Climate Change: Farmer Perception and Adaptation Strategies and its Impacts on Agriculture in District Nagar, Gilgit-Baltistan, Pakistan

MASTER THESIS
MAY 2023

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GLODEP COHORT 2021-2023

UNIVERZITA PALACKÉHO V OLOMOUCI
Přírodovědecká fakulta
Akademický rok: 2022/2023

ZADÁNÍ DIPLOMOVÉ PRÁCE
(projektu, uměleckého díla, uměleckého výkonu)

Jméno a příjmení:	**Yousuf ALI, BA (Hons)**
Osobní číslo:	**R210667**
Studijní program:	**N0588A330004 Global Development Policy**
Téma práce:	**Community perception of the impact of climate change on agriculture and their coping strategies**
Zadávající katedra:	**Katedra rozvojových a environmentálních studií**

Zásady pro vypracování

The study is aimed to achieve the following objectives.

1. *To study community perception about climate change and its impact on agriculture production in Nagar Valley.*
2. *To study the perception of the community regarding climate change in Nagar Valley.*

To identify the coping strategies being adopted by the community to cope with climate change in Nagar valley

Rozsah pracovní zprávy:	**dle potřeby**
Rozsah grafických prací:	**10 – 15 000 slov**
Forma zpracování diplomové práce:	**tištěná/elektronická**
Jazyk zpracování:	**Angličtina**

Seznam doporučené literatury:

Farmers' perception and adaptation to climate change: A willingness to pay analysis
Adaptation to climate change in the developing world

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Datum zadání diplomové práce: **19. ledna 2023**
Termín odevzdání diplomové práce: **31. května 2023**

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V Olomouci dne 19. ledna 2023

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ACKNOWLEDGMENT

Abstract

Like any other developing country, Pakistan is confronting climate-induced hazards, but the intensity and severity of these hazards are high and threaten the residents of the higher mountainous regions of Pakistan, such as District Nagar, Gilgit-Baltistan.

The primary objective of this study is to understand farmers' perception of climate change, adaptation strategies, and its impact on agriculture production in district Nagar; for this study, a mixed research approach was adopted to collect data from respondents. Quantitative data were obtained from 204 farmers of Rakaposhi and Phaker Valley by simple random sampling, while qualitative data was obtained from key informants and focus group discussions. Percentage analysis, Trend analysis, Chi-square distribution, and Logistic regression are used to analyze the data. The result of this study shows that climate change impacts agricultural productivity adversely, as most farmers claimed that due to climate-induced hazards, they are suffering from numerous negative consequences such as loss of soil fertility, crops infestation diseases, water shortage, and premature repining of crops, which eventually reduce the agriculture production in district Nagar.

The study also revealed that the farmers of district Nagar perceived the symptoms of climate change such as increase in temperature, change in precipitation, erratic rainfall, Glacial Lake Outburst Floods (GLOFs),and glaciers melting, and farmers associated these changes with abrupt climate change. Moreover, the study further revealed that crop diversification, changing planting dates, shifting to horticulture, crop rotation, and moving to non-farm activities are prominent adaptation measures through which farmers mitigate the impact of climate change.

Keywords: Climate change, Perception, Adaptation strategies, Barriers of adaptation, Gilgit-Baltistan

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GB   *Gilgit-Baltistan*

GDP   *Gross Domestic Production*

GLOF   *Glacial Lake Outburst Flood*

GEPA   *Ghana Environmental Protection Agency*

HKH   *Himalayas Karakorum Hindus Kush*

ILO   *International Labour Organization*

IPPC   *Intergovernmental Panel on Climate Change*

IRB   *Indus River Basin*

IRFC   *International Federation of Red Cross and Red Crescent Societies*

KPK   *Khyber Pakhtunkhwa*

OCHA   *United Nations Office for the Coordination of Humanitarian Affairs*

UN   *United Nation*

UNDP   *United Nations Development Program*

UNEPA   *United Nations Environmental Protection Agency*

WB   *World Bank*

WWF   *Worldwide Fund*

Chapter 1

Introduction

1. Introduction

1.1 Background

Climate change is widely considered one of the greatest threats of the 21st century, and evidence shows that change is happening at an unprecedented rate. Globally, climate change is now considered a burning issue as it induces disasters and catastrophes such as floods, droughts, and wildfires (Abbas et al., 2022). The agriculture sector is particularly vulnerable to climate change, directly affecting production and farming communities, especially smallholder farmers who are very prone to climate change in developing countries (Menike and Arachchi, 2016; Lindoso et al., 2012). As an agricultural country, Pakistan relies heavily on agriculture, either directly or indirectly. In Pakistan, especially the high mountainous areas are very susceptible to climate change hazards such as drought, floods, shortage of water which eventually reduce agricultural productivity (Bacha, 2012).

1.2 Climate Change: Global Scenario

The term "climate change" refers to a shift in the global or regional weather patterns that have persisted for an extended period. Although these climatic shifts could take tens, hundreds, or even millions of years, they are happening much more quickly due to human activities such as industrialization, deforestation, and shifts in land use (Singh & Singh, 2012). Moreover, according to IPCC (2007) climate change directly impacts food products across the globe, and reduces crop production, globally. Climate change is a reality, and evidence from different countries shows that our planet's climate is changing at a faster rate. These evidence are increase in temperature, changes in rainfall, fluctuations in weather patterns, and fast melting of glaciers (Singh & Singh, 2012; Weitzman, 2009). According to the UN (2013) in the last few decades, our planet's climate has changed significantly, and the earth's temperature is expected to increase if anthropogenic activities continue.

People living in rural areas highly dependent on agricultural production are expected to be the most disturbed by climate change, especially in developing countries. These developing countries are vulnerable to climate change despite their minuscule contribution to global warming (Maskrey et al., 2007). According to Zhuang (2009) the global south, especially Asian countries, is most affected because, in these countries, most people are poor and highly dependent on agriculture. These changes in climate change pose numerous challenges to ecological, social, and economic systems. World Bank report on South Asia's climate change

in 2009 also highlighted the same concern that people in the least developing countries are at substantial risk of climate due to unfavorable geography and high dependence on climate-sensitive means of livelihood (World Bank, 2009).

1. 3 Climate change: Pakistan's Scenario

Climate change poses various threats to agricultural development in developing countries in the 21st century (UNIPCC, 2014). According to Global Climate Risk Index, Pakistan is a highly vulnerable country and ranked eighth, most affected by global warming and climate change. According to Abbas & Dastgeer (2021) agriculture is the backbone of Pakistan's economy and plays a crucial role in the development of the country. However, temperature variations and rainfall cycles have affected the agriculture sector over time. Such variations in temperatures, changes in rain patterns, variability of monsoon season, and water-stressed conditions such as floods and drought have negative implications on agriculture in Pakistan (Chandio & Magsi, 2020). The variation in monsoon rainfall impacts crop productivity negatively in Pakistan, such as rice, wheat, and maize (Chandio & Gokmenoglu, 2021). The research Chandio & Gokmenoglu (2021) further identified climate change's impact on cereal production in Pakistan. Another research conducted by Ali & Erenstein (2017) analyzed the effects of climate change, and their finding also shows a significant negative impact on production in Pakistan. The frequent flood and droughts in Pakistan are negative repercussions of climate change despite its low contribution to carbon dioxide gases (Smadj et al., 2015). Pakistan has been facing several catastrophes due to which it has experienced economic losses such reduction in agriculture productivity and damage to public and private infrastructure (Hussain & Rasool, 2016).

1.4 Climate change: Perception and Adaptation

Maddison (2007) suggests splitting climate adaptation into two stages. The first stage is farmers' awareness, or how they interpret the weather changes they have seen around them. Farmers collect information and indications from their environment and convert them into consciousness through the phenomenon of perception. The second stage is associated with farmers' activities based on their awareness and perception of climatic conditions, and this pertains to farmers' adaptation tactics. All these methods of farmers' responses against climatic conditions to reduce the vulnerabilities associated with biological, economic, and social environments. Scientists also argued that the adaptation of farmers depends on the farmer's perception of changes in the climate of their surroundings. The higher level of farmers' perception of climate change and favorable reaction leads to sustainability of the environment, and thus farmers' understanding and perception of change increase their psychological awareness (Ban & Hawkins, 2000)

Maddison (2007) further suggested that farmers must understand climate change and then look for alternative coping measures because, most of the time, farmers notice the changes in their agriculture production. Still, they are not linked with abrupt climate change due to a lack of awareness. So, farmers must understand climate change and make different strategies to combat the climate of their surroundings to sustain their livelihood.

Acquah (2011) discusses that understanding climate change perception and willingness to adapt the practice before initiating any policy is especially important. He argued that before adaptation, the utmost important thing is the level of perception of farmers about climate change and awareness about adaptation as well as knowledge about barriers that hinder adaptation strategies.

1.5 Statement of the Problem

Agriculture is still one of the mainstays of rural communities of Gilgit-Baltistan, Pakistan. These communities have suffered in the last few decades due to abrupt climate change. Despite its widespread impacts, climate change is less prioritized in Gilgit-Baltistan, so climatic resilience must improve more. The variability in climate change reduced agricultural productivity and increased susceptibility to hazards. Rural communities are dependent on glacial reservoirs for their agricultural production. The affected mountainous people are not fully equipped to mitigate climate change and needed external support to understand climate change phenomena better. In higher mountainous regions, the public perception of climate change has yet to be developed scientifically, so they primarily exercise malpractices. However, these communities are using their Indigenous knowledge to cope climate induced hazard by different adaptation strategies. So, it is need of the hour that this knowledge can be intricate and utilized in the future as policy items. Thus, the main objective of this study is to investigate farmers' perceptions, coping mechanisms, and their impact on agriculture production.

1.6 Objectives

The main objective of this research is to investigate farmer perception of climate and adaptation strategies. ***The precise objectives of the study are as follows,***

To Investigate the impacts of climate change on agriculture in district Nagar.

To probe the perception of farmers about climate change in district Nagar

To study the farmers adaptation strategies to climate change in district Nagar

To study the barriers to adaptation in district Nagar

1.7 Hypothesis

Agricultural practice and productivity are declining in mountainous areas like Gilgit-Baltistan due to climate change. Local people perceived climate change as threats and adopt different coping strategies to avert climate change. The more specific hypothesis are following;

Agriculture productivity is declining due to climate change in District Nagar

Farmers perceived the impacts of climate change in District Nagar

Farmers adapt coping strategies to avert climate change in District Nagar

1.8 Organization of the Study

The research is comprised of five chapters. The first chapter is about the introduction. The second chapter deals with the literature review. The next chapter is about the research's methodology, the fourth chapter is about the result and discussion of the study, and the fifth chapter is about the study's conclusion.

2. Literature Review

This chapter gives insight into the current study's accessible literature and global insights into local viewpoints. The study builds on previous worldwide research, giving it a solid foundation. Furthermore, perception and adaptation to climate change is getting attention in the contemporary world. District Nagar in Gilgit-Baltistan, Pakistan, is not immune to this threat, which will impact the studied region's agriculture productivity, livelihood sources, and natural environment. Although climate change research in Pakistan is still in its embryonic phases, and the available literature is limited, an attempt has been made in this chapter to provide a descriptive picture of the situation using local and international efforts made thus far.

2.1 Climate Change

Climate change is defined by the UNEP (2011) as "any change in climate, whether caused by the change in nature or by human activity." Climate change has become an unavoidable reality, and its widespread repercussions have been observed worldwide. However, high-altitude areas warn faster than low altitudes at different intensities, whereas continents have warned faster than the oceans (Dessens & Köhler, 2014).

The IPCC (2007) demonstrates that in the upcoming time rise in temperature is expected to be high and more robust over land compared to the ocean and stronger in attitude areas compared to the tropic. These future anticipations about climate change shows that the negative impact of climate change is inevitable and will affect the entire human settlement (Pouliotte & Smitt, 2009). Today, unprecedented change has induced and led to catastrophes, such as frequent floods, melting glaciers, rising sea levels, droughts, and cyclones (Watson, 1998). It is clear from the past that the abrupt climate change undermined development action and impacted agriculture productivity differently (Watson, 1998). The erratic rainfall, increase in temperature, and change in precipitation patterns can impact the agriculture sector adversely. Moreover, those countries whose economic sector is highly dependent on weather conditions can become subject to climate induce threats (Acosta & Nicolli, 2021).

2.2 Impact of Climate Change on Agriculture: Global Scenario

Agriculture is considered one of the crucial foundations of this planet. Issues and challenges in this sector have related to the development and prosperity of humankind (Guo & Xia, 2022). In many parts of the world, agriculture is considered one of the key and essential prerequisites for developing secondary and

tertiary industries (Adamson & Hannaford, 2018). However, in the last couple of decades, the agriculture sector has been suffering dramatically due to its reliance on climatic conditions (Adamson & Hannaford, 2018). As the global temperature is frequently increasing, it is predicted that global temperature may rise 1.40°C-3.1°C and decrease the productivity of different crops in different regions of the world (Wu & Sadiq, 2021). The change in climatic conditions may affect total productivity, i.e., on the one hand, it affects productivity by changing resource allocation. On the other side, it changes the output variable (Malla, 2008).

According to Dubovitski & Konovalova (2021); Salokhiddinov & Borisov (2020) frequent changes in climate decline agriculture production in Russia. In Vietnam, climate change has affected the rice crop negatively (Bricknell & Birkel, 2020). In Turkey, rice and wheat production has declined due to fluctuations in temperature and precipitation. Similarly, in Arab countries, crop yield has declined (Chandio & Gokmenoglu, 2021). According to Chandio & Magsi (2020) in South Asia, the temperature harms crop yield while the precipitation positively affects agriculture, i.e., in Nepal, the maize crop has declined due to temperature and precipitation boosts agriculture production. However, the scientific community has different opinions about the effects of climate change. According to Mendelsohn & Jinxia (2017) due to better coping capacity and adaptation strategies in developed nations, climate change impacts are negligible as compared to least developed and developing countries (Mendelsohn & Dinar, 2016; Mendelsohn & Jinxia, 2017).

2.3 Climatic Variability and extreme weather in Pakistan

The climate of Pakistan is a tropical type with significant variability in temperature and rainfall. Most of the land is arid, and some are semi-arid (Chaudhry, 2017). The rainfall season is divided into two periods, i.e., the winter and summer monsoons. The monsoon in the southwest, which starts from June to September, brings rain to the southern and eastern parts of the country every year. In contrast, the north and west of part country receive rainfall during winter from December to March (Chaudhry, 2017).

