325	17.6
Total	1843	100.0

Table 4: Personal/Individual Adaptation Measures Against Future CC Vulnerabilities in the Study Area

Adaptation Measures	Frequency	Percent
Brining water on animals or shoulders	4	.4
Change in house structure (to minimize energy usage)	34	3.0
Change in life style	14	1.2
Construction energy efficient houses	23	2.0
Construction of dams on River Swat for electricity	13	1.1
Flood emergency awareness in the community	30	2.7
Installation of hand pumps for drinking water	128	11.3
Heat resistant crops	13	1.1
Improve spring conditions through community help	6	.5
improvement in irrigation channels to minimize loss of water	37	3.3
installation of tube wells for irrigation	42	3.7
introduction of modern irrigation techniques to reduce water losses	15	1.3
Search another Job if livelihood affected	45	4.0
Loan from government	67	5.9
Mass awareness about environmental concerns and CC	30	2.7
Migration	109	9.6
Planting more and more trees to subset the impacts of CC (to reduce CC)	182	16.1
Promote eco-tourism	36	3.2
Protecting the community forests	31	2.7
Rainwater harvesting	36	3.2
Reducing pollution through reducing the use of fossil fuels	55	4.9
Research on social aspects of climate change	4	.4
Slope stabilization to stop soil erosion	1	.1
Start a business	31	2.7
Use of modern agriculture practices	27	2.4
Use of Biogas	17	1.5
Use of CNG in vehicles	31	2.7
Use of Good Variety Seeds	17	1.5
Use of renewable energy (Solar Panels)	29	2.6
Using social media for awareness	21	1.9
Will adapt to the changes automatically	3	.3
Total	1131	100.0

Table 5a: How Much of the Crop Production or Horticulture was Affected (in Percent)

% of crop production affected	N	Percent	Valid Percent
5	2	.6	1.2
10	14	4.2	8.1
15	5	1.5	2.9
20	29	8.7	16.8
25	2	.6	1.2
30	38	11.4	22.0
40	26	7.8	15.0
50	26	7.8	15.0
55	1	.3	.6
60	7	2.1	4.0
65	1	.3	.6
70	3	.9	1.7
80	14	4.2	8.1
90	5	1.5	2.9
Total	173	52.0	100.0
Missing	160	48.0	
Total	333	100.0	

Table 5b: How Much of the Crop Production or Horticulture was Affected (in Percent)

N	Valid	173
	Missing	160
Mean		38.47
Median		30.00
Std. Deviation		21.223
Minimum		5
Maximum		90

Table 6: Reasons Behind the Reduction of Farming Areas of Respondents/Farmers

Reason (land reduction)	N	% of respondents
Selling	2	4.1%
Lost due to flooding	31	63.3%
Giving to children/relatives	8	16.3%
Droughts	8	16.3%
Other	3	6.1%
	52	106.1%

Table 7: Assistance Needed by the Respondents/Farmers to Help in Adaptation to Climate Change Vulnerabilities

Assistance	N	Percent	% of respondents
Agricultural Loans	93	26.0	31.2
Better variety of Seeds	182	50.8	61.1
Change in the livelihood source	77	21.5	25.8
Other	6	1.7	2.0
Total	358	100.0	120.1

Table 8: Main Tourist Attractions in the Study Area

<i>Tourist Attractions</i>	<i>N</i>	<i>% of Respondents</i>
Streams	135	21.6%
Springs	116	18.5%
Beautiful Landscape	68	10.9%
Lakes	55	8.8%
Forests	36	5.8%
Hiking and Camping	33	5.3%
Wilderness	27	4.3%
Wildlife	26	4.2%
Glaciers	21	3.4%
Handcrafts	14	2.2%
Archeological/Cultural heritage sites	8	1.3%
	626	100.0%

Table 9: Has Tourism Affected by Recent Flooding in River Swat

	<i>N</i>	<i>% of the responses</i>
<i>No</i>	15	8.7
<i>Yes</i>	151	87.3
<i>Don't know</i>	7	4.0
<i>Total</i>	173	100.0

Table 10: List of the Sectors or Infrastructure Damaged/Affected by Flooding in District Swat

<i>Damages</i>	<i>N</i>
<i>architectural sites</i>	2
<i>bridges</i>	20
<i>hotels</i>	24
<i>houses</i>	148
<i>agricultural lands</i>	103
<i>Roads</i>	44
<i>Tourist Destination</i>	12
<i>Restaurants</i>	4
<i>Other Businesses</i>	4
<i>Water Supply System</i>	6

Table 11: Is Climate Change Concern for Your Business/Livelihood Source?

	<i>N</i>	<i>Percent</i>
<i>No</i>	5	2.9
<i>Yes</i>	168	97.1
<i>Total</i>	173	100.0

Table 12: Source of Fish Capture and Use by Respondents in the Study Area

Fish Use	Fish capture (N)	Fish farms (N)	Total (N)	Total (%)
Own use	16	3	9	26.8
Commercial use	51	0	51	71.8
Missing	0	0	1	1.4
Total	67	3	71	100.0

CHI-SQUARE ANALYSIS

Q5: SOURCE OF INFORMATION ABOUT CLIMATE CHANGE

AGE GROUPS

	Age Groups				Chi-Square (P=.05)	Cramer's V
	21-30	31-40	41-50	51 or above		
Television	16.5%	7.3%	4.9%	7.1%	0.00	.149
Radio	2.4%	.5%	.7%	1.6%	.166	.070
Newspaper	11.2%	7.0%	4.2%	6.0%	.025	.095
Internet	2.4%	.8%	.3%	0.0%	.039	.090

Special publications/academic journals	1.0%	0.0%	0.0%	0.0%	.043	.088
Environmental groups/NGOs	.5%	1.1%	.3%	2.7%	.071	.082
School/College/Univeristy	21.4%	13.6%	9.4%	6.0%	.000	.153
Government Agencies	0.0%	1.6%	1.4%	2.2%	.257	.062
Friends/Family	29.1%	33.3%	35.5%	39.6%	.169	.069
Local Community gatherings	59.7%	74.0%	76.3%	67.6%	.000	.135
Self-Observed	11.7%	13.8%	11.5%	9.3%	.488	.048
Other	5.8%	.5%	3.1%	7.1%	.000	.140