Additionally, the monsoon contributes 60% of the total rainfall in Pakistan. At the same time, three-quarters of the country receives 250mm of rainfall annually. Even less, the south slope of the Himalayas and their sub-regions receives 2000mm (Chaudhry, 2017). The Variability in temperature and rainfall as the effect of El Nino Southern Oscillation (ENSO) in Pakistan and rising temperature will also lead to glacial melt, and the Indus River basin will change seasonal river flow due to weather variations (Ministry of Climate Change, 2021).

Cold waves are occurring in high-altitude regions such as Kashmir and Gilgit Baltistan, and their compound impact devasted people's livelihoods (IRFC, 2019). In January 2020, 106 people died due to avalanches and landslides caused by snowfall and heavy rainfall (IRRC, 2019). Due to heavy rain in the monsoon season, Pakistan is facing devasting floods and landslides (Mahmood et al., 2016). Drought also leaves severe implications for food and water security as well as for health. The drought in 2018-2019, according to the government of Pakistan, 5 million people were affected (OCHA, 2019). Drought is caused by irregular rainfall, a prolonged dry spell, and other socioeconomic factors such as human displacement (Anjum & Ding, 2019; IFRC, 2019).

Akram & Turan (2018) estimated that from 1997-2015, around seven heat waves per year predicted increasing trends and 1200 heat-related deaths occurred in the province of Sindh. Charlotte (2017) both Lahore and Karachi are the most vulnerable cities of Pakistan to extreme heat waves and pose heat stroke. In the summer season, Pakistan experience extremely hot and humid, and the temperature reaches 49°C, while in winter is colder, and the temperature fluctuates between 4°C-20°C in all parts of the country (Ali & Mayes, 2019). The heavy rainfall in summer usually leads to floods. The Mountainous part of Pakistan witnessed flash floods and landslides because of increased rainfall and thunderstorms (Ministry of Climate Change, 2012). The fluctuation in the monsoon season caused floods and drought and decreased water reduction to evaporation rates. Moreover, the arid part of the country will face severe desertification, floods, salinity ingress, and soil erosion (Ministry of Climate Change, 2012). Winter droughts are predicted to increase and increase the risk of forest fires as temperature increases and rainfall decreases (Ministry of Climate Change, 2012).

2.4 Impacts of Climate Change on Agriculture: Pakistan Scenario

According to the Brookings Institute of Asia Third Assessment Report, the severity and intensity of weather events increased unprecedentedly over the 20 years (Ahmed & Khan, 2016). Pakistan is a country facing challenging climate-related events even though its minimal contribution to global warming. These impacts are due to many reasons, such as rapid population growth, unplanned development and exploitation of ecosystem services. In the last year, Pakistan has been exposed to hazards induced by climate change such as floods, earthquakes, and drought (Chaudhry, 2017). Pakistan is facing these hazards due to its geographical location on seismically active geological plates. The glacial melt by (the Himalayas, the Karakoram, and the Hindu Kush) fed these active floodplains. It triggered extreme weather events, while the semi-arid land frequently faces drought, heat waves, and cyclones (Chaudhry, 2017). The fifth IPPC assessment report on climate change for South Asia shows that the warming in the region is above the

global mean, intensifying the melting of glacier rate, precipitation pattern and affecting the timing of monsoon rainfall (Chaudhry, 2017).

It is evident that temperature increases, and precipitation fluctuations adversely affect Pakistan's agriculture sector productivity (Malik & Haque, 2012). In Pakistan, climate-induced changes include fluctuations in monsoon timing, rise in temperature, extreme rainfall events, and impact on the country's ecosystem service, biodiversity, and human settlement in districts (Ahmed & Wang, 2022). Pakistan is a developing country, and agriculture is the mainstay of the country's economy, providing 42 percent of employment and 21 percent of GDP to the country's economy (ILO, 2018). According to Syed & Raza (2022), more than sixty percent of people in Pakistan directly or indirectly depend on the agriculture sector. It depends on weather patterns, but the steady global temperature affects Pakistan's monsoon season conditions affecting Pakistan's agriculture production badly. Farmers of Pakistan are engaged in different activities such as crop production, livestock management, and forestry, but these activities are very susceptible to climate sensitivity. The agriculture sector is highly reliant on irrigation from the Indus River, so any climate change makes farmers more vulnerable (UNDP, 2016). Due to glacier melting and irregular rainfall in monsoons, Pakistan is facing floods (Qaisrani & Umar, 2018).

Pakistan is vulnerable to atmospheric changes since it is situated in a region where temperature increases are more significant than the global average. Approximately 60% of the area receives less than 250 millimeters of rain annually, and 24% receives between 250 and 500 millimeters; the glaciers supply the rivers. Pakistan is at threat of atmospheric alteration due to its geographic location, where the temperature is high than the global mean. Glaciers supply by rivers and global warming make agriculture more vulnerable. From the last couple of years, Pakistan has been facing a shift in monsoon weather which cause flood and drought in all parts of Pakistan (Godde & Boone, 2020).

In Pakistan, both Kharif and Rabi crops are cultivated, wheat is a significant rabi crop, while kharif crops include sugarcane, rice, and maize. These crops are cultivated in the summer starting from February to August. However, both irrigated and spatial farming is prone to water quantitative and changes in temperature, and it is projected that by 2040 crop production will decline by 8% to 10 % (Lawrence & Cradock, 2020). Chaudhry (2017) by using the crop growth simulation method and estimated that crop production is reduced across Pakistan. They further predicted a 6% decline in wheat yield and 15% to 18% in rice in Pakistan. According to Gbetibouo & Hassan (2005) the temperature is increasing faster, and most probably, it will shift to cropping season, and some crops are expected to eliminate permanently. A study by Raza (2022) revealed that climate had affected all significant crops, such as wheat, rice, and cotton.

2.5 Perceive Threat of Climate Change in Higher Mountainous Region

Ten percent of the world's population resides in mountainous areas, most of them found in the global south, a region with a high concentration of developing countries and low economic and political integration. As a result of climate change, people have fewer options for making a living (Dessens & Köhler, 2014; Huddleston & Hinton, 2011; Macchi, 2010; FAO, 2015). More than 85 percent of all species, including reptiles, birds, and mammals, live in just 22 percent of the world's geographical area (Rahbek & Borregaard, 2019). These species are among the most at risk worldwide due to climate change (FAO, 2015).

As per the Intergovernmental Panel on Climate Change's Fifth Assessment Report IPCC (2014) increasing temperatures and extreme weather events have led to adverse impacts on crop production, livestock, fisheries, and forests, particularly those people who are dependent on agriculture will be at risk due to their limited adaptive capacity to sustain their agriculture production in higher mountainous regions. Climate change threatens the very existence of mountainous regions, and many of them are very poor (Maraseni & Gentle,2012). These abrupt variability in climate pose survival threats to these people. In most current decades, Himalaya, Karakorum, and Hindukush (HKH's) substantial warming is equivalent to the world average (Krishnan & Shrestha, 2019). This leads to glacial retreats, impacting biodiversity, and losing agricultural yield (Pritchard & Blenkinsop, 2017).

Most Asian countries, including Pakistan, HKH, and other mountains, are considered significant sources of rivers because they contain and store snowfall. Therefore, it's known as the third polar (Bolch, 2012). In these areas, most rivers originated from glaciers melting in summer. Millions of people depend on these rivers for different agriculture activities, but nowadays, the snow cover is changing. It has been observed that change significantly impacts the people of these areas (Gurung & Karki, 2012). In the upstream area of HKH, the precipitation falls in the form of snow partly, it causes a delay in river discharge, and the snow cover declined over the period, effect downstream rivers (Zhang & Ma, 2018). The change in temperature and precipitation patterns affects the quality and quantity of freshwater resources due to global warming (Huanget al., 2017). The changes in snowfall patterns and ice melt lead to insufficient and excessive water supply, eventually leading to a flood (Xu & Chen, 2009).

2.6 Impacts of Climate Change on Gilgit-Baltistan

Gilgit-Baltistan plays a substantial role in the sustainable progress and development of Pakistan. It is situated in the extreme north of Pakistan, extending over 2,971 km² (Khan 2014). Nature has blessed Gilgit-Baltistan with large glaciers and high mountain ranges extending over splendid valleys. Gilgit-Baltistan is the backbone of fresh water for the Indus River Basin (IRB), and most provinces of Pakistan depend on it

for irrigation (Khan et al., 2014). However, the people of mountain communities depend on local resources (Hussain & Rasool, 2016). The primary livelihood sources in G.B are agriculture, livestock, and horticulture but medical plants (herbal medicines), small businesses, and remittances also have little contribution to the livelihood of Gilgit-Baltistan (Hussain & Rasool, 2016). In recent years, various biophysical and socioeconomic factors led to severe repercussions, eventually affecting the natural resourceof Himalayan Karakorum Hindukush (Rasool et al., 2014).

In Pakistan, the high-temperature trend shows variation with regions. High elevation, such as Gilgit Baltistan, has been experiencing double warming trends compared to low elevations. According to Chaudhary & Aryal (2009) in the last 40 years, the temperature increase is 0.7°C for Pakistan, whereas the mountainous part of Pakistan hosting the largest glaciers was recorded at 1.5°C. This continuous increase in temperature and melt glacier at a faster rate. Thus, these glacier changes have caused new lakes and expanded the size of existing lakes (Rasul & Sharma, 2015). The sporadic discharge of water from lakes is known as Glacier Lake Outburst Flood (GLOF), and in addition, due to the changes in rainfall, the GLOF event is happening at a faster rate in G.B (Awan, 2017). GLOF is a phenomenon of an enormous amount of water discharge with pressure from the glacial lake, and it creates two primary conditions for flooding. Due to the impoundment create, upstream flooding is less dangerous for human losses but damage property, whereas downstream flash flooding is a result of basin outbreak (UNDP, 2016).

According to UNDP (2016), in the past 200 years, G.B. has experienced more than 35 GLOF, and five major GLOF events occurred from 2007-2008. The frequency increases at a faster rate, and the experts link this with increase in temperature and melting of the glacier. The glacier of G.B. is receding at a rate of 40 to 60 meters per decade and forming new outburst floods, which lead to tremendous destruction (Gohar, 2018). So, it is evident that glacier melting can significantly impact Pakistan because 70 fresh water originated from mountain areas Himalayas and Hindu Kush (Hussain, 2005). Mountainous regions are susceptible to climate change and global warming, and a slight fluctuation in temperature can lead to a considerable loss (Gohar, 2018).

2.7 Climate Change Risk Perception

Now a day, risk perception has become a key research area in disaster reduction, and the existing literature shows that risk perception helps and can affect the adaptation measures (Irfan, 2020). Risk perception is a multidisciplinary field highlighting the importance of community preparedness to cope with potential disasters (Pino & Miranda, 2017). Risk perception mostly depends on previous disaster experience

communities that are isolated and more prone to disaster may have a higher perception of disaster events because of prior experience compared to no hazardous community (Schneiderbauer & Rufat, 2021).

The risk perception of environmental studies hardly relies on the local context and characteristics, particularly in the less developed world (Walker et al., 2014, p. 710). These can differ in different ways due to access to natural resources, geography, means of livelihood, social and cultural belief, and norms also shape the perception of environmental risk and their decision (Walker & Rasmussen, 2014). Xie (2019) conducted a study on data produced by The Lowy Institute, Australia. According to the study's findings, in 2006, 68% of people in Australia perceived global warming as a threat to their life. However, the percentage declined in 2012 to 36%, and in 2016 it again up to 53%. Schneiderbauer & Rufat (2021) have argued that social culture and demographic factors also affect climate change risk perception.

2.8 Climate Change Perception in Developing Countries

2.8.1 Perception of climate change in Bangladesh

Adaptation measures in nations like Bangladesh require appreciating local context vulnerability (Ahmed & Wang, 2022). The research on climate perception in Bangladesh has shown a more significant quantitative overview and investigative studies that include focus group discussion and a multi-disciplinary approach to understanding public understanding about climate change. These studies show that in all countries, including both developed and developing countries, awareness and information about climate change in Bangladesh is high among people (World Bank, 2009; Kim, 2011). The role of Education, media, and disaster experience play a significant role in spreading awareness about climate change whereas gender, age, and family income are not considered significant factors in climate risk perception in Bangladesh (Hasan & Akhter, 2014). The studies of farmers' perceptions of climate change illustrate that farmers have experienced and perceived fluctuations in climatic conditions in most recent years and, more precisely rainfall and temperature. Both climatic and non-climatic factors expedite the consequence of drought, and these droughts severely affect culture production, social life, and health in Bangladesh (Habiba & Shaw, 2012). According to Haque & Sauerborn (2012) the study of two villages from the northern and south demonstrated that people at the local level reported the perceived longer summers, warmers winters, and sharp reduction in rainfall.

2.8.2 Public Perception of Climate Change in Africa

According to the Ghana Environmental Protection Agency (GEPA) climate change indicators are include rising temperatures, abrupt precipitation declines, rising sea levels, and an increase in the frequency of

natural disasters (Ghana Environmental Protection Agency, 2012). This fluctuation has been felt in Ghana, especially in Agriculture, as it is a crucial sector of the Ghanian economy (Environmental Protection Agency, 2012; Stanturf et al., 2011). The study of Gyampoh et al. (2008) in rural communities in Ghana illustrated that the local indigenous knowledge and people's experience about climate are vital for policy formulation about climate change. According to them, theses local knowledge and experience are building decisions, and it is significant to know how the local people can adapt and address these climatic variabilities.

In Ghana, Kamau (2010), farmers have different opinions about climate change, and these conceptions and perceptions are worth investigating. There are also some misconceptions and beliefs about climate change; many people in Ghana believe that climate change is not due to human activities. It is just an act, and the study conducted by Golo and Yaro (2013) confirmed this assertion. They further asserted that this misconception about climate change is due to a lack of knowledge in Ghana. Therefore, to make effective policy about climate change, there should be a link between Indigenous knowledge and climate change in the case of Ghana (Toan et al., 2014).

Public Perception in India and Nepal

The study conducted by Macchi et al. (2014) in 20 towns in India and Nepal find out what people thought about climate change. The results show that the amount and length of rainfall had decreased significantly over the past 5 to 10 years and that rainstorms have become less predictable. Furthermore, the study finding shows that the respondent felt that winter rainfall had significantly declined or stopped in the last 5 to 10 years. The people of the region above argued that the delay and irregularity in the onset of monsoon were more unpredictable. Moreover, the respondent also thought that the hot days had increased, and the winter days had become moderate. There was a perception of the increase in temperature at high elevations. The finding also shows that the women had difficulties in asses the climatic changing in the study area. At the same time, older adults easily differentiate the change in climatic conditions by comparing their childhood. The study of Chaudhary and Bawa (2011) about climate perception in the eastern part of Nepal IIam district also reported a higher prevalence of short-duration downpours, increasing temperatures, declining water availability, and widespread pet diseases, especially in higher elevations. Kelkar et al. (2008) illustrated that the residents of Uttarakhand noticed a sharp decline in the snowfall and the snow cover.

2.9 Public Perception of climate change in Pakistan

In Swat, Pakistan, a higher mountainous district of Khyber Pakhtunkhwa, Pakistan, Bacha et al. (2021) did a study to comprehend perception. As a part of the Hindu Kush-Himalayan region, the area is significantly

impacted by climatic hazards like earthquakes and landslides. The study by Bacha et al. (2021) identified that most respondents perceived that temperature has increased in the last couple of years. According to the study, 34% of people perceived and observed changing temperatures and rainfall quickly from their personal experience, especially in areas where people depend on geography and livelihood on rainfall. The study also demonstrated local people's perceptions about the cause of abrupt climate change. According to the respondent, deforestation is a major cause of climate change as the swat area covers 8.1 of the total forest in KPK province. Other than deforestation, a few respondents identify that anthropogenic causes such as greenhouse emissions and fossil fuels are major contributors to climate Change.

Another researcher, Ali et al. (2021) studied the farm-level perception of climate change in two districts of KPK, the northern-western part of Pakistan. Their study revealed that the farmers of Marden observed and perceived an increase in temperature compared to the Swabi district. Furthermore, the farmers of the Malakand district revealed a decrease in temperature. Khan's (2012) research examined farmers' perspectives on climate change in four provinces of Pakistan, including Gilgit-Baltistan. He gathered information from 25 districts, including urban and arid regions. The questionnaire includes questions about temperature, precipitation and the causes of climate change. The study of his finding revealed that 100% of respondents reported that the climate is changing in their respective areas. The respondent has different opinion about the cause of climate change, such as 57% showing that climate change is happening due to population growth and deforestation. The study also revealed that people in the arid region perceived decreased rainfall and an increase in temperature.

2.10 Climate change perception studies in Gilgit-Baltistan

2.10.1 Farmer Knowledge and observation about Climate change

In two Gilgit Baltistan districts, Hunza and Ghizer, Gioli & Khan (2014) researched how the locals perceived climate change. The respondents were questioned regarding their knowledge of climate change. In Ghizer District, 80% of the sample said they had never heard of climate change, and 83% could not discuss it, compared to 49% and 66% in Hunza. The difference in opinion is because of the Attaabad disaster. Many training and counseling sessions have been held under the umbrella of the Agha Khan network and UN agencies to tackle the consequence of the natural disaster. Literacy is another reason that might impact the perception of climate change.

It is crucial to consider linguistic issues when communicating the right message (Tschakert, 2007; Tambo & Abdoulay, 2013). No word for "climate" exists in the local languages; only "weather" exists. Many

respondents in the most educated group cited that due to global warming; climate change is happening, and these changes reduce agricultural productivity. They pointed to the need for governance and investments as significant obstacles to effective risk management and adjustments and their community's high exposure and susceptibility. (Gioli & Khan, 2014). However, these findings contrasted with the finding of Bacha (2021)study conducted in the KPK province of Pakistan. The result of his study showed that 85% of respondentswere familiar with the term climate change, and they possessed information about climate change.

2.10.2 Farmer's Perception of Climate Change

In the study of livestock herders in Gojal, Gilgit Joshi (2013) found that most respondents experienced an increase in temperature and claimed that temperature has changed over the last 20-30 years, particularly in the winter season. The study also demonstrates that local people witnessed the change in summer precipitation, rare weather events, and climate change. In the districts of Hunza and Nagar, Gioli, and & Khan (2014) investigated how locals perceived climatic variability. According to their finding, 75% of the respondents and 85% claimed that the summer season has become colder in the last ten years. Hussain & Rasool (2016) conducted a study on climate change perception in northern Pakistan, i.e. (Chitral, Gilgit, and Hunza-Nagar). According to them,almost 100 percent of local respondents perceive that climate change induced a hazard increase in those tenyears particularly floods.

According to Hessburg & Miller (2019) research, 92 to 95 respondents in district Nagar agreed that snowfall has decreased over the past several years. The study revealed that the perception of snowfalls across the district was consistent. None of the respondents claimed that the snowfall had increased or remained unchanged. In another study conducted by Batool & Shah (2019) on local perceptions of climate change in District Shiger of Gilgit-Baltistan, 90% of Shiger residents believed that summertime rainfall had increased, while 100% of respondents believed that temperatures had risen. They further argued that the local people also perceive a change in snowfall 75% of local people believed that the snow has decreased in the last couple of years.

2.10.3 Farmer's Perception about Causes of Climate Change

The research by Gioli & Khan (2014) revealed that the people of Ghizer perceived floods as a main cause of climate change, while the people of Hunza perceived that they are facing land sliding due to climate change. These two hazards are not univocally attributed to climate change equally. It is essential to consider that these hazards are occurring due to the combined effect of climate change, such as deforestation and extensive land use, which is quite common in Gilgit Baltistan (Schickhoff & Singh, 2016).

The study by Hessburg & Miller (2019) revealed that the irrigation system in Nagar depends on glacial water. However, the Phaker, Shayar, and Summyar valleys of District Nagar face water shortages during cultivation season due to declining snow cover. On the other side, the study also reported that the local people claimed that the quality of posture decreased due to less snowfall and the decline in the soil moisture cover because of water scarcity. Thus, due to this observed effect, the local people blame climate change for having negatively impact the district, Nagar. The irregular rainfall affects the agricultural season, i.e., destroying trees blossoming, increasing the disease inapricot and potatoes and triggering mudflow, which affects irrigation channels and infrastructure.Pakistan, including GB, is susceptible to geological and hydro-metrological hazards (Forsee & Ahmad, 2011). The hilly or mountainous and fragile environment increases the hazard risk (WWF, 2010).

Bhatta et al. (2019) interviewed 300 respondents in Rakaposhi Valley, and most respondents stated that because of climate change, the frequencies and intensities of avalanches increased over the last 25 years. The rapid climate change led to the habitat loss of many floras and fauna and disturbed the routes of migrator species (Khan et.al, 2014). The variability in the climatic condition also negatively affects plant phenology, such as the production and metabolism in higher mountains (Burkett & Wilcox, 2005). The study by Bhatta et al. (2019) also confirmed that 63 % of steady respondents reported that the local and wild plants disappeared due to abrupt climate change.

In Gilgit-Baltistan, 33% of the land is Rangeland, which offers almost one-third of its total area (Khan M. T., 2014). The study by Bhatta & Shrestha (2019) reported that 73% respond claimed that in the last 25, the forage productivity is declined in both the alpine and sub-alpine Rangeland and the local people reported that the grass and fodder depend on climatic conditions such as temperature and precipitation. Climate change impacts agriculture crops negatively by shortening the growing period, causing losses in yields because of extreme climate events (Iqbal & Sultana, 2009). In district Nagar, Rakaposhi Valley, 54 % of respondents reported that the agriculture productivity climate changed, and 46 percent stated that there was an increase in productivity (Bhatta & Shrestha, 2019).

2.11 Definition of Adaptation

According to the IPCC (2007) climate adaptation is defined as "ecological, social, or economic changes in reaction to present the climatic stimuli and their impacts". Climate change adaptation includes all possible adjustments to negative and positive consequences from climatic variability. These adjustments include multiple actions such as switching from various crops to another crop and diversifying livelihood as a fence against climate change. Additionally, this modification could take the shape of institutional reforms, i.e.,

amending land possession and farmers' right to use the land and water to create better resource management. Adaptation is learning about risk, creating a possible solution and action, and evaluating response strategies, but the genesis of adaptation is very important for creating and formulating public interventions (Anwar & Leary, 2007).

Climate change adaptation has not been studied enough yet (Berkes & Jolly, 2002). Climate change adaptation should be treated as a separate strategy. It should, however, be coordinated with initiatives to alleviate poverty and combat environmental risks. Despite climate change's more visible local impacts, policy, and activities should not be limited to the local scale. Instead, an integrated approach should be established comprising national and district-level policies and strategies or methods; concerning livelihood, poor households' adaptation needs are far greater than those of the wealthy and well-off groups (Gentle & Maraseni, 2012). The capability of people to tackle the adverse changes of climate change is affected by obstacles and is limited to adaptation. Thus, they cannot handle the risk that helps boost their well-being (Islam & Sallu, 2014). Effective adaptation to climate change needs the action of individuals and international institutions at a relevant scale (Butler & Bohensky, 2015).

Farmers often adopt those measures more dependent on their behavior and understanding of climate change perception than actual climate knowledge (Butler & Bohensky, 2015; Weber, 2010). The correct perception of farmers about climate change and scientific knowledge plays a pivotal role in designing policies to address climate change (Arunrat & Wang, 2017; Burnham & Ma, 2017). It is imperative to have appropriate information about climate change at the farm level to mitigate and minimize its effect. Conversely, misconceptions about climate change can also lead to malpractices and more effects (Grothmann & Patt, 2005).

2.12 Farmer's Responses to Climate Change: Coping Mechanisms and Adaptations

According to research conducted by Abid et al. (2018), most farmers are utilizing various coping tactics and strategies to deal with the harmful consequences of climate change. These strategies include mixing their crops, utilizing different inputs, and adjusting their tree-planting schedules. Similarly, Ullah et al. (2017) analysis of local farmers' adaptation strategies in the districts of Shabara and Gulabad, farmers employ a variety of coping mechanisms to avert the impact of climate change, including changing crop varieties, using high-quality fertilizer, switching from one crop to multiple crops, and using heat-tolerant wheat to cope with extreme temperatures.

Ali & Warsame (2021) performed a study in Khyber Pakhtunkhwa (KPK). They found that changes in

planting time, irrigation, and non-farm activities were the respondents' most popular strategies. Moreover, to show how climate change is affecting Punjab's rice production, which is highly vulnerable to climate change, Khan & Manes, (2021) investigated On-Farm Autonomous Adaptation of Strategies. They found different coping strategies such as water management, changing rice cultivation dates, and use of fertilizers. According to Khan & Manes (2021), 65% of farmers adopted supplementary irrigation, 35% adopted plot resizing, and 52% harvesting dates as OFAA measures to minimize the adverse impact of climate change.

Additionally, Ali & Erenstein, (2017) assess the factors that affect climate change adaptation practices using data from all four major provinces of Pakistan. They found that most farmers in four provinces used shifts of crop, drought tolerant varieties, and changing the date of sowing the seed to respond to climate change. The study also revealed that education, land size, and access to credit are positively associated with coping practices. The results also find some policy recommendations that awareness and knowledge about climate change are vital for adaptation strategies and stress that farmers' wealth and ability to invest in coping mechanisms in Pakistan. According to Macchi (2010) these coping strategies are different strategies taken by local farmers after any hazards to ward off immediate risk with short-term vision, such as for one season.

Adaptation tactics against the alleged change in Gilgit-Baltistan were explored by Gioli & Khan (2014). The study revealed that the most highly rated threat local people perceive in Hunza and Ghizer is the unexpected weather conditions in summer, such as fluctuation in temperature, and effect on agriculture production, such as ripening fruits. Local people adjust and shift their cropping calendar to minimize these threats to give more ripening time. However, these coping strategies might help in emergency response and are not appropriate for substantial for any long-term response to make the community more resilient. Potato crops have been considered one of the leading cash since 1980 and are considered a primary source of income in Hunza. However, after the Attabad disaster, local people suffered from additional loss of their income due to increased transportation costs for boat shipping. To mitigate this loss, they are cultivating peas as a cash crop. Spatial diversification is also found in Hunza, which helps to reduce their dependency on agriculture production.

According to Joshi et al. (2013) Gilgit-Baltistan herds were aware of climate change. They considered numerous coping strategies like increasing the provision of forage to animals and constructing a new irrigation channel to irrigate postures. According to herders, these strategies help them minimize climate change's effect. The warming trend also affects the phenology of forage plants. By changing the grazing

pattern, they address these by diversifying their herds, which they use as insurance against disease outbreaks. A combination of the different herds also ensures in drought or cold seasons. Thus, the response of the herds' community shows that they perceived climate change in Gilgit-Baltistan.

The study by Hussain et al. (2019) revealed that the farmers of Naltar Valley Gilgit are aware of climate change by different indigenous methods they are averting the threat of climate change. On the household level they have made different coping mechanism to deal with harsh environment economically stable families has made sheet homes and people who are poor and cannot afford sheet in their houses use plastics in their roofs and put a little layer of soil on it so that rainwater cannot seep through. People who live around vulnerable areas have made protected walls to avoid any sort of flood and water flow into their lands and houses. To deal with economic problems most of the population grow potatoes instead of wheat or maize as potatoes give them a handsome amount of money that other crops cannot. Owing to the current development in technology all the respondents cleared that they have shifted from traditional farming systems to advance systems like the use of tractors and machinery as in the past times people use to plow their fields with animals (Hussain et al., 2019).

Chapter 3
Methodology

3. Methodology

The main purpose of this chapter is to present the research methodology adopted to conduct this study. The mixed research method has been adopted to collect quantitative and qualitative data from the field. Both data sources, i.e., Primary, and secondary sources, are used to conduct this study. The collected data is carefully administered and processed using STATA 15 and Excel for various statistical analyses.

3.1 Study Area

The region Gilgit-Baltistan, Pakistan, previously known as the Northern Areas, is located between latitude 34-45_N and longitudes 75-77_E and is sharing borders with China, India, Afghanistan, and Tajikistan. Agriculture and livestock graze is a fundamental part of the local economy. The physical environment is severe due to the high height and steep terrain, with a long, cold winter and little precipitation. Many sites in Gilgit-Baltistan have temperatures ranging from 20°C to 40°C. Nagar Valley is a high mountainous district of Gilgit-Baltistan located in the western part of Karakorum Mountain. The district is considered critical due to its immense potential for agriculture, horticulture crops and produced hefty revenue for the GB economy. Nagar has two Tehsils, known as Nagar-1 and Nagar-2. Local people are dependent on agriculture for their livelihood; most people harvest wheat, potatoes, maize, and bulk wheat. Apart from the agricultural crop, the district is also famous for its fruits, such as apricot, cherry, and peas, which contribute to the local economy.