EDUCATION

	Education of the respondents (in %)							Chi-Square (P=.05)	Cramer's V
	Primary/Middle	Matric/O-Level	FSc/A-Level	BA/BSc	MSc/BSc(Hons.)	Postgraduate	No Education		
Television	12.2%	12.4%	13.2%	29.6%	18.8%	50.0%	4.0%	.000	.209
Radio	1.7%	2.9%	0.0%	0.0%	0.0%	0.0%	.7%	.367	.079
Newspaper	9.7%	11.7%	5.7%	18.5%	31.3%	100.0%	3.2%	.000	.255
Internet	0.0%	0.0%	0.0%	18.5%	12.5%	100.0%	0.0%	.000	.589
Special publications/academic journals	0.0%	0.0%	0.0%	0.0%	12.5%	0.0%	0.0%	.000	.351
Environmental groups/NGOs	0.0%	.7%	0.0%	0.0%	12.5%	0.0%	1.4%	.000	.153
School/College/University	13.4%	23.4%	47.2%	44.4%	68.8%	50.0%	3.3%	.000	.426
Government Agencies	.4%	1.5%	0.0%	0.0%	12.5%	0.0%	1.6%	.006	.131
Friends/Family	32.8%	30.7%	26.4%	11.1%	0.0%	50.0%	38.4%	.001	.144
Local Community gatherings	66.4%	65.7%	71.7%	44.4%	50.0%	50.0%	75.5%	.001	.148
Self-Observed	7.1%	15.2%	20.8%	3.7%	12.5%	0.0%	12.8%	.044	.111
Other	3.8%	5.8%	1.9%	7.4%	0.0%	0.0%	2.8%	.487	.072

INCOME GROUPS

	Income of the Respondents					Chi-Square (P=.05)	Cramer's V
	Very Low Income	Low Income	Middle Income	High Income	Very High Income		
Television	11.6%	8.8%	10.3%	2.2%	9.4%	.011	.056
Radio	2.1%	.9%	.5%	.5%	2.3%	.315	.068
Newspaper	7.4%	7.5%	5.6%	4.3%	10.9%	.200	.076
Internet	1.6%	.3%	.9%	.5%	1.6%	.519	.056
Special publications/academic journals	.5%	0.0%	0.0%	.5%	0.0%	.473	.058
Environmental groups/NGOs	.5%	1.3%	1.4%	0.0%	2.3%	.302	.068
School/College/University	12.2%	13.2%	13.1%	14.0%	8.6%	.669	.048
Government Agencies	.5%	.3%	1.4%	1.6%	4.7%	.006	.118
Friends/Family	29.6%	21.6%	34.1%	48.4%	50.0%	.000	.231
Local Community gatherings	70.9%	69.6%	63.1%	78.0%	75.0%	.017	.108
Self-Observed	4.8%	13.2%	19.1%	13.4%	5.5%	.000	.157
Other	4.8%	4.1%	3.7%	1.1%	3.1%	.335	.066

Table: Chi-Square Statistics Changes in the Indicators of Climate Change as Observed by Respondent

Public observations about CCC	Rainfall		Temperature		Snowfall		Size of Glaciers		Floods	
	Increased	Decreased	Increased	Decreased	Increased	Decreased	Increased	Decreased	Increased	Decreased
Tehsil										
(p = .05)	.000		.000		.004		.000		.000	
Cramer's V	.567		.545		.148		.652		.243	
Barikot	4.5%	95.5%	96.1%	3.9%	13.5%	86.5%	89.5%	10.5%	72.9%	27.1%
Babuzai	5.9%	94.1%	99.2%	.8%	7.6%	92.4%	100.0%	0.0%	77.3%	22.7%
Kabal	3.0%	97.0%	93.3%	6.7%	9.7%	90.3%	100.0%	0.0%	65.5%	34.5%
Charbagh	1.1%	98.9%	98.9%	1.1%	4.6%	95.4%	39.5%	60.5%	75.9%	24.1%
Matta Sabujni	52.8%	47.2%	48.8%	51.2%	7.1%	92.9%	11.5%	88.5%	71.7%	28.3%
Khwazakhela	51.5%	48.5%	53.5%	46.5%	7.7%	92.3%	31.0%	69.0%	73.8%	26.2%
Bahrain	65.5%	34.5%	37.9%	62.1%	5.1%	94.9%	0.0%	100.0%	67.9%	32.1%
Matta Khararai	23.0%	77.0%	79.5%	20.5%	1.6%	98.4%	30.8%	69.2%	81.1%	18.9%
Kalam	65.6%	34.4%	39.3%	60.7%	0.0%	100.0%	10.2%	89.8%	31.1%	68.9%
Age Groups										
(p = .05)	.001		.000		.012		.000		.021	
Cramer's V	.131		.160		.104		.468		.099	
21-30	33.7%	66.3%	67.7%	32.3%	9.4%	90.6%	66.1%	33.9%	78.4%	21.6%