The study was conducted in Nagar-2, Named Rakaposhi Valley and Phaker Valley. Both valleys are very famous for agricultural production. These two-twin valleys are near to mighty Rakaposhi mountain, the 8th Highest Mountain in the world. The whole irrigation system depends on the melting of snow from Mighty Rakaposhi. The recent fluctuation in climate creates a devasting situation in both valleys. Both valleys face frequent floods, landslides, avalanches, erratic rainfall, and increasing temperature. These climatic distortions affect agriculture production badly. The study investigates how local people perceive these changes in both valleys and what strategies they are adapting locally to avert climatic events such as floods, temperature, erratic rainfall, avalanches, and landslides.
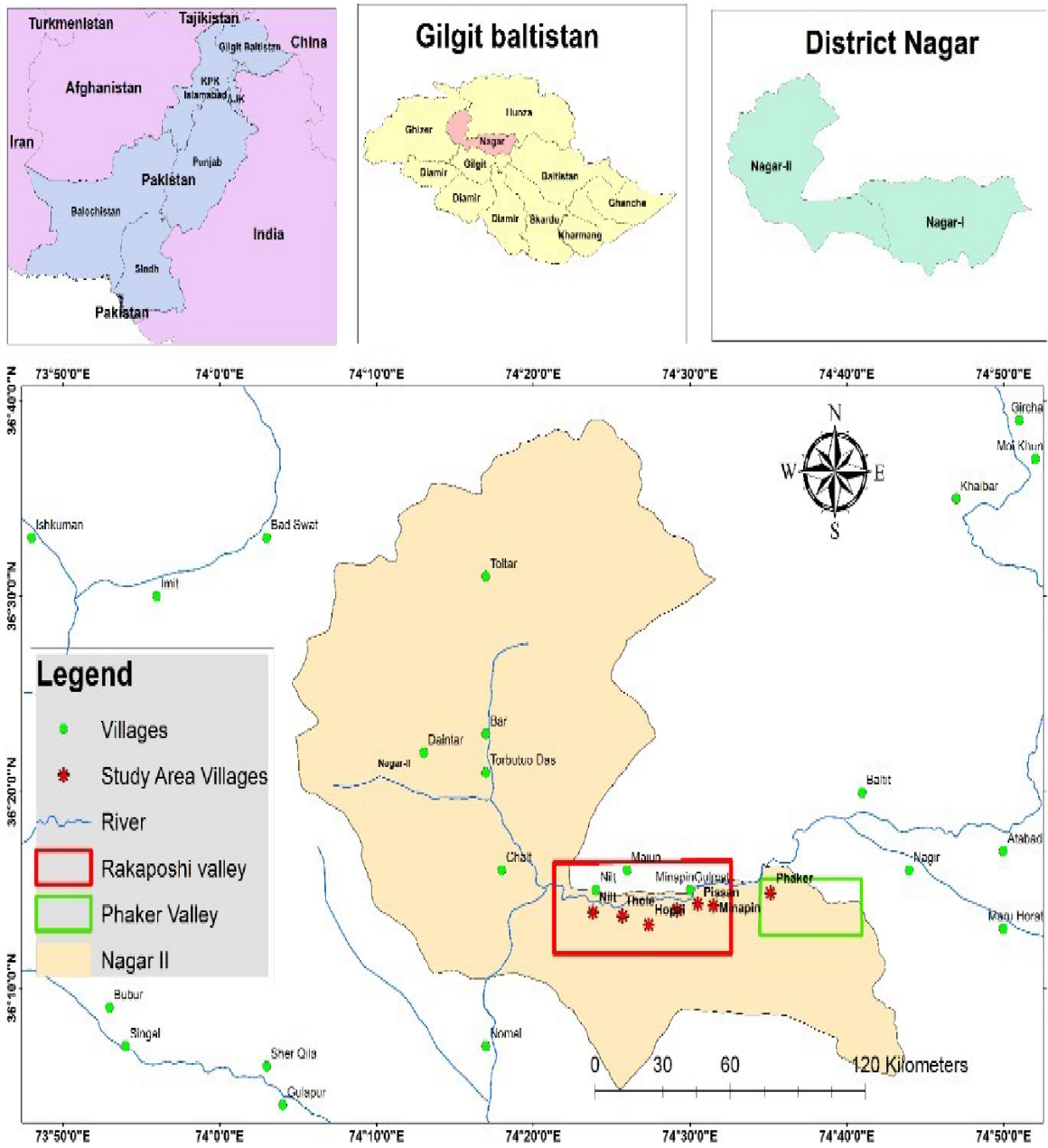
Figure 3.1: The Map of the Study Area. Author elaboration
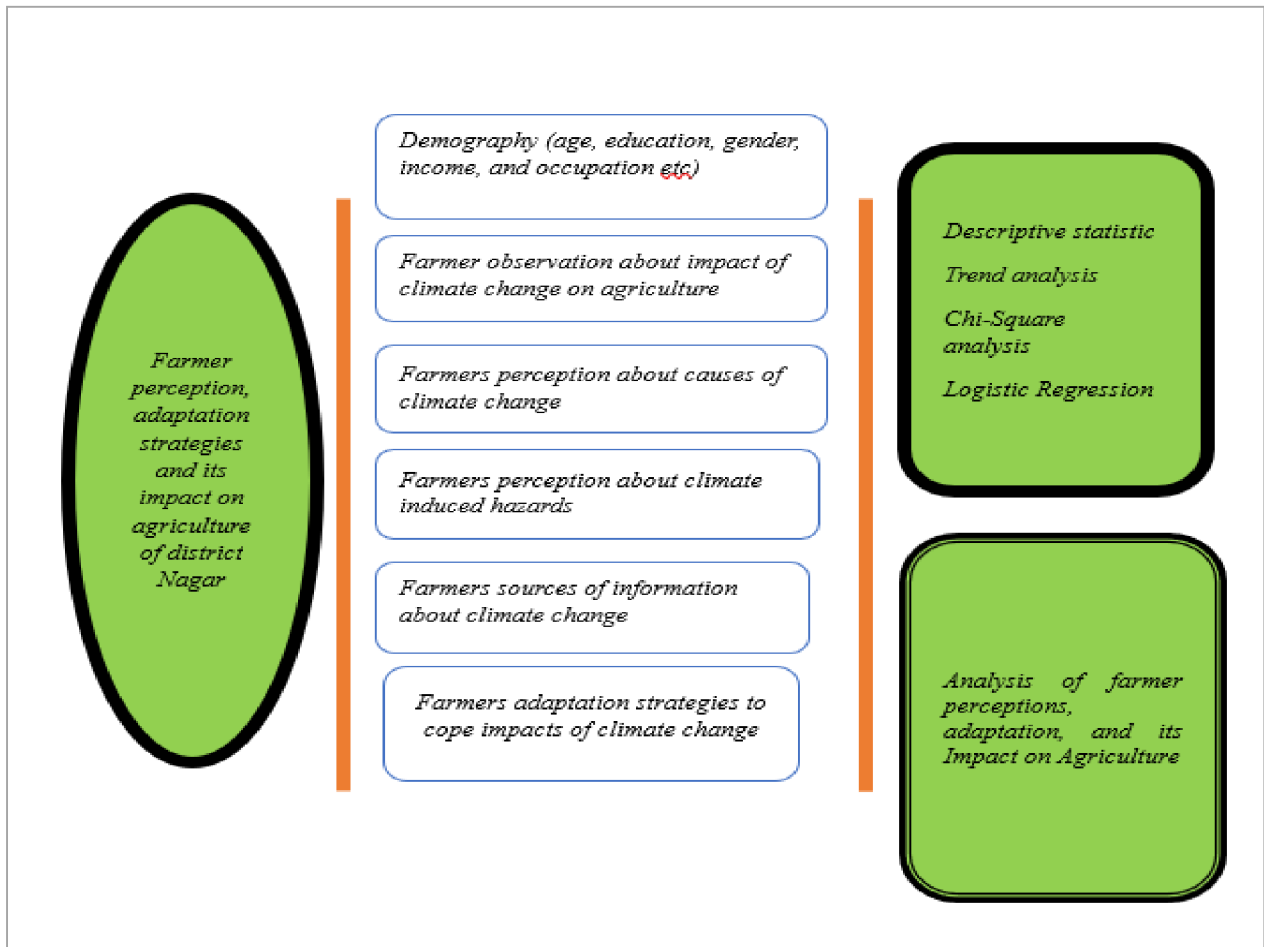
Figure 3.2: Research framework of farmer perception, adaptation strategies, and its impact on agriculture in District Nagar

3.2 Sample Selection

This study considers a sample of 204 household heads from Rakaposhi and Phaker Valley, District Nagar. The sample was chosen to statistically represent the total population of the farmers of the investigated area. The simple random sampling technique was used to collect the field data from the respondent of both valleys. Data was also collected from 10 key informants by purposive sampling who are working on climate change in Gilgit-Baltistan.

3.2.1 Sample Calculation

The study population in the Nagar District is homogenous, and the population is known. The unit of analysis is household. Considering these aspects and the nature of the research, this study's sample volume was calculated by applying the formula suggested by Yamane (1967:886) with a 95 % confidence level and a P-value of 0.05 mentioned in equation 1 below,

$$n = \frac{N}{1+N(e)^2} \qquad \text{………………….. (1)}$$

Whereas, "n" is the sample size, "N" is the total population, and "e" is level of precision.

$$n = \frac{2170}{1+2170(0.05)^2} \qquad \text{------------------ (2)}$$

A 204 head-of-household sample was drawn from the total population of 204 (2170) through the formula suggested by Yamane (1967), as shown in Equation 1. It is evident that more samples produce more reliable results by considering this aspect; this study used a sample.

3.3 Data Collection

The data for this study was gathered from both primary and secondary sources. Primary sources included a questionnaire by 204 locals, interviews with Key Informants, and focus groups. As a bonus, quantitative and qualitative approaches were used to compile this data. Focused group discussions and key informants interviews are examples of qualitative data collection, while a standardized questionnaire is utilized for quantitative field data collection.

3.3.1 Structure of Household Questionnaires

Household characteristics data included the head of household age, education level, income, and occupation, as well as their views on climate change and the adaptation tactic and strategies they had taken to adapt to it. Age, gender, family size, education level, income, and tenancy status were all considered to gauge how residents viewed climate change and adaptation methods.

The Questionnaire contained the following sections:

The first part of the questionnaire comprises of demographic information of the respondent.

The second section of the Questionnaire focuses on how climate change is impacting the agricultural output in the highly vulnerable district of Nagar.

The third section of the Questionnaire is dedicated to gathering information about how locals see, experience, and comprehend climate change.

The fourth part consists of adapting strategies to deal with the adverse effects of climate change.

3.3.2 Questionnaire Distribution

A one-on-one and face-to-face interview filled the questionnaire with participants or respondents due to a lack of literacy and language issues, as most local people don't speak and understand English. Special attention was given to each questionnaire filled in and appropriately noted. The primary terms, such as variables and climate change, were described in the native language in Shina and Bruskhki to understand what it meant to them. Four enumerators filled out the questionnaire, two males and two females. Due to cultural sensitivity, female enumerators collected data from the female head of household, and male enumerators are from the male head of respondent. The primary purpose of this research is to comprehend farmer perception and coping strategies of local people, so it was attempted carefully that older people should fill out the questionnaire because older respondents carry more information about the changing climate change; because of this reason, the survey didn't include less than 25 years of age group.

3.3.3 Focused Group Discussion

Focused group discussions were conducted with the local people to collect information about their understanding and perception of climate change. A total of 8 focused group discussions were held to collect information about climate change. Out of 8 FDS, two separate FDGS were organized for females because of cultural sensitivity. Each focus group comprises 5-8 members of the community. The topics covered different aspects of climate change, their understanding, coping mechanisms, and hurdles to cope with. Additionally, the FDGs served the objective of assessing and collecting adequate data about farmers' perception of climate change and its effect on agriculture and the way they coped and adapted different strategies.

3.3.4 Key Informants

Ten interviews were performed during the research project to gain a thorough insight into the local circumstances. These interviews also featured important informants and subject-matter specialists. Most of the interview questions were open-ended and semi-structured to allow the respondent to share their understanding of the situation and the facts. Critical respondents were interviewed in both Urdu and English; most are bilingual. The phrase "key informant" refers to a person who has educational background or professional experience, possesses specialized competence or knowledge of climate change,

its effects, and reaction mechanisms. These interviews aimed to provide information about the province's policies, trends, and ability to adapt to climatic changes.

3.3.5 Secondary data

For this study secondary data is obtained from different Journals and Books. Additionally, weather station data is obtained from 1990 -2020 collected from metrological department Gilgit-Baltistan.

3.3.6 Pre-Testing of Questionnaires

To get accurate results, adequate data is prerequired. For this purpose, the enumerators went into the area to know the ground realities and get familiarized with the local environment. The questionnaire pretesting was conducted in January 2023, and the survey was carried out in February 2023. The testing of the questionnaire helped to include missing information suggested by the enumerator after visiting the field and excluding unnecessary information.

3.4. Data Analysis

3.4.1 Quantitative Data Analysis

The primary tool used for this study to collect data from the field was a structured questionnaire, and the questionnaire data comprised structured responses, but few questions were openly kept. The Quantitative responses of respondents were analyzed in both Stata and Excel. The questionaries of this study were input in Stata and Excel manually by the researchers themselves. Great care was taken during the coding of variables in Stata and Excel.

3.4.2 Qualitative Data Analysis

The Qualitative data of this research include data from main informants and focus group discussions. The qualitative data was input in Excel and Word as an illustration, while the respondent response is shown in different boxes throughout the result chapter.

3.4.3 Statistical Analysis

The questionnaire's findings are evaluated using descriptive statistical tools and methods such as percentages, mean standard deviation, minimum, maximum, and frequency. The descriptive statistics are demonstrated in tables and graphs.

3.4.4.1 Trend Analysis

The time series data of Zairat weather station is calculated by following formula to analyzed temperature and precipitation.

$$y = \alpha + \beta x \text{-----------} (3)$$

Whereas;

y = temperature, rainfall, and x time(year), α is constant and β is coefficient (estimated by least square method)

3.4.4.2 Chi-Square Analysis

The Chi-Square test was used to assess the association between climate change perception of respondent with the socio-economic characteristic of respondents such as age, gender, education, type of family, marital status, occupation, tenancy status, type of farming and total household income.