31-40	27.9%	72.1%	71.9%	28.1%	9.6%	90.4%	15.0%	85.0%	67.7%	32.3%
41-50	21.8%	78.2%	82.8%	17.2%	3.5%	96.5%	14.9%	85.1%	67.0%	33.0%
51 or above	16.7%	83.3%	85.0%	15.0%	5.7%	94.3%	20.0%	80.0%	73.7%	26.3%
Education										
(p = .05)	.002		.003		.467		.032		.507	
Cramer's V	.136		.131		.067		.214		.065	
Primary/Middle	25.8%	74.2%	75.0%	25.0%	5.2%	94.8%	26.6%	73.4%	71.2%	28.8%
Matiric/O-Level	31.2%	68.8%	69.6%	30.4%	7.2%	92.8%	28.2%	71.8%	67.6%	32.4%
FSc/A-Level	45.3%	54.7%	58.5%	41.5%	7.5%	92.5%	25.0%	75.0%	79.2%	20.8%
BA/BSc	34.6%	65.4%	76.9%	23.1%	11.1%	88.9%	42.9%	57.1%	74.1%	25.9%
MSc/BSc(Hons.) / Postgraduate	22.2%	77.8%	77.8%	22.2%	16.7%	83.3%	83.3%	16.7%	83.3%	16.7%
No Education	21.6%	78.4%	80.2%	19.8%	7.6%	92.4%	22.5%	77.5%	69.7%	30.3%
Income										
(p = .05)	.000		.000		.153		.008		.500	
Cramer's V	.176		.164		.081		.228		.058	
Very Low Income	36.8%	63.2%	65.7%	34.3%	5.4%	94.6%	24.3%	75.7%	69.8%	30.2%
Low Income	29.7%	70.3%	73.2%	26.8%	10.1%	89.9%	21.8%	78.2%	67.5%	32.5%
Middle Income	23.9%	76.1%	76.5%	23.5%	6.6%	93.4%	24.5%	75.5%	74.3%	25.7%
High Income	15.5%	84.5%	86.2%	13.8%	7.2%	92.8%	64.3%	35.7%	70.4%	29.6%
Very High Income	15.4%	84.6%	84.6%	15.4%	4.1%	95.9%	42.9%	57.1%	73.6%	26.4%

Continued

Public observations about CCC	Droughts		Summer Days		Winter Days		Early Springs	
	Increased	Decreased	Increased	Decreased	Increased	Decreased	Increased	Decreased
Tehsil								
(p = .05)	.000		.000		.000		.000	
Cramer's V	.484		.268		.325		.475	
Barikot	93.5%	6.5%	78.4%	21.6%	17.0%	83.0%	88.8%	11.2%
Babuzai	96.6%	3.4%	85.1%	14.9%	10.9%	89.1%	95.8%	4.2%
Kabal	97.6%	2.4%	79.5%	20.5%	3.6%	96.4%	100.0%	0.0%
Charbagh	98.9%	1.1%	93.0%	7.0%	6.9%	93.1%	100.0%	0.0%
Matta Sabujni	51.2%	48.8%	93.3%	6.7%	14.4%	85.6%	100.0%	0.0%
Khwazakhela	63.8%	36.2%	91.3%	8.7%	4.6%	95.4%	99.2%	.8%
Bahrain	67.8%	32.2%	79.7%	20.3%	36.2%	63.8%	79.7%	20.3%
Matta Khararai	81.8%	18.2%	87.3%	12.7%	5.8%	94.2%	100.0%	0.0%
Kalam	41.0%	59.0%	46.5%	53.5%	47.4%	52.6%	50.0%	50.0%
Age Groups								
(p = .05)	.000		.000		.004		.181	
Cramer's V	.136		.180		.116		.070	
21-30	70.1%	29.9%	73.2%	26.8%	13.0%	87.0%	91.1%	8.9%
31-40	79.3%	20.7%	82.7%	17.3%	16.3%	83.7%	95.2%	4.8%
41-50	85.6%	14.4%	85.4%	14.6%	10.4%	89.6%	95.4%	4.6%
51 or above	83.2%	16.8%	94.8%	5.2%	5.7%	94.3%	94.8%	5.2%

Education								
(p = .05)	.003		.005		.956		.028	
Cramer's V	.133		.130		.033		.112	
Primary/Middle	79.4%	20.6%	80.2%	19.8%	12.8%	87.2%	93.2%	6.8%
Matric/O-Level	75.9%	24.1%	83.3%	16.7%	12.0%	88.0%	93.4%	6.6%
FSc/A-Level	64.2%	35.8%	81.3%	18.8%	11.5%	88.5%	94.2%	5.8%
BA/BSc	66.7%	33.3%	60.0%	40.0%	7.7%	92.3%	80.8%	19.2%
MSc/BSc(Hons.) / Postgraduate	70.6%	29.4%	88.2%	11.8%	17.6%	82.4%	100.0%	0.0%
No Education	83.6%	16.4%	86.8%	13.2%	12.0%	88.0%	95.6%	4.4%
Income								
(p = .05)	.000		.031		.000		.000	
Cramer's V	.142		.105		.144		.206	
Very Low Income	73.1%	26.9%	76.3%	23.8%	18.1%	81.9%	84.8%	15.2%
Low Income	75.7%	24.3%	84.2%	15.8%	15.7%	84.3%	94.0%	6.0%
Middle Income	80.8%	19.2%	88.7%	11.3%	11.5%	88.5%	97.2%	2.8%
High Income	87.8%	12.2%	85.1%	14.9%	4.9%	95.1%	100.0%	0.0%
Very High Income	87.7%	12.3%	82.5%	17.5%	7.5%	92.5%	95.1%	4.9%

Table: Time Interval of the Changes in CC indicators Observed by the Respondents in the Study Area

Public observations about CCC	Rainfall			Temperature			Snowfall		
	1-5	6-10	11-20	1-5	6-10	11-20	1-5	6-10	11-20
Tehsil									
(p = .05)	.000			.000			.000		
Cramer's V	.277			.281			.284		
Barikot	16.1%	50.3%	33.6%	16.8%	48.3%	34.9%	19.0%	44.2%	36.7%
Babuzai	.8%	56.3%	42.9%	.8%	55.5%	43.7%	.8%	55.5%	43.7%
Kabal	4.2%	63.0%	32.7%	4.2%	63.0%	32.7%	4.2%	63.0%	32.7%
Charbagh	15.5%	60.7%	23.8%	14.5%	61.4%	24.1%	14.5%	62.7%	22.9%
Matta Sabujni	22.0%	68.5%	9.4%	22.0%	68.5%	9.4%	21.3%	68.5%	10.2%
Khawazakhela	10.0%	83.8%	6.2%	10.0%	83.1%	6.9%	9.2%	83.1%	7.7%
Bahrain	13.8%	82.8%	3.4%	13.8%	82.8%	3.4%	13.8%	82.8%	3.4%
Matta Khararai	24.6%	64.8%	10.7%	25.4%	63.9%	10.7%	24.6%	64.8%	10.7%
Kalam	21.3%	72.1%	6.6%	21.3%	72.1%	6.6%	21.3%	72.1%	6.6%
Age Groups									
(p = .05)	.000			.000			.000		
Cramer's V	.313			.308			.312		
21-30	36.8%	57.2%	6.0%	36.5%	57.0%	6.5%	37.0%	57.5%	5.5%
31-40	15.0%	70.1%	15.0%	15.5%	69.3%	15.2%	14.7%	69.3%	16.1%
41-50	2.1%	70.3%	27.6%	2.1%	69.6%	28.3%	2.5%	69.3%	28.3%
51 or above	1.8%	57.1%	41.2%	1.8%	57.1%	41.2%	2.4%	54.8%	42.9%
Education									
(p = .05)	.000			.000			.000		
Cramer's V	.146			.140			.136		
Primary/Middle	17.67%	67.24%	15.09%	17.17%	67.81%	15.02%	17.24%	67.24%	15.52%
Matric/O-Level	15.22%	70.29%	14.49%	15.33%	68.61%	16.06%	16.06%	65.69%	18.25%
FSc/A-Level	20.75%	67.92%	11.32%	20.75%	66.04%	13.21%	20.75%	66.04%	13.21%
BA/BSc	34.62%	50.00%	15.38%	34.62%	50.00%	15.38%	34.62%	50.00%	15.38%
MSc/BSc(Hons.) / Postgraduate	11.76%	82.35%	5.88%	17.65%	76.47%	5.88%	11.76%	82.35%	5.88%
No Education	9.65%	63.39%	26.96%	9.85%	62.96%	27.19%	9.87%	63.07%	27.06%
Income									
(p = .05)	.000			.000			.000		
Cramer's V	.182			.180			.180		
Very Low Income	25.82%	62.09%	12.09%	25.27%	62.64%	12.09%	25.82%	62.09%	12.09%
Low Income	15.14%	67.82%	17.03%	15.24%	66.98%	17.78%	14.65%	67.20%	18.15%
Middle Income	12.02%	68.75%	19.23%	12.50%	68.27%	19.23%	12.98%	67.31%	19.71%
High Income	2.79%	64.80%	32.40%	2.78%	64.44%	32.78%	3.33%	63.89%	32.78%
Very High Income	9.84%	58.20%	31.97%	10.66%	56.56%	32.79%	9.92%	56.20%	33.88%

Continued

Public observations about CCC	Size of Glaciers			Floods			Droughts		
	1-5	6-10	11-20	1-5	6-10	11-20	1-5	6-10	11-20
Tehsil									
(p = .05)	.248			.000			.000		
Cramer's V	.176			.392			.306		
Barikot	0.0%	100.0%	0.0%	5.3%	26.0%	68.7%	23.6%	48.6%	27.7%
Babuzai	NA	NA	NA	.8%	56.3%	42.9%	.8%	43.7%	55.5%
Kabal	NA	NA	NA	4.8%	81.2%	13.9%	4.8%	61.8%	33.3%
Charbagh	31.3%	68.8%	0.0%	14.3%	51.2%	34.5%	17.9%	56.0%	26.2%
Matta Sabujni	32.7%	61.2%	6.1%	22.0%	68.5%	9.4%	22.0%	68.5%	9.4%
Khwazakhela	0.0%	100.0%	0.0%	10.0%	83.1%	6.9%	9.2%	83.1%	7.7%
Bahrain	14.3%	83.9%	1.8%	13.8%	82.8%	3.4%	13.8%	82.8%	3.4%
Matta Khararai	NA	NA	NA	25.4%	63.9%	10.7%	23.8%	63.9%	12.3%
Kalam	21.3%	72.1%	6.6%	21.3%	72.1%	6.6%	21.3%	72.1%	6.6%
Age Groups									
(p = .05)	.000			.000			.000		
Cramer's V	.315			.292			.287		
21-30	41.5%	58.5%	NA	31.8%	59.5%	8.7%	35.4%	58.1%	6.6%
31-40	28.9%	71.1%	NA	14.4%	67.3%	18.3%	17.7%	65.1%	17.2%
41-50	5.8%	94.2%	NA	2.1%	71.4%	26.5%	2.5%	69.6%	27.9%
51 or above	7.7%	92.3%	NA	1.2%	52.4%	46.3%	4.7%	52.9%	42.4%
Education									
(p = .05)	.204			.000			.000		
Cramer's V	.181			.145			.150		
Primary/Middle	20.69 %	75.86%	3.45%	14.35%	68.16%	17.49%	18.97%	65.52%	15.52%
Matiric/O-Level	17.86 %	78.57%	3.57%	14.93%	70.15%	14.93%	17.52%	67.88%	14.60%
FSc/A-Level	22.22 %	55.56%	22.22%	20.75%	64.15%	15.09%	22.64%	67.92%	9.43%
BA/BSc	60.00 %	40.00%	0.00%	34.62%	50.00%	15.38%	34.62%	50.00%	15.38%
MSc/BSc(Hons.) / Postgraduate	0.00%	100.00%	0.00%	11.76%	70.59%	17.65%	6.25%	75.00%	18.75%
No Education	24.27 %	72.82%	2.91%	8.64%	62.13%	29.23%	10.73%	60.36%	28.91%
Income									
(p = .05)	.248			.000			.000		
Cramer's V	.159			.132			.197		
Very Low Income	23.81 %	71.43%	4.76%	22.29%	60.00%	17.71%	26.37%	60.44%	13.19%
Low Income	26.67 %	72.22%	1.11%	13.59%	63.11%	23.30%	17.09%	64.87%	18.04%
Middle Income	23.53 %	73.53%	2.94%	11.06%	65.87%	23.08%	14.35%	68.90%	16.75%
High Income	0.00%	87.50%	12.50%	2.79%	70.39%	26.82%	3.35%	60.34%	36.31%
Very High Income	0.00%	87.50%	12.50%	10.08%	62.18%	27.73%	9.09%	54.55%	36.36%