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \text{-------------------------------} 4$$

Whereas χ^2 is chi square, O_{ij} is observed value, Eij is expected value and (r-1) (c-1) is degree freedom

3.4.4.3 Logistics Regression Analysis

Logistic regression was used to determine and explore the impact of different variables on the adapting strategies of farmers to climate change:

$$Adapt = \alpha + \beta_1 GEN + \beta_2 EDUC + \beta_3 OCCUP + \beta_4 TYPE.F + \beta_5 THI + \beta_6 AGE + \varepsilon i \text{----} (5)$$

Adapt is the dependent variable representing the adaptation of farmers against climate change and takes the value 1 and 0 for Yes and No, respectively. GEN is showing gender of respondents and takes the value1 and 0 for males and females. EDUC shows the education level of the household head and takes the values 1 for literate and 0 for illiterate, respectively. OCCUP shows the occupation and takes the value of 1 for farming and 0 for other occupations. TYPE.F shows the type of farming takes a value of 1 for those who are involved in both sectors and 0 for those who are involved in a single sector. THI represents the total annual income of the household; AGE represents the age of the respondent and εi is the error term.

Chapter 4

Result and Discussion

4. Result and Discussion

4.1 Introduction

This chapter presents the results and discussion of farmers' perceptions about climate change, adaptation measures, and its impact on agriculture. This chapter also presents the analysis and interpretation of data acquired from the field, both qualitative and quantitative.

4.2 Descriptive Statistics of Socio-Economic Data

Table 4.1: Descriptive Statistic of Socio-Economic Data of Respondents

Variables	Obs	Mean	Std.Dev	Min	Max
Age (Year)	204	47	13.77	25	85
Family Size (Number)	204	7.12	2.05	2	15
Cultivational land (Kanal)	204	8.46	5.63	1	30
Total Household Income Annually (PKR)	204	707058.8	518135.3	100000	3000000
Total Agricultural Income (PKR)	204	233946.1	252689.9	15000	2000000

Notes: Obs= Observation, Std.Dev= Standard Deviation, Min= Minimum, Max= Maximum

Table 4.1 reveals that the mean age of respondents is 47 (years) with a standard deviation of 13.77 while the minimum age of respondents is 25 years, and the maximum age is 85 years. Table 4.1 also illustrates that the mean family size is 7.12 with a standard deviation is 2.05, the minimum size of the family is 2, and the maximum family size is 15. Moreover, the mean of cultivational land is 8.46 (Kanal) with a standard deviation of 5.63 (Kanal) and the minimum land is 1(Kanal) and the maximum land is 30 (Kanal). Table 4.1 also illustrates that the mean of total annual household income is 707058.8 (PKR) having a minimum total household of 100,000 (PKR) and a maximum of 300,0000(PKR) with a standard deviation of 518135.3.

Moreover, table 4.1 also illustrates the total agriculture income with a mean of 233946.1 PKR minimum of 15000 (PKR,) and a maximum of 2,000,000 (PKR) with a standard deviation of 233946.1.

4.3 Descriptive Analysis Respondents of Gender (%)
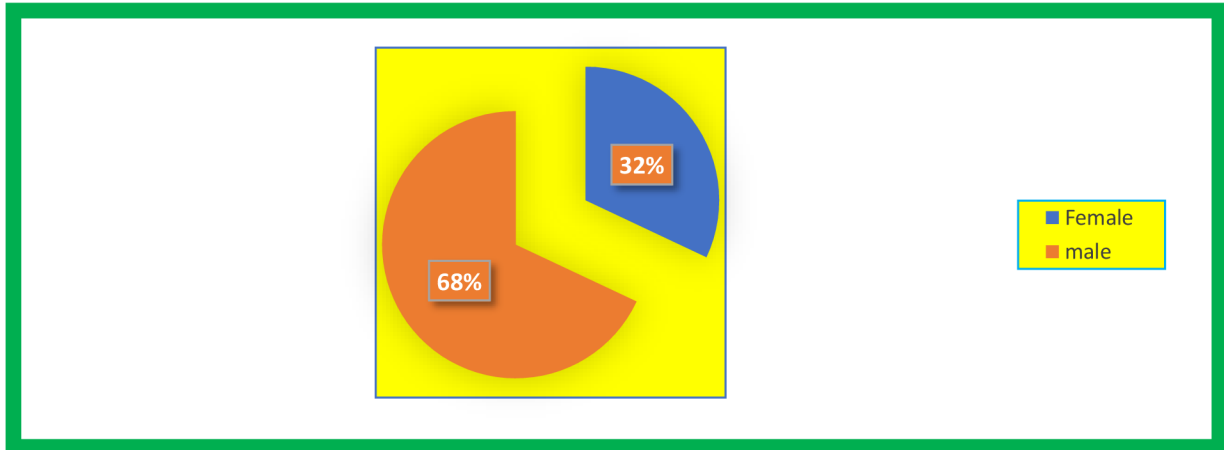
Figure 4.1: Gender of Respondent

Figure 4.1 represent that 68% of respondents are males, while 32% of respondents are female. The number of male respondents is higher than the female because it is extremely hard to collect from the female due to cultural sensitivities and social norms.

4.4 Descriptive Analysis of Farming Type (%)
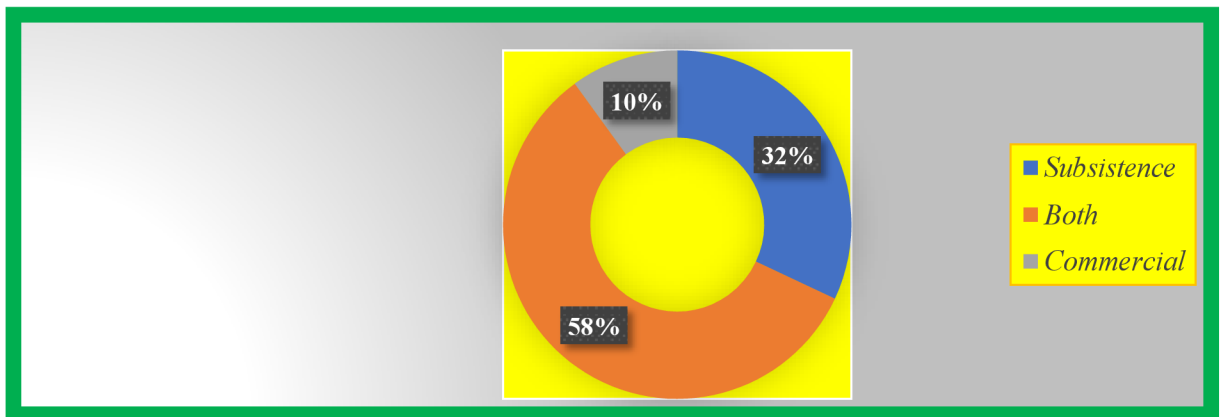
Figure 4.2: Type of farming in district Nagar

Figure 4.2 shows the type of farming of respondents in the study area. According to Figure 4.2, 58% of respondents are involved in both types of farming (Subsistence and Commercial), while 32% of respondents are involved in subsistence farming and 10% are in commercial farming.

4.5 Trend analysis of Temperature and Precipitation using weather data from 1990-2020
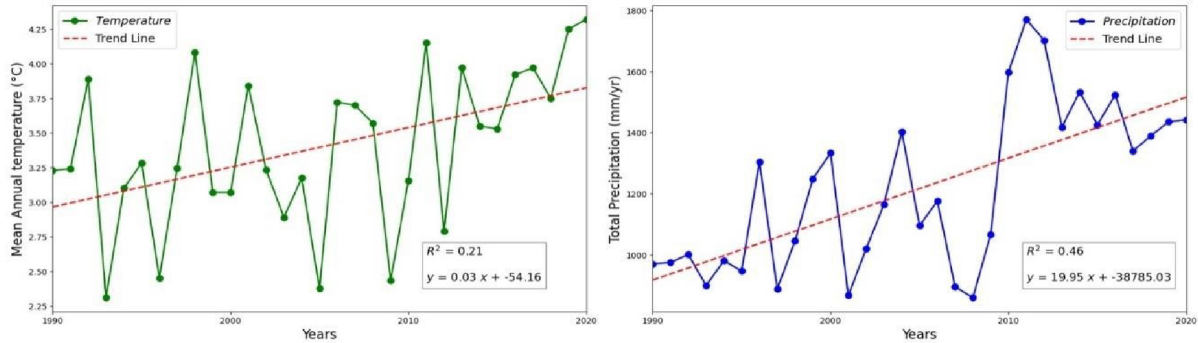
Figure 4.3: Trend analysis of weather data from 1990-2020 of Zairat station

Figure 4.3 shows time series data (1990-2020) in the study area. The figure 4.3 shows that the linear trend line for mean annual temperature indicates an increasing trend of 0.03°C per year (y=0.03 x - 54.16, R^2=0.21). The figure 4.3 further depicts that the linear trend line for Total precipitation annually (mm/yr) also shows an increasing trend of 19.95 per year (y=19.95 x - 3.879e+04, R^2=0.46).

4.6 Farmers' Observation about the impact of Climate Change on Agriculture (%)

	Soil fertility declined	Climate has led crops infestation disease	Water availability declined	Premature ripening of fruits	Productivity declined
No	48	40	30	37	20
Yes	52	60	70	63	80
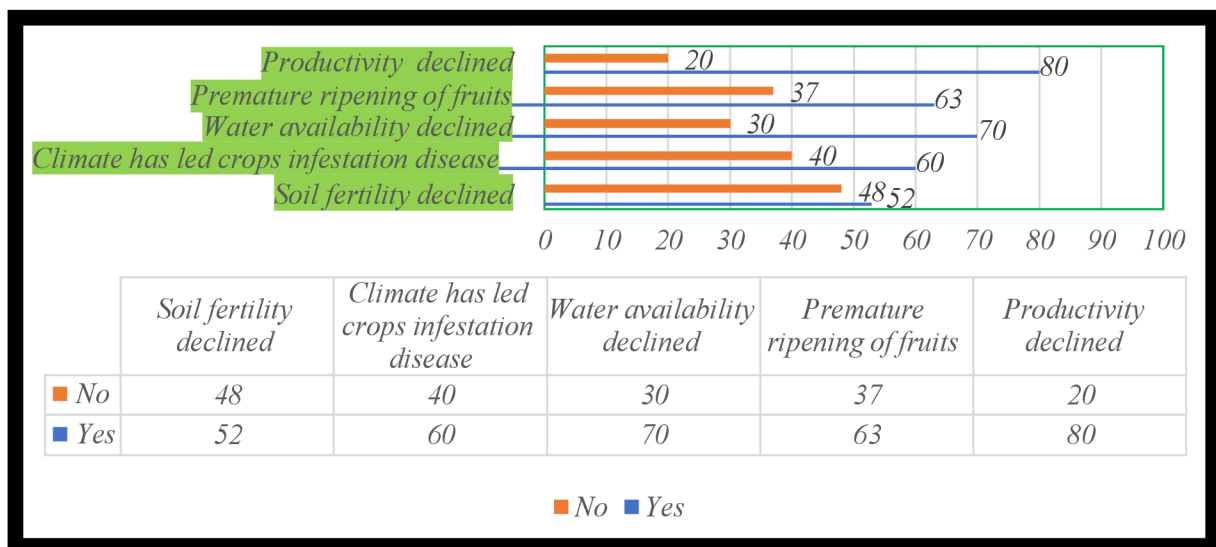
Figure 4.4: Farmers' Observation about the impact of climate change on agriculture

Figure 4.4 shows the impact of climate change on the agriculture sector in the research area. The respondents were asked about their experiences and observations about the impact of climate change on agriculture. As per respondents, due to abrupt climate change agriculture production declined in the last couple of years. 80% of respondents agreed that due to climate change, their agriculture productivity

declined. According to 70% of respondents, due to climate change, they are facing a shortage of availability of water during the time of harvesting. Moreover, 63% agreed that due to fluctuations in the climatic condition they are facing premature repining of fruits. Climate change and its negative effect also led to crop infestation and diseases. Figure 4.4 also illustrate that 52% of respondents reported that soil fertility declined due to floods and avalanches.

During the focus group discussion, the participants argued that they are facing severe climatic variability and shifting in seasons for the last couple of years. The intensity and severity of climate change has increased over the last few years. According to the participants, there were deadly floods last year in the whole district that destroyed their standing crops, especially potatoes, maize, and wheat crops. Furthermore, during the Focus group discussion, the Jirga's head claimed that the entire union council faced water scarcity during the crop seasons – reason being the climate change. The elderly respondents in the group discussion indicated that due to climate change, glacier cover is melting at an unprecedented rate during the summer which results in the shortage of water availability in spring (March- April), at which time is the period of cultivation, and this phenomenon is occurring for the last couple of years. The change in temperature and precipitation such as the erratic rainfall is now becoming a usual phenomenon, which leads to the premature ripening of fruits such as cherries and apricots. They were also worried about the sharp decline in soil fertility, which according to them is due to the excessive use of chemical fertilizer and the muddy water flowing down the mountains in the shape of floods and avalanches.

Besides the above-mentioned climate change impact revealed by focused group discussion, the key informants further argued that:

According to key informants, the abrupt climate change induced several hazards in the entire Gilgit-Baltistan, especially in District Nagar, because of its susceptible topography and closeness to the longest glaciers in entire Pakistan. According to key informants, it is a fact that glaciers are melting at a faster pace. Glacier melting could potentially change the physical and human geography of the region. There would be more flash floods, more GLOFs, huge landslides, rockfall, and debris flow episodes. All the hazards that the region faces are occurring more, both in frequency and intensity today than ever before. Water is the central element for the communities; the water is used for domestic purposes and agriculture. In the coming decades with glaciers melted and gone, the communities will also disappear from those locations (migration to a better location). The communities carry traditions, norms, and other cultural aspects which are also vulnerable in this situation. According to them, the local people have seen these changes in agriculture as well due to climate change, farmers are unable to cultivate wheat, and bulk wheat maize at times and they had to change their calendar every year which eventually led to a decline in

agriculture production. Furthermore, key informants argued that loss in soil quality is due to the excessive number of inorganic fertilizers like urea, nitrate, and diammonium phosphate (DAP), causing soil desertification.