Continued

Public observations about CCC	Summer Days			Winter Days			Early Springs		
	1-5	6-10	11-20	1-5	6-10	11-20	1-5	6-10	11-20
Tehsil									
(p = .05)	.000			.000			.000		
Cramer's V	.336			.338			.352		
Barikot	33.8%	40.5%	25.7%	34.7%	38.8%	26.5%	39.2%	35.8%	25.0%
Babuzai	.8%	42.0%	57.1%	.8%	42.0%	57.1%	.8%	42.0%	57.1%
Kabal	4.8%	61.8%	33.3%	4.8%	61.8%	33.3%	4.8%	61.8%	33.3%
Charbagh	19.0%	53.6%	27.4%	20.2%	51.2%	28.6%	22.6%	48.8%	28.6%
Matta Sabujni	22.0%	68.5%	9.4%	22.0%	68.5%	9.4%	22.2%	69.0%	8.7%
Khwazakhela	9.2%	83.8%	6.9%	10.8%	83.1%	6.2%	10.0%	83.1%	6.9%
Bahrain	13.8%	82.8%	3.4%	13.8%	82.8%	3.4%	13.8%	82.8%	3.4%
Matta Khararai	24.6%	63.9%	11.5%	24.6%	63.9%	11.5%	24.6%	63.9%	11.5%
Kalam	19.3%	73.7%	7.0%	19.6%	73.2%	7.1%	19.6%	73.2%	7.1%
Age Groups									
(p = .05)	.000			.000			.000		
Cramer's V	.279			.282			.267		
21-30	38.1%	54.8%	7.1%	38.8%	54.1%	7.1%	38.8%	53.6%	7.7%
31-40	18.3%	65.0%	16.7%	18.3%	65.0%	16.7%	19.2%	64.2%	16.7%
41-50	5.3%	66.3%	28.4%	5.7%	66.7%	27.7%	6.7%	65.6%	27.7%
51 or above	4.7%	53.8%	41.5%	5.9%	50.6%	43.5%	7.1%	51.2%	41.8%
Education									
(p = .05)	.000			.000			.000		
Cramer's V	.128			.128			.134		
Primary/Middle	19.30%	64.47%	16.23%	20.61%	62.72%	16.67%	21.05%	62.28%	16.67%
Matiric/O-Level	18.98%	66.42%	14.60%	17.52%	67.15%	15.33%	18.25%	67.15%	14.60%
FSc/A-Level	22.64%	67.92%	9.43%	22.64%	66.04%	11.32%	23.08%	67.31%	9.62%
BA/BSc	30.77%	50.00%	19.23%	36.00%	48.00%	16.00%	40.00%	44.00%	16.00%
MSc/BSc(Hons.) / Postgraduate	17.65%	64.71%	17.65%	17.65%	64.71%	17.65%	17.65%	64.71%	17.65%
No Education	12.93%	58.83%	28.23%	13.32%	58.58%	28.10%	14.21%	57.74%	28.05%
Income									
(p = .05)	.000			.000			.000		
Cramer's V	.190			.176			.184		
Very Low Income	27.53%	58.99%	13.48%	27.12%	58.19%	14.69%	29.38%	56.50%	14.12%
Low Income	19.05%	63.49%	17.46%	19.05%	62.54%	18.41%	19.37%	62.54%	18.10%
Middle Income	17.31%	64.90%	17.79%	17.87%	65.22%	16.91%	19.23%	63.46%	17.31%
High Income	3.89%	61.67%	34.44%	5.00%	60.56%	34.44%	4.44%	61.11%	34.44%
Very High Income	9.84%	53.28%	36.89%	11.48%	53.28%	35.25%	12.30%	52.46%	35.25%

Annexure-IV: SURVEY QUESTIONNAIRE FOR THE MAIN STUDY

QUESTIONNAIRE 1.1: PUBLIC UNDERSTANDING ABOUT CLIMATE CHANGE

Union Council	Date	Unique ID
Telephone:		Email:

I- PERSONAL INFORMATION

1. Name of the respondent:
2. Gender
 - a. Male
 - b. Female
3. Age:
 - a. 21-30
 - b. 31-40
 - c. 41-50
 - d. 51 or Above
4. Number of household members:
5. Are you literate?
 - a. Yes
 - b. No
6. If yes, what is your qualification?
 - a. Primary/Middle
 - b. Matric/O-level
 - c. FSc
 - d. BA/BSc
 - e. MSc/BSc (Hons.)
 - f. Postgraduate,
 - g. Other (specify)
7. Approximate income per month? (in PKR)
 - a. Up to 10000
 - b. 10001-15000
 - c. 15001-20000
 - d. 20001-30000
 - e. 30001-40000
 - f. 40001-50000
 - g. 50001 and above
8. Source of livelihood?
 - a. Farming/Agriculture
 - b. Tourism
 - c. Fisheries
 - d. Livestock
 - e. Forestry/Forest Resources
 - f. Business
 - g. Government service
 - h. Pension of retired
 - i. Medicinal plants
 - j. Other
9. Information about other family members?

S. No	Relation to respondent	Education	Source of Income
i			
ii			
iii			
iv			
v			
vi			

II- GENERAL INFORMATION ABOUT CLIMATE CHANGE

1. Do you know Climate change/Global warming?
 - a. Yes
 - b. No
 - c. Don't know

2. How do you recognize climate change?
 - a. Increase in temperature
 - b. Erratic Rainfall pattern
 - c. Rise in Sea level
 - d. Extreme weather events (flooding or droughts)
 - e. Changes in bio-diversity
 - f. Melting of ice-caps or Glaciers
 - g. Other

3. Main causes of Climate Change?
 - a. Greenhouse gases
 - b. Fossil fuel burning
 - c. Deforestation
 - d. Natural causes
 - e. Act of God or nature
 - f. Don't know
 - g. Other

4. What are the Impacts of climate change?
 - a. Flooding
 - b. Droughts or dry spells
 - c. Low fish catch
 - d. Storms
 - e. Road erosion
 - f. Landslide
 - g. Change in flora and fauna
 - h. Change in temperature
 - i. Vector borne diseases
 - j. Lower agricultural productivity
 - k. Increase in extreme events
 - l. Glacier retreat
 - m. Extended summers/increase in number of warm days
 - n. Decrease in cold/winter days
 - o. Low/no rainfall
 - p. Other (specify).....