4.7 Farmers' Sources of Information About Climate Change (%)

	Radio	Internet	School/college/ university	Government agencies	Local gathering
■ Series1	42	20	8	4	26
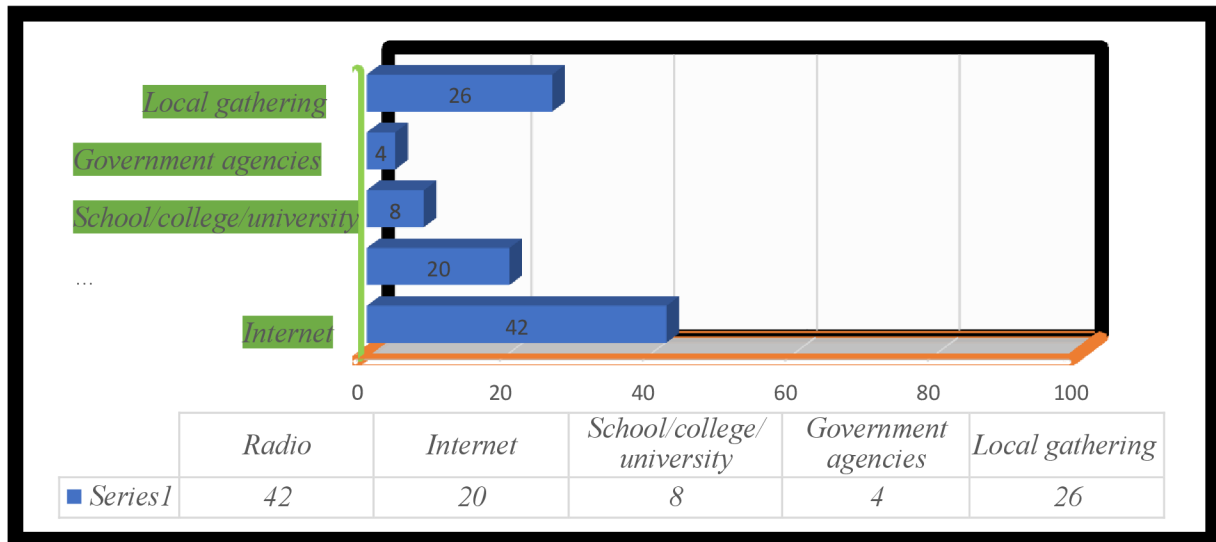
Figure 4.5: Farmers' Sources of Information about Climate Change

Figure 4.5 shows the source of information regarding climate change in the study area. The respondents were asked about through which medium they got information about climate change. The results show that the most common source of information is Radio with the highest percentage at 42%. The respondent especially illiterate and elderly people who do not speak Urdu and English relied on the news in local languages. In open end questions most of the respondents claimed that for the last three years, the Government of Pakistan launched a special program about climate change in their local language on FM radio at 9 p.m. Most of them relied on the news broadcast on Fm Radio. The second information through which local people got the information is local gathering with 26%. The place where local people gather is called Biyak (A special place near to mosque or Imam Bargha) where the local people especially the elderly gather in the afternoon and discussed different affairs of their village. This gathering is also important because they discuss how to set the harvesting calendar for the coming season and how to avert unpleasant climatic events by mutual consensus.

The third source of information according to respondents is the internet with a percentage of 20%. A government official from district Nagar claimed that in the last two-year due to the accessibility of the internet and other social media sources such as Facebook and Twitter local people especially young people

particularly educated people got familiar with the change in climate change. The Fourth contributor of source information is school or university with a percentage of 8%. The fifth source of information through which the local people got the information is Government agencies with a percentage of 4%.

While arguing the available source of information in District Nagar the key informant demonstrates:

The primary source of information gathering and sharing, among the farmers of District Nagar, remains Biyak gatherings (A place of common convenience, where people of the villages gather for discussions). The key informants argued that usually the local people gather at Biyak every day for afternoon prayers, especially during harvesting time, and set a calendar and a list containing all or any information to alert, prepare, and avert a hazardous situation throughout the year. The key informant stated that Television has become a significant source of information (gathering and dissemination) in Nagar-2, Gilgit-Baltistan, especially for the people who are uneducated and cannot speak English and Urdu. The news about climate change in local languages has had a significant role in the spreading of awareness and understanding about climate change. For the last couple of years, news about floods, avalanches, land sliding, and rainfall has been broadcasted in local languages via FM radio at 9 pm. This information at least helps people in general and farmers in specific to prepare for any unpleasant hazard. They further argued that internet facilities and special weather forecasting system is not functioning properly and the government's role in the dissemination of information is negligible.

4.8 Farmer Perception of Climate Change (%)
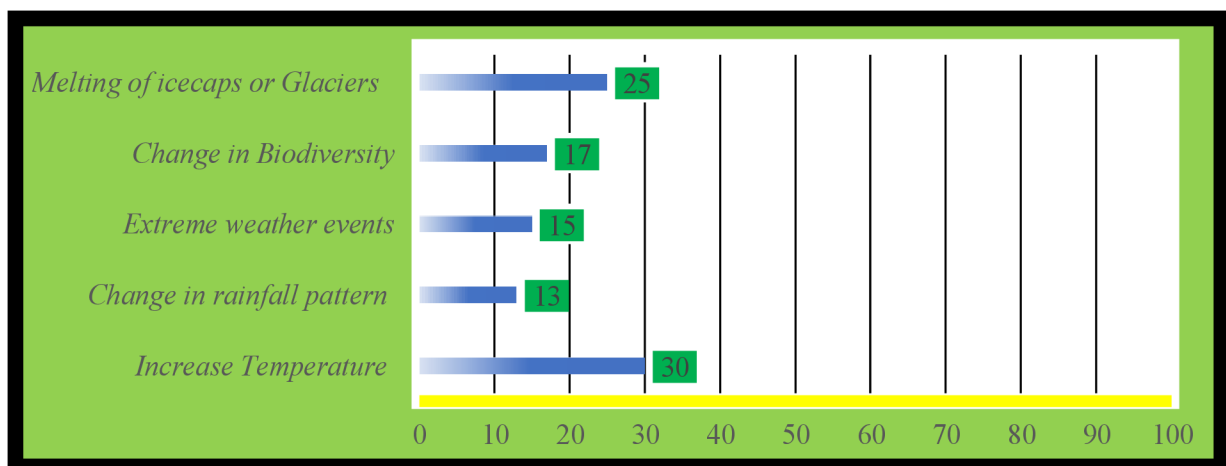
Figure 4.6: Farmer Perception of Climate Change

Figure 4.6 illustrates different indicators through which respondents recognized climate change in district

Nagar. Increased temperature is the most common indicator of climate change recognized by local people. 30% of respondents claimed that they perceived an increase in temperature in the last couple of years. The second indicator through which respondents recognized climate change is the melting of ice cap glaciers. 25% of respondents indicated that they recognized climate change because glaciers are melting at a fast rate. Likewise, change in biodiversity is the third indicator of climate change through which local people recognized as 17% of respondents agreed that biodiversity is changed due to climate change. Similarly, figure 4.6 shows 15% of people recognized climate change as extreme weather events while 13% of people recognized climate change in rainfall patterns.

During the focus group discussion, the respondent argued that they are experiencing extreme temperatures, particularly in the summer. During the discussion, the elderly respondents mentioned that they remembered the entire Rakaposhi Mountain used to be covered with snow, and they never had seen the Mountain without snow cover. They further argued that, during their childhood, they used to put animals' ashes on the ice in their fields to melt it. However, they argued that in the last couple of years, the Rakaposhi mountain looks different (stripped of snow cover) - due to the melting of snow cover, which according to them due to climate change. According to participants of the focus group, untimely rain, and harsh weather events such as more aggressive and disruptive winds are an indication of changes in the climate. The focus group discussion further revealed that climate change has changed and affected biodiversity, some domestic as well as wild plants have vanished from the Rakaposi and Phaker Valley.

4.9 Farmers Perception of Climate induced hazards (%)
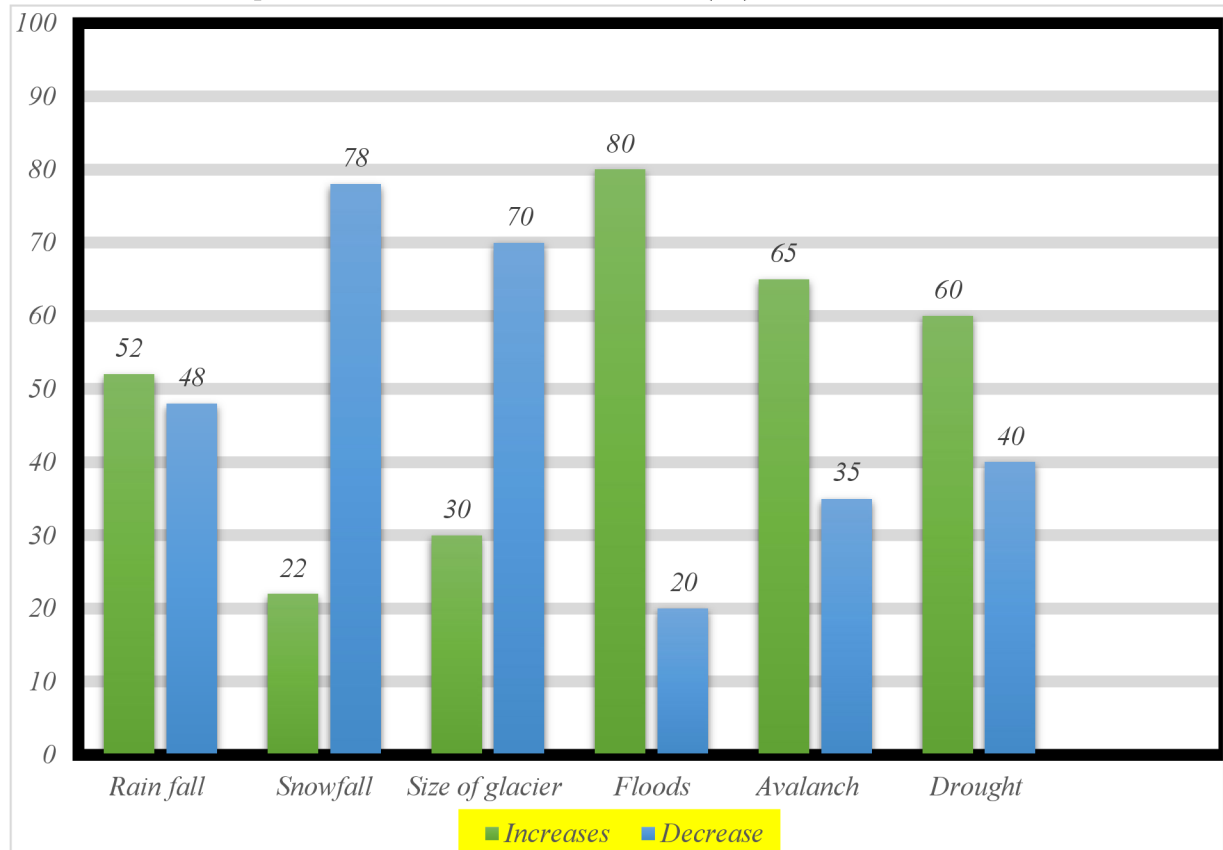
Figure 4.7: Farmer's perception of climate- induce hazards

Figure 4.7 shows farmers' opinion of the climate induces events in the study area. Different indicators were used to know how the respondents perceived climate change in district Nagar. Respondents were asked whether they observed an increase or decrease in the above-mentioned impacts of climate change. 52 % of respondents believed that rainfall is increasing while 48% believed that rainfall is decreasing in district Nagar. 78% of respondents reported that they have been experiencing a decrease in snowfall. Figure 4.7 also illustrates that local people reported that floods, avalanches, and droughts are also increasing at a faster rate. 80% of respondents agreed that in the last couple of years, floods are increasing in District Nager due to the Glacial Lake Outburst Flood (GLOFs) phenomena.

The Focus group with respondents revealed that the locals are suffering devastating floods, avalanches, drought, and extreme weather events. During the discussion, respondents claimed that the frequency of floods had dramatically increased during the last couple of years, particularly during the summer season which resulted in damaging property, standing crops, and infrastructure. Some respondents

claimed during focus group discussion that they are now thinking of migrating to other cities owing to their exposure to floods, avalanches, and their devastating impacts on their property, land, and cultivation. The participant of FDGs stated that due to the melting of glaciers in summer, they are facing dire shortage of water in the winter season, and to sustain their lives, they store water in muddy wells for the whole winter season, which leads to water-borne diseases. According to FGDs Participant the GLOFs and erratic rainfall is now becoming a regular phenomenon, which results in flash floods and avalanches in both the Rakaposhi and Pheker Valley.

4.10 Perception of Farmers about Causes of Climate Change

Table 4.2: Perception of farmers about climate change cause

Cause of climate change	Frequency	Percentage
Act of God or nature	66	33
Deforestation	70	35
Greenhouse gases	31	14
Fuel-burning	37	18

Table 4.2 shows the public perception of the causes of climate change in the study area. According to local people, the biggest cause of climate change is deforestation as 35% claimed that due to cutting off forest trees causes climate change. The second cause of climate change is acts of God or nature as 33% of respondents claimed that climate happening because of revenge from Allah. Similarly, 18% and 14% of local people believed that climate change is happening in the study area due to Greenhouse gases and fuel burning.

Group discussions with locals revealed that heavy reliance on forests for different domestic and construction purposes is the biggest reason for climate change. The locals maintained that for the winter season, they cut down forest trees for domestic consumption as they do not have access to gas and electricity. Some respondents claimed that the timber mafia is involved in deforestation and deforestation of such a large scale had greatly contributed to changing the climate of their area. Some respondents linked the phenomenon with the acts of God, as revenge for their bad deeds. During FDGs, the educated respondents argued that traffic and tourist influx from other parts of the country have significant adverse effects on the climate of the area. The region is a tourist destination that attracts tourists from other parts

of the country, and the CO2 emission from their vehicles is responsible for abrupt climate change.

Additionally, the in-depth interviews with the key informants revealed that.

According to Key Informants, it is common for people belonging to deeply religious backgrounds to attribute physical earthly phenomena to the will of God. It is a big part of their faith. Religion is a huge part of their lives. Instead of trying to dismiss their belief system, efforts should be made to build capacity in them to secure themselves against the harmful impacts of climate change. Local people who believe Climate change to be an act of God, do not necessarily negate science because for them science is a tool to understand the world that God has created. The problem with the belief system arises when people refuset to take action to lower their vulnerability and continue with the bad practices. The key informant further stated after the agriculture sector, due to its natural landscape, GB is getting attention and lost tourists visiting every year to enjoy the natural landscape, to gain benefits from tourism local people are now constructing hotels and resorts at a massive level and even more the local people are constructing the hotels on Rakaposi base camp to adjust tourist. Due to huge emissions from vehicles, the temperature of GB is increasing at a higher rate leading ad to severe consequences.