5. Where have you heard about climate change?
 - a. Television
 - b. Radio
 - c. Newspaper
 - d. Internet
 - e. Specialist publications/academic journals
 - f. Environmental groups/NGOs
 - g. School/ college/ university
 - h. Government agencies/ information
 - i. Friends/ family
 - j. Local community gatherings
 - k. Self-Observe
 - l. Other (specify).....

6. Based on your observation over the past 10-30 years, please provide information on the following items.

Items	Increased	Decreased	Unchanged	Don't know	When do you start to notice the changes? (in years)
1. Rainfall					
2. Temperature					
3. Snowfall					
4. Size of the Glaciers					
5. Floods					
6. Avalanche					
7. Droughts					
8. Soil Erosion					
9. Summer Days (or Months)					
10. Winter Days (or months)					
11. Early Spring					

7. Compare the current weather with the weather 10-30 years ago?

- a. Cool c. Warm e. Don't know
b. Very Cool d. Very warm

8. Is climate change going to affect you, personally?

- a. Yes b. No c. Don't know

9. If yes, in which way is it affecting you or will affect you in the future?

- a. Affecting your livelihood
- b. Health
- c. Water availability
- d. Overall family welfare
- e. Low agriculture productivity
- f. Other (specify)

10. Do you know anything can be done to tackle climate change?

- a. Yes b. No c. Don't know

11. If yes, what in your opinion, can be done to tackle the problem?

- a. Plant more trees
- b. Install air conditioners
- c. Change in housing structure
- d. Migration
- e. Transfer from non-renewable to renewable energy
- f. Water conservation in agriculture
- g. Pollution control
- h. Do nothing

12. Who in your opinion is responsible to take action against climate change?

- a. International organizations (e.g. the UN, WWF, IUCN etc.)
- b. The national government
- c. Provincial government
- d. Business and industry
- e. Local community/Individuals
- f. Other (specify).....
- g.

III- ENVIRONMENTAL CHANGES

1. Have you noticed any environmental change in the past 10-30 years?
 - a. Yes
 - b. No
2. What are the observed environmental changes?
 - a. Air pollution
 - b. Deforestation
 - c. Water Pollution
 - d. Increase in Solid Waste
 - e. Loss of bio-diversity
 - f. Extreme weather events
 - g. Other (please specify)
3. Do you feel any change in the wildlife species in the past 10 years?
 - a. Yes
 - b. No
 - c. Don't know
4. Have you experienced any form of flood in the last 10 years?
 - a. Yes
 - b. No
 - c. Don't know
5. If yes, what damage did you receive?
 - a. Life
 - b. House
 - c. Land/agriculture
 - d. Business
 - e. Other:
6. Is there any relationship between the floods and climate change?
 - a. Yes
 - b. No
 - c. Don't know
7. Has the flooding affected your livelihood?
 - a. Yes
 - b. No

IV- ADAPTATION MEASURES

1. Are there any adaptation measures against the climate change vulnerabilities in your area?
 - a. Yes
 - b. No
 - c. Don't know
2. What are the locally adapted measures against climate change?

3. Do you have a plan to adapt with the future environmental changes (drought, flooding etc.)?
 - a. Yes
 - b. No

4. If yes, state the adaptation measures you would adopt?

5. What are the barriers in adopting the above adaptation measures?

- | | |
|------------------------------------|--|
| a. Population growth | h. Lack of knowledge |
| b. Illiteracy | i. Lack of proper technology |
| c. Low soil quality | j. Lack of technical knowhow |
| d. Poor seeds | k. Lack of awareness about CC early warnings |
| e. Land tenure | l. Other (specify) |
| f. Lack of access to communication | |
| g. Insufficient cultivatable land | |

6. Do you think climate change/global warming can be slowed by community actions?

- | | | |
|-------------------|----------------------|-------------|
| a. Strongly Agree | c. Disagree | e. Not sure |
| b. Agree | d. Strongly disagree | |

7. List down the community actions/measures taken against climate change?

QUESTIONNAIRE 1.2: ASSESSMENT OF THE IMPACTS OF CC ON LIVELIHOOD SOURCES: AGRICULTURE

1. Please specify the size of land that is used/owned by the household.

S. No	Area (Kanals)	Ownership (1)	Land Type (2)	Land Quality (3)	Irrigation Type (4)
1					
2					
3					
4					

1) Code: 1= Renting, 2=Borrowing, 3= Others

2) Code: 1= land used for cultivation, 2=used for aquaculture, 3=forest land, Rangeland, 4=residential land, 5=commercial land/used for business activities, 6=other

3) Code: 1= Good, 2 = very good, 3 = Bad, 4 = Very Bad, 5= Don't know

4) Code: 1=no irrigation, 2=tube well, 3= Canal, 4= Rain-fed, 5= other

2. Indicate the reasons if quality of the land is not good?

- | | |
|-------------------------------|--------------------|
| a. Affected/Damaged by floods | d. Desertification |
| b. Drought | e. Other |
| c. Water logging | |

3. Is your land affected by natural disasters in the last 10-30 years (floods, cyclone, drought etc.)?
- a. Yes b. No
4. If yes, how much of your crop production/Horticulture was affected? (in %)
5. Any change in farming land area in the past 10 years?
- a. Increased c. Same e. Much reduced
b. Much increased d. Reduced
6. If increased, please state the reasons;
- a. Buying c. Allocated e. Other (specify).
b. Inherited d. Lease/Ijara
7. If reduced, please state the reasons;
- a. Selling d. Giving to children/relatives
b. Lost due to flooding e. Establishment of protected area
c. Landslide f. Other
8. Is the quality of your farming land been affected by climate change in the past 10-30 years?
- a. Yes b. No
9. If yes, please indicate the reasons.
- a. Droughts c. Floods e. Water logging
b. Desertification d. Salinity f. Other

10. Kindly provide information about your crop production?

S.no	Crop/Fruits	Area (Kanals)	Sold (Kg)	For own use (Kg)
1				
2				
3				
4				
5				
6				

11. What are the important problems that has reduced your crop yield/production? (choose as many as you please)
- a. Lack of finance f. Loss of land due to floods
b. Lack of good variety seeds g. Lack of good irrigation practices
c. Lack of modern techniques h. Bad weather
d. Low rainfall i. Other (specify)
e. High rainfall

12. A list of weather related hazards are given in the table below. How did they affect your crop production in the last 10-30 years?

S. No	Events	Severity of the events (1)					Impacts on the crop production (2)
		1	2	3	4	5	
1	Flood						
2	Storm						
3	Droughts						
4	Landslide						
5	Low/no rainfall						
6	Warm wave						
7	Cold wave						
8	Other						

(1) Code: 1 being not severe and 5 very severe

(2) Code: 1= Reducing productivity; 2= Reducing quality; 3=Increased input cost; 4=Reducing cultivation area; 5=Others (Please specify)

13. Any change in the crop diseases/pests?

- a. Yes b. No c. Don't know

14. If yes, please specify:

- i. .
- ii. .
- iii. .
- iv. .

15. What adjustment have you made so far to adapt to the long term changes in rainfall and temperature on crop production?

- a. Irrigate more
- b. Change crop variety
- c. Improved seed varieties
- d. Adopting soil conservation techniques
- e. Rainwater harvesting
- f. Migration
- g. Shifted from crop production to livestock
- h. Reducing the number of livestock
- i. Leasing out land
- j. Find another job
- k. Other (specify)

16. What kind of assistance do you need to help you adapt?

- a. Agriculture loans
b. Better variety of seeds
c. Change in the livelihood source
d. Other

17. Do you apply any of these new farming methods?

- a. Terraces
- b. Grass lines
- c. Fertilizers
- d. Contour Bunds
- e. Mulching
- f. Animal Manure
- g. Compost manure
- h. Other

18. Other Adaptive Measures adopted by the farmers: -

QUESTIONNAIRE 1.3: ASSESSMENT OF THE IMPACTS OF CC ON LIVELIHOOD SOURCES: FISHERIES

1. Please provide information regarding the fisheries your household own or capture for household or commercial use in the last 12 months?

S. No		Own use (Kg)	Commercial use (Kg)
1	Fishery capture		
2	Fish farm		
3	Other		

2. What is your fish farm area (in case the household own a fish farm)?

Activities	Area (kanal)	Total area in comparison to 10-30 years ago? (1)
Fish farming		

(1) Code: 1 = increased, 2 = Same, 3 = Decreased

3. Where do you catch fish (in case you catch fish)?

- a. River
- b. Pond
- c. Spring
- d. Offshore
- e. Others

4. What do you think are the limiting factors for fishery production in your area?

- a. Lack of good varieties
- b. Change in the climate
- c. Change in the water temperature
- d. Flooding in rivers
- e. Change in water Quality
- f. Over fishing in rivers
- g. Other (specify)

5. A list of weather related hazards are given in the table below. How did they affect your fishery production in the last 10-30 years?

S. No	Events	Severity of the events (1)					Impacts on the fishery production (2)
		1	2	3	4	5	
1	Flood						
2	Storm						
3	Droughts						
4	Landslide						
5	Low/no rainfall						
6	Quality of River Water						
7	Warm wave						
8	Cold wave						
9	Other						

(1) Code: 1 being not severe and 5 very severe

(2) Code: 1= Reducing productivity; 2= Reducing quality; 3=Increased input cost;
4=Reducing cultivation area; 5=Others (Please specify)

6. List the adaptation measures you have taken against climate hazards?

QUESTIONNAIRE 1.4: ASSESSMENT OF THE IMPACTS OF CC ON LIVELIHOOD SOURCES: TOURISM

1. Are you related to tourism industry in any mean?
 - a. Yes
 - b. No

2. If yes, then how are you related to tourism?

a. Hotel business	c. Transportation	e. Tourist Guide
b. Restaurant	d. Hiking	f. Other

3. Main attractions for tourists in your area?

a. Streams	g. Lakes	k. Architectural/cul
b. River Swat	h. Beautiful	tural heritage
c. Wildlife	landscape	sites
d. Forests	i. Glaciers	l. Handcrafts
e. Wilderness	j. Hiking and	m. Other (specify)
f. Springs	camping	

4. Has the tourism been affected by the recent flooding in River Swat?
 - a. Yes
 - b. No
 - c. Don't know

5. If yes, list the sectors or infrastructure got affected the most? (eg., roads, housing, hotels, tourist attraction spots etc)
 - a.
 - b.
 - c.
 - d.
 - e.

6. Climate change hazards related to tourism industry in District Swat?

a. Extreme weather conditions	i. Road erosion
b. Storms	j. Landslide
c. Decrease in rainfall	k. Deforestation
d. Increased Forest fire	l. Increase in Temperature
e. Shortage of water	m. Loss of scenic beauty
f. Quality of River Swat	n. Loss of bio-diversity
g. Loss of Glaciers	o. Loss of wildlife
h. Floods	p. Air pollution