4.11 Chi-square test for assessing the association between Socioeconomic variables with Climate Change Perception.

Table 4.3: Chi-square test for assessing the association between Socioeconomic variables with climate change perception.

Socio economic Variables	Category	Climate Change Perception		Chi-square	P-value
		Yes	No		
Gender	Female	30	35	17.0863	**0.000**
	Male	105	34		
Education	Literate	87	19	24.9188	**0.000**
	Illiterate	48	50		
Type of family	Joint	34	24	2.0670	0.151

	Nuclear	101	45		
Marital status	Married	83	38	0.7772	0.378
	Single	52	31		
Occupation	Business	27	14	12.2691	**0.002**
	Framer	103	49		
	Govt	5	6		
	Owner	94	37		
Tenancy Status	Tenant	41	32	5.0911	0.024
Type of farming	Subsistence	58	8	27.48	**0.000**
	Commercial	6	14		
	Both	71	47		
Total household income	100000 to 199999	34	11	9.3393	0.025
	200000 to 299999	41	16		
	300000 to 399999	13	5		
	Above 400000	47	37		

Table 4.3 shows that the gender of respondents is highly significant at 0.05 significance level (P<0.05). This indicates that the gender has influence on the climate change perception in study area. Similarly, education of respondents is highly significant (P< 0.05) suggesting that the education has also influence on perception of climate. Moreover, the Type of family is not statistically significant (P> 0.05) showing that type family has no influence on perceptions about climate change in study area. Furthermore, Martial status is also not found statistically significant (P>0.05) shows that the perception about climate change does not varies in both groups of farmers. Similarly, the table 4.3 depicts the tenancy status of farming also not

significant (P>0.05). Moreover, the occupation of farmers is also statistically significant (p<0.05) meaning that the perception of climate change varies among the different occupation of respondent. Table 4.3 also illustrates that the total annual income (Annual) is also not significant because (P>0.05) means that the income has no influence on perception of climate change.

During the focus group discussion, the participant believed, disparity exists between genders (Male and Female) about climate change awareness. The illiterate female participants, when asked about the term 'climate change', showed no familiarity with the term, hence, also with the associated consequences. The reason is their inability to access television and other sources of information due to social and cultural stigmas/taboos. On the other hand, the literate females demonstrated their awareness regarding climate change.

To the question of the opposing consequences of climate change, asked from the group, the participants of the focused group discussion opined that, they are facing and perceiving the calamities of climate change. Both illiterate males and females were unfamiliar with the term 'climate change' since no similar term exists or is used in the local language. However, the farmers were more aware of the susceptibility of climate change as demonstrated by the comments of the Jirga's head that, their agricultural productivity has declined since last couple of years due to errotic rainfall and flood, and now are trying to diversify their means of livelihood. Moreover, a notable and influential member stressed that he is advising his sons to find government job opportunities to secure their source of income, as their land and agriculture production both have been adversely affected due to climate change.

In the in-depth interviews about the perception of climate change, key informants shared their expert opinion.

According to key informants, Usually, females receive their knowledge second hand i.e., through the male members of the household because they do not roam freely in public spheres like bazars and Dhaba/local tea stations where usually such discussions originate. Women also do not visit the sight of hazards (landslide cracks, glacier surge, rockfall); they usually experience these hazards when they are turning into disasters where they are threatening themselves. The downside of receiving second-hand knowledge is that men only the detail that they deem important and leave out other information. Therefore, there is censorship of information which means that women have less information now about a subject to build a perception. One mode of knowledge for women is observation. For example, they observe the change in the weather patterns and compare with previous years, they observe the changes in the crops/fruit trees and quality of crops/fruits. Women are also not part of the meetings held with authorities on the topics

of climate change and its impacts on local agriculture, livelihood, biodiversity, or food security. Therefore, they are usually eliminated from the decision-making process which means that they live with the consequences of others' decisions."

4.12 Logistic Regression Between Adaptation Strategies and Socio-Economic Characteristic Respondents

Table 4.4 Logistic regression between Adaptation strategies and socio-economic characteristic of Respondent

						Number of Obs = 204	
						LR chi2(6) = 33.89	
						Prob > chi2 = 0.0000	
Dependent Variable						Pseudo R2 = 0.1207	
Adaptation strategies							
Explanatory variables	**Description**	**Odds Ratio**	**Std. Err.**	**Z**	**P>z**	**[95% Conf.**	**Interval]**
Gender	*1 for males otherwise, 0*	*2.73*	*0.96*	*2.84*	*0.005*	*1.365326*	*5.466302*
Education	*1 literate otherwise, 0*	*2.93*	*0.98*	*3.23*	*0.001*	*1.528897*	*5.653271*
Occupation	*1 for farmers 0 otherwise*	*0.63*	*0.35*	*-0.82*	*0.415*	*0.209539*	*1.905268*
Type Farming	*1 both otherwise 0*	*1.10*	*0.64*	*0.16*	*0.871*	*0.3473232*	*3.485367*
Total household income	*Continuous variable*	*0.99*	*3.23E-07*	*-0.97*	*0.332*	*0.9999991*	*1*
Age	*Continuous variable*	*0.99*	*0.01*	*-0.71*	*0.475*	*0.9693404*	*1.014602*
_cons		*0.51*	*0.39*	*-0.86*	*0.387*	*0.1117934*	*2.33803*

Table 4.4 illustrate the finding of logistic regression. According to Table 4.4, the Gender of the respondent is statistically at 0.05 significance level with an odd ratio of 2.71, and positively associated with adaptation strategies, this means that the adapting strategies of male (household head) have probability of 2.71 more than as compared to female head of household. Table 4.4 also illustrates that the education of respondents is highly significant at 0.05 significance level (P<0.05) and positively associated with the adaptation strategies. This represents that by passing from illiterate to literate, the probability of adaptation strategies increases by 2.93. The respondent occupation is not significant at 0.05 significance level as the (P>0.05) but positively associated with adaptation strategies this means that the those who are engaged in farming as a main occupation, the adaptation strategies against the impact of climate change are high as compared to other who have the different occupation.

Furthermore, the type of farming is also not significant at 0.05 significance level but positively associated with the adapting strategies of farmers representing that the adaptation strategies of respondents who participated in both sectors of farming are high as compared to the respondents who are engaged in a single sector. Moreover, the result also shows that total house annual income is also not significant, but the odds ratio shows that it is positively associated with the adaptation strategies, suggesting that a one percent increase in income will lead to adapting strategies by 0.99. Table 4.4 also depicts that the age of respondents isnot significant but also positively associated with adapting strategies meaning that an increase of one year will increase the probability to adaptation by 0.99.

The key informants furthermore argued that:

According to key informants' people who are educated have different means of acquiring knowledge. They use those sources of knowledge to construct a better-informed perception whereas uneducated people usually rely on generational and communal information that is generated locally based on observations. It is important to realize that both perceptions have their strengths. The perceptions carried by uneducated people often verify the information that the educated person has obtained from multiple sources. Similarly, one cannot disregard the solutions provided by uneducated people, [in terms of formal education from public or private schools] because they have the most experience with local conditions. They are very much in touch with their natural surroundings and have developed a sense of how environmental entities behave in different scenarios. Their perception is also backed by a local understanding of the environment which is the generational knowledge transferred from ancestors could be in the form of folklores, folksongs, poems, quotes, sayings, or proverbs.

4.13 Famers Adaptation Strategy against Climate Change (%)
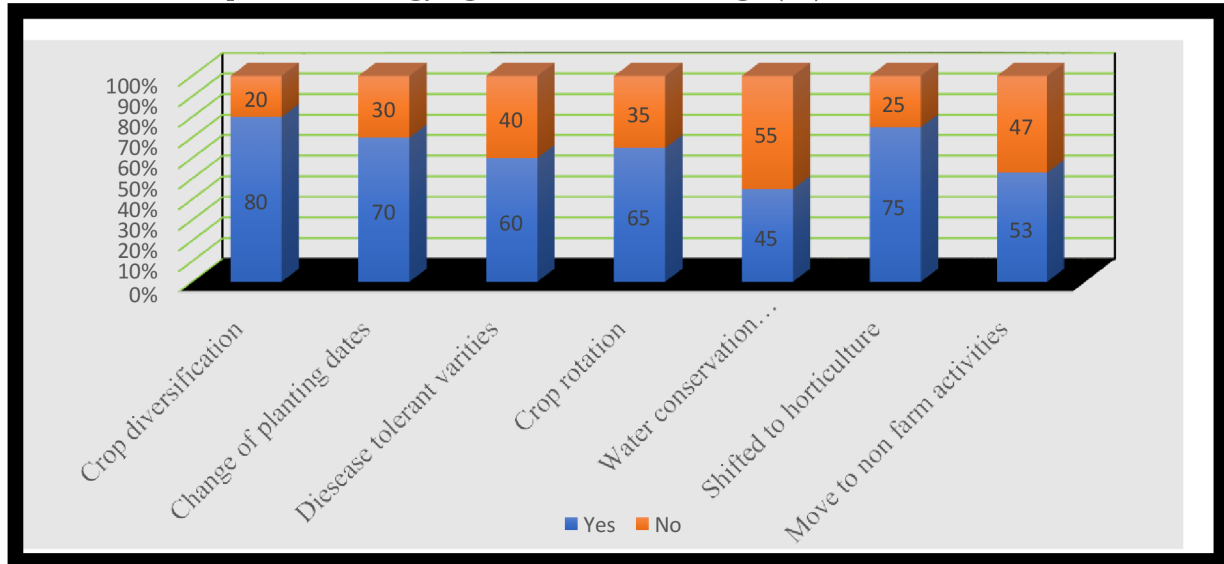
Figure 4.8: Farmers Adaptation Strategy against Climate Change

Figure 4.8 illustrates farmers' adaptation methods and strategies to minimize the negative effects of climate change in district Nagar. The most common adapting strategy is cropping diversification. 80% of respondents agreed that they diversified their crops in order as a coping strategy to respond to climate change the second adapting strategy is the shift of horticulture crops as 75% reported that they shifted to horticulture to avert the impact of climate change. Changing planting dates is the third common strategy as 70% agreed that they frequently change their painting calendar as adopting the strategy. Figure 4.8 also depicts crop rotation, disease tolerant varieties, water conservation, and moving to non-farm activities are different adopting strategies farmers are using to minimize the impact of climate change in district Nagar.

Moreover, during the focus group discussion, the respondent demonstrated their coping strategies against climate change.

During focus group discussions, the farmers demonstrated that they are now diversifying their crops, while their reliance previously was limited to wheat and potatoes. However, according to them, they have now started to cultivate different vegetable crops, such as tomatoes cucumbers, and red beans, which to some extent mitigate the losses they incur due to extreme climatic events and provide a sense of security to their livelihood. Furthermore, the trend, they argued, is to plant fruits and vegetables, such as cherries and apricots plants because according to farmers these plants have high resilience against erratic rainfall

and temperature. The farmer's future demonstrated that they are focused on non-farm activities because of the widespread implication of climate change in the region.

 Additionally, key informants shared their expert opinion about the coping mechanism.

There are places in Skardu where climate-smart agriculture such as drip irrigation has been introduced. The key informants argued that drip irrigation along with vertical farming systems would be beneficial for farmers in high altitudes. Other than these, composting, mulching, crop rotation, and intercropping should be introduced. It is very important to teach farmers climate-smart agricultural strategies because; they should get the maximum yield from their harvest, and they should not only be self-sufficient [cater to the local food security issue including accessibility as the villages are far from the market area] but also farming as an income source and in the coming years the intensity and frequency of natural hazards will increase and the local communities will be extremely vulnerable in terms of food security, and water scarcity.

4.14 Farmer Adaptation Barriers Against Climate Change (%)
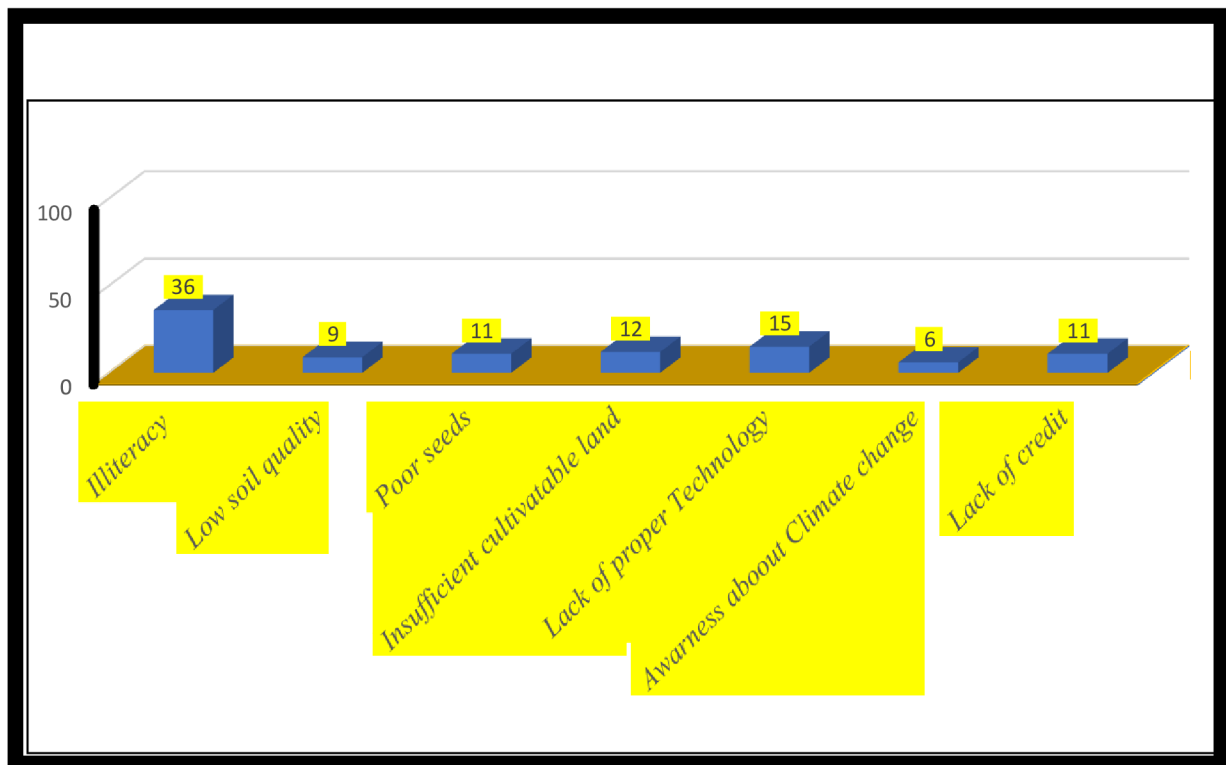
Figure 4.9: Farmer adaptation barriers against climate change

Figure 4.9 shows the barriers to adapting different strategies to cope with the effects of climate change.

Respondents were asked about barriers that create hurdles to adapting coping strategies. Thirty-six percent of respondents demonstrate that due to illiteracy they are not able to adopt different coping strategies. Furthermore, respondents argued that lack of proper technology is the second barrier as 15% of respondents claimed that due to lack of proper technology, they are not adopting coping strategies. According to the respondent, lack of credit is also a barrier in the way of adaptation as 11% of respondents claimed that due to proper credit mechanisms, they are unable to adopt different coping strategies.

During the focus group discussion, the participant further shed light on adaptation barriers against climate change:

The discussion with the focus group revealed that most people are unaware of modern coping strategies their reliance is still on their conventional strategies/techniques of cultivation and farming. One of the notables of the community argued that they are unaware of modern technology, and its use due to them being illiterate. Lack of literacy, which leads to a lack of information, results in malpractices and eventually lowers our production or affects the quality of the crops. Further, the locals were also of the opinion that remoteness and lack of financial resources hamper their ability to acquire necessary modern machines and equipment to increase, store, and protect their agricultural production. Moreover, local people also mentioned that financial constraints, such as access to micro-credit and financial support from the government, limit their ability to diversify their existing practices, as most of them do not have access to any micro-financial bank due either to the cumbersome and lengthy process of credit facility or even due to absence of any credit facility.

Chapter 5
Conclusion

5. Conclusion

Climate change is one of the stark realities of the 21st century due to its far-reaching impacts on our planet, the consequences are evident now more than ever before. Pakistan, like other developing countries, is suffering from climate change, especially, the northern part of Pakistan due to its susceptibility to climate hazards, such as GLOFS, avalanches, unpredicted rise in temperature, and changes in precipitation patterns. These variabilities in climatic conditions had adversely affected the lives of residents of higher mountainous regions of Gilgit-Baltistan, particularly, district Nagar due to its topography, geological location, and close vicinity to the glaciers. Keeping these realities in consideration, the aim of this study is to understand the farmer perception and adaptation strategies and to analyze their impacts on agriculture production in district Nagar.

The results of the survey revealed that the agricultural production in the study area is affected adversely by the impacts of climate change. The effects of climate change range from its disastrous impacts on the quality of the produce to forced desertification of agricultural lands. Supporting this claim, the survey respondents asserted that, they are now observing the premature repining of their produce, loss in soil quality, shortage of water, and infestations disease. According to 80% of respondents, their agriculture production has declined due to devastating floods, avalanches, GLOF
and land sliding in district Nagar.

The study results also present ample evidence that climate change is happening, and farmers of the study area are aware of the change in weather patterns and recognize that climate has changed. Increases in temperature, changes in rainfall patterns or erratic rainfalls, extreme weather events, changes in biodiversity, and shrinking of ice caps are the main ways the respondents recognize the changes in climate. Likewise, 80% of the respondents claimed that extreme flooding and unprecedented melting of glaciers are associated with climate change and its affects.

 A multitude of factors, as revealed by study, are the main causes of climate change in the study area, which include but not limited to; large scale deforestation, increasing use of fossil fuel, rapid increase in the number vehicles and transportation activity, to name a few. In support of the above finding, 35% of the respondents argued that the forest cover has now declined due to excessive use of forest for domestic consumption as well as commercial purpose, as the study area doesn't have access to electric cities and gas. Additionally, 33% of the respondent associated climate change with religious reasons, such as act of God

as a revenge for their wrong deeds and doings. However, the literate sample of the study area opined that, climate change is a global phenomenon, which results from emission of greenhouse gases and steady increase in pollution level in the atmosphere, to which Gilgit Baltistan is more susceptible. They further supported their argument with the fact that there had been rapid increase in the number of local vehicles in addition to the tourist influx, which not only pollutes the environment but also increase the CO_2 content in the atmosphere, which subsequently results in the increase in the temperature.

Proper and timely information is regarded as one of the key factors in identification of events associated with climate change and for necessary preparedness to avert its consequences. In this regard, the study identified sources of information, which the local people rely on, to receive and disseminate information about climate change. Such sources including, local gatherings, newspapers, and television has significant role in disseminating information about climate change and help people in making necessary and timely plans to avoid climate related hazards, where possible. In this connection, 42% of the respondents claimed that, they relied on Radio, especially, the elderly respondents who are not familiar either with English or Urdu relied on news broadcasting on the television and FM radio in local languages, hence regarded it as the main source of information. However, local gatherings at Biyak can be considered as the second main source of information about climate change. At such gatherings, people discuss and plan collective strategies to avert or lessen the effects of any climate related hazards. Furthermore, the role of government institutions, such as local administration, academic institutions, and meteorology department has negligible role in spreading information as per the result derived from the study.

The phenomenon of climate change had forced the farmers and people related to the agricultural industry to plan and adopt alternative strategies to cope with the growing threats and devastating effects of climatic events. The survey identifies and highlights the local adapting strategies by farmers to avert and mitigate the adverse consequence of climate change on the local agricultural sector. Such local adaptation strategies include, crops divarication, shifting to horticulture, and changing harvesting dates, crop rotation, disease tolerant crops, water conservation, and move to non-agricultural activities. However, challenges and barriers exit which not only limit the use of adaptation strategies, but sometimes also leads to use of inadequate strategies. Illiteracy, lack of access to modern technology, poor seeds selection, lack or insufficient awareness about climate change, insufficient and infertile land are, are the main constrains to adapt coping strategies.

To sum up, climate change induces devasting effects in district Nagar and the farmers perceive climate change for widespread and far-reaching consequences on agriculture production. To minimize and mitigate, the impacts of climate change on their agricultural production, the famers, due to lack and access to more efficient strategies and equipment, rely on conventional methods and adaption strategies. However, keeping in view the pace at which the unexpected climate events and related hazards are happening, such conventional method and adapting strategies are neither sufficient nor sustainable to protect the agriculture productivity. An immediate and comprehensive climate resilient and agricultural friendly policy framework is required to avoid further losses to the people connected with agricultural activities. Government has the primary responsibility to intervene not only for the introduction of such policies but also in providing financial and technical assistance to the famers, which may help them in the long run. Other institutions, such as NGOs and members of the Civil Society in general and those connected with climate change, need to assist the farmers and government in framing agriculture-friendly policies.

5.1 Limitation

Due to time and financial resources for this study data is collected from two union council and exclude other union councils of District Nagar. Although, this study may not present the whole picture of perception of climate change and adaptations strategies of farmer, however it may give understanding of farmers of two union council and provide the roadmap to conduct future research. Thus, the study may help to other researchers to conduct research on these aspects of climate change in Gilgit-Baltistan.

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<u>**INTERVIEW SCHEDULEs**</u>

Dear Participant,

The current survey is part of my master's dissertation titled "***Climate Change: Farmer Perception and Adaptation Strategies and its Impacts on Agriculture in District Nagar, Gilgit-Baltistan, Pakistan.***"

The study is aimed to achieve the following objectives:

To Investigate the impacts of climate change on agriculture in district Nagar.

To probe the perception of people about climate change in district Nagar

To study the local people's adaptation strategies to climate change in district Nagar

To highlight the barriers to adaptation in district Nagar

Section A: Demographic Data

1. *Name: _____*

2. *Village: _____*

3. *Age (years): _____*

4. *Size of Family: _____*

5. *Head of Household: ⊔ Male ⊔ Female*

6. *Type of family: ⊔ joint ⊔ nuclear ⊔ combine*

7. *Marital Status: ⊐ Married ⊏ Single.*

8. *Education: ⊔ Literate (year's_____) ⊦ Illiterate*

9. *Main Occupation: ⊏ Business ⊏ Farmer ⊏ Government job ⊐ private job*

10. *Size of cultivational land holding (kanal) -----------------------------*

11. *Status of tenancy: a. Owner   b. Owner-cum-tenant c. Tenant*

12. *Farming: a. Subsistence b. Commercial   c. Both*

13. *Growing crop in a season: a. Single b. Multiple c. Non*

14. *Annual Income (PRs):_____, Annual Agricultural income:_____, others:*

15. *Choose your main livelihood source.*

    a. *Agriculture*

    b. *Tourism*

    c. *Livestock*

    d. *Forestry/Forest Resources*

    e. *Business*

    f. *Government service*

    g. *Pension of retired*

    h. *Other*

Objective: 1

Sr. No.	Statement question (Please answer following Questions)	Yes	No
1	The irregular seasons have badly affected crop/horticulture productivity.		
2	Climate change affected soil fertility		
3	Due to climate change your crop production declined		
4	Drying of crops due to reduction in soil moisture.		
5	Shortage of water due to climate change		
6	crop infestation and diseases due climate change		
7	Climate change has led to horticulture infestation and diseases.		
8	Premature ripening of fruits reduces quality and taste due to climate change		

Objective: 2

1. **Do you experience Climate change?**

    a. *Yes*   b. *No*   c. *Don't Know*

2. **Which source of information through you for information about CC?**

a. Television b. Radio c. Newspaper d. Internet e. Research papers

f. Environmental groups/NGOs g. School/ college/ university

h. Government agencies/ information i. Friends/ family j. Local community gatherings

k. Self-observation.   L. Other (specify). ---------------------------

3. Please tell us how understand and recognize climate change in your area?

        a. Increase in temperature   b. Unpredictable rainfall pattern

        c. Increase in snowfall   d. Unpredictable snowfall pattern

        e. Extreme weather events (flooding, droughts, winds etc.)

        e. Changes in bio-diversity   f. Melting of icecaps or glaciers g. Other

3.   Please, could identify what are different cause of climate change in District Nagar?

a. Co2 emission b. Fossil fuel burning c. Deforestation d. Natural causes.

e. Act of God or nature f. Don't know g. Other

4.   Based on your experience over, please provide information on the following items.

S/No	Items	Increased	Decreased
1	Rainfall		
2	Temperature		
3	Snowfall		
4	Size of the Glaciers		
5	Floods		
6	Avalanche		
7	Droughts		
8	Summer Days (or months)		
9	Winter Days (or months)		
10	Water availability		
1= Increased, and 2=Decreased			

5.   As a result of climate change, some unexpected things/consequences might have happened. Do you agree that the following are the consequences of climate change during the last year

Sr. No.	Consequences of climate change	Yes	No
1	High temperature		
2	More rainfall		
3	More snowfall		
4	Increase in melting of glaciers		
5	Shorter summer season		
6	Longer summer season		
7	Shorter winter season		
8	Longer winter season		

6. **What is the important climate related problems that have affected your land-based livelihoods? (Choose as many as you please)**

   a. Low rainfall

   b. High rainfall

   c. Loss of land due to floods

   d. Lack of good irrigation practices

   h. Bad weather

   i. Other (specify) j.

   Decrease in water availability

   k. shorter summer season

Objective: 3

1. **Are there any coping strategies against the climate change impacts in your area?**

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

2. **Do you adopt any coping strategies to cope with Climate Change?**

   a. Yes   b. No   c. Don't Know

3. **The following is the list of coping strategies to cope with climate change. Do you agree that these strategies are being adopted by you?**

Sr. #	Coping strategies	Yes (1)	No (0)
1	Practicing crop diversification		
2	Change of planting dates		
3	Use of drought and diseases tolerant varieties		
4	Cultivating short-duration crops		
5	Moved to Non-farm activities		
6	Switching from crop production to livestock		
7	Shifted from crop production to horticulture		

1. *Are there any barriers to the adoption of climate change?*

    (a) Yes   (b)   No   (c)   Don't Know

2. *What are the barriers to adopting the above adaptation measures?*

    a) Population growth

    b) Illiteracy

    c) Low soil quality

    d) Poor seeds

    e) Lack of access to

    f) Insufficient cultivatable land

    g) Lack of knowledge

    h) Lack of proper technology

    i) Lack of technical knowhow

    j) Lack of awareness about CC early warnings

    k) Other (specify)

3. *What are the factors/constraints that create hindrance in adopting the climate change strategies by you?*

Sr.	Factor/hindrance	Response	If yes, the intensity of

#		Yes	No	hindrance		
				1	2	3
1	Climate variability (Drought, increase in temperature, erratic rainfall, wilting of crops)					
2	Soil fertility (Crops failure, erosion, stunted crop growth, change incrop color, Low crop yields)					
3	Pests and diseases (Locusts, beetles, whiteflies, aphids,)					
4	Lack of information					
5	Shortage of land					
6	Lack of credit/money					
7	Lack of market access					
8	Shortage of farm inputs					

Scale: 1 = To some extent 2 = To average extent, 3 = To much extent

VILLAGE-WISE NUMBER OF HOUSEHOLDS, POPULATION & VOTERS GBA-IV & V NAGAR

S No	Village	No. of Household	Population	No of Voters
1.	Bar	487	3608	1765
2.	Chaprote	396	2734	1486
3.	Rabat	289	1774	912
4.	Akbarabad	170	1242	621
5.	Chalt Bala	345	2305	1118
6.	Chalt Paeen	575	4695	1602
7.	Sonikote	131	936	533
8.	Budalas	305	2234	1234
9.	Sikanderabad	387	2772	1531
10.	Jaffarabad	329	2558	1514
11.	Nilt	205	1633	1099

12.	Thole	185	991	794
13.	Hopai	141	1092	476
14.	Ghulmet	406	2747	2048
15.	Pissan	186	1534	807
16.	Minapin	281	2087	1182
17.	Miacher	477	2725	1461
18.	Dadimal	187	1331	622
19.	Phekar	767	5256	2281
20.	Hakochar	66	517	223
21.	Shayar	185	1302	742
22.	Asqurdas	644	3661	3242
23.	Sumayar	1129	6326	1624
24.	Nagar Proper	1781	9033	4926
25.	Hoper	619	4770	2821
26.	Hisper	162	980	606
Total		**10835**	**70843**	**37172**

Note: (No. of households and population is as per Census 2017 and number of voters is as per registration carried out for Elections

Key Informants details

Name	Designation
Abda Khalid	Gender and Environmental expert
Zanaib Khalid	Gender and Environmental Expert
Wajid Ali	Assistant Director at Agricultural and forest department
Shah Abbas	Economist
Iftikhar Ali	Development expert
Shezad Ali	Social right activist
Imtiaz Hussain	Economist
Sajid Ali	Social right activist
Imtiaz Hussain	Head of Jirga

Ahmed ali	Head Jirga

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