q. Others

7. Is there any change in number of tourists to your area in the last 10-30 years?
- | | | |
|-------------------------|-------------|----------------|
| a. Decrease | c. The same | e. Significant |
| b. Significant decrease | d. Increase | increase |
8. If the change is “Decrease” or “Significant decrease”, then what are the main reasons?
- | | |
|----------------------------------|---------------------------|
| a. Recent Flooding in River Swat | d. Loss of greenery |
| a. Damages of access roads | e. Security concerns |
| b. Increase in Temperature | f. Lack of Govt. interest |
| c. Loss of scenic beauty | g. Other |
9. If increased, please mention the reasons
- | |
|---------|
| a. |
| b. |
| c. |
10. Do you think climate change is going to impact the tourism industry of Swat Valley?
- | | | |
|--------|-------|---------------|
| a. Yes | b. No | c. Don't know |
|--------|-------|---------------|
11. If yes, how is it going to affect tourism in Swat?
- | | |
|-----------------------------------|--------------------------------|
| a. Decrease in number of tourists | d. Damage to build environment |
| b. Affecting livelihoods | e. Other (specify) |
| c. Damage to natural environment | |
12. Is climate change a concern for your business/livelihood?
- | | |
|--------|-------|
| a. Yes | b. No |
|--------|-------|
13. If yes, then how will it affect your tourism activity?
- | |
|---|
| a. Damage to infrastructure and facilities (hotels, resorts etc.) |
| b. Decrease in the number of tourist |
| c. Damage to roads and transportation |
| d. Damages to glaciers |
| e. Damage to landscape/greenery |
| f. Other (specify) |

14. A list of weather related hazards are given in the table below. How did they affect tourism industry in the last 10-30 years?

S. No	Events	Severity of the events (1)					Impacts on Tourism (2)
		1	2	3	4	5	
1	Flood						
2	Storm						
3	Droughts						
4	Landslide						
5	Low/no rainfall						
6	Quality of River Water						
7	Warm/heat wave						
8	Cold wave						
9	Other						

(1) Code: 1 being not severe and 5 very severe

(2) List the impacts of climate change on tourism sector/infrastructure (see the options in Q 6, 12 & 14)

15. How you adapted to the hazards that affected your livelihood?

- a.
- b.
- c.

16. What are the adaptive measures taken by the government against climate change to promote tourism in Swat?

17. What are the locally adaptive measures in tourism sector taken against climate change?

Thank you!

SURVEY COVERING LETTER

Dear Sir,

The current Questionnaire Survey is part of PhD dissertation titled “**Study on Sustainable Livelihoods, Vulnerability and Adaptation to Climate Change in District Swat**”. The study is aimed to achieve the following objectives;

- To understand the climate change vulnerability and local adaptation strategies in the study area.
- To investigate the impacts of climate change on livelihood sources in selected mountainous communities of the study area.
- To explore the public perceptions about climate variability and role of local knowledge in the climate change adaptation.

The questionnaire survey is aimed to collect firsthand information from the locals of District Swat. How they perceive Climate Change in their minds, their personal observations over the past years and how they adapted to these changes. The survey will provide a better insight to public opinions and understanding about climate variability, vulnerability to different livelihood sources and locally adapted measures to the observed climate change impacts in District Swat.

The data collected in any form will be used for academic purposes only and shall not be shared with third parties.

You are requested to participate in the survey and kindly provide your response positively.

Thanks,

Sincerely,

*M. Suleman Bacha,
PhD Scholar, Department of Environmental
Sciences, University of Peshawar.*

INTERVIEW GUIDE FOR THE LOCAL ELDER/LOCAL FARMER

Name:

Age of the respondent:

Profession/Position:

Duration of stay in the village/ area

Village/Union Council

1. Understanding of Climate Change
2. Are there any changes in the state of the climate e.g. rainfall, temperature for the past 20-30 years?
 - Rainfall amounts, distribution and variability (annual and seasonal)
 - Changes in mean annual temperatures
3. Why do you perceive these changes and what are the major reasons behind these changes?
4. Major climatic events (weather related hazards) and impacts on community (reasons/Impacts-Observed: no. of years)
 - Floods (experience of floods, how many occurring in your life time, damages received)
 - Droughts, Storms
 - Head Waves, Cold Waves
 - Landslide, Erosion
 - Low/no rainfall, Water Scarcity/Shortage
5. Interviewee practical experience evidencing climate change in the village/ area in terms of:
 - forest resources (access and use compared to past years)
 - water resources (access and use compared to past years)
6. Impacts of climate change on farmer livelihoods?
 - Change in Cropping yields, crop diseases and flood security
 - Household income, health and overall welfare
7. How are you motivated to changes the farming practices in certain times?
 - Is it due to perceived changes in climate?
 - New farming techniques
 - Local adaptive techniques
 - Crops switching
 - Change in crops

8. What socio-economic changes have occurred on household and community level as a result of climate change?
9. Local coping mechanisms used to reduce the impacts? / adaptation measures by the farmer and barriers to adaptation.
10. Have you got any assistance from the government/NGOs in times of climate related crisis? (Floods, droughts etc.)
11. What can you propose as appropriate interventions (recommendations for govt) to help you (for your area or district in general) to adapt sustainably and enhance your resilience to climate change and variability?
12. Impacts of climate change on fisheries sector, and individual livelihood
 - Floods
 - Landslide
 - Pollution in rivers
 - Coping mechanism/Adaptation
13. Impacts of climate change on tourism, and individual livelihood
 - Floods
 - Damaged infrastructure
 - Coping mechanism/Adaptation

Annexure-V: Snapshots of the field survey



Figure 1: Research Team in the Field

Figure 2: Flood Damages in the Study Area



Source a: <http://www.telegraph.co.uk/>
Source b: <http://www.tribune.com.pk/>

Rehabilitation Efforts after Floods (Pak Govt and NGOs)



a)



b)

Figure 3: Government Rehabilitation efforts of the flood effected areas through Billion Tree Tsunami Project
a) Rehabilitation of Degraded Watershed (Kalam, District Swat) b) Ramate Afforestation (Kalam, District Swat)



a)



b)

Figure 4: Rehabilitation efforts for Flood Damaged agricultral systems in district Swat a) Rehabilitation efforts of flood damaged irigation channels (Mankial, Swat) b) Rehabilitation plan for the flood effected farmers



Figure 5: Rehabilitation efforts of flood damaged infrastructure in the study area
 (caption: Rehabilitation of flood damaged water and sanitation system and improved
 service delivery in District Swat. Funded by European Union)