Community Approaches to Climate Change Adaptation and Disaster Risk Reduction for Building Resilience: A Case Study of Hunza District of Gilgit–Baltistan

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Dedication

I dedicate my thesis to my loving parents, as well as my teachers, mentors, and supporters Ali Panah and Bibi Nigar. I will always be grateful for their endless love, support, and encouragement throughout my life.

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Abstract

Pakistan is the fifth most populous country and has a diverse topography, which brings both opportunities and challenges, especially in the face of climate change. Regions like Gilgit-Baltistan, including the Hunza District, are particularly at risk from climate-related dangers such as floods, glacier lake outburst floods (GLOFs), landslides, and earthquakes. These disasters are the manifestation of the need for community-focused approaches to climate change adaptation and disaster risk reduction (DRR).

This study *"Community Approaches to Climate Change Adaptation and Disaster Risk Reduction for Building Resilience: A Case Study of Hunza District of Gilgit–Baltistan"* aims to explore and assess community strategies for climate change adaptation and disaster risk reduction in the Hunza District of Gilgit-Baltistan. The research utilizes mixed methods, incorporating qualitative research and participatory action research, to highlight the significance of local community involvement and indigenous knowledge in enhancing resilience to climate change. It employs a SWOT analysis to identify the strengths, weaknesses, opportunities, and threats associated with climate change adaptation and resilience in the region.

The study identifies that the absence of indigenous knowledge in the disaster management framework significantly hinders efforts to enhance resilience in Hunza, making its integration into climate change adaptation and disaster risk reduction (DRR) strategies essential. Local communities possess valuable knowledge regarding the construction of climate- and disaster-resilient infrastructures, such as houses, roads, and water channels. However, their coping capacities are greatly affected by limited financial resources, climate change, and disasters.

The study emphasizes the need to embed disaster risk management (DRM) into governance frameworks, enact necessary legislative measures, enhance organizational and community capacities, and increase investments in mitigation efforts. Despite these needs, significant constraints arise from political, administrative, and resource-related factors, alongside gaps in institutional capacity and community awareness. The study highlights the importance of integrating indigenous knowledge and local practices into existing disaster management frameworks, which can significantly enhance resilience efforts. It advocates for community participation in decision-making and policy formulation, calling for a reassessment of current strategies to improve community resilience and mitigate climate risks. Ultimately, the research emphasizes sustained collaboration among communities and stakeholders, enabling Hunza to pursue sustainable development and strengthen its resilience against future climate-induced challenges.

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Acronyms

AC - Adaptation Committee/Assistant Commissioner

AKAH - Aga Khan Agency for Habitat

AKRSP - Aga Khan Rural Support Programme

CBOs - Community-Based Organizations

CCA - Climate Change Adaptation

CBDRM - Community-Based Disaster Risk Management

CBPR - Community-Based Participatory Research

CMA - Conference of the Parties serving as the meeting of the Parties to the Paris Agreement

CSA - Climate-Smart Agriculture

DPMC - Disaster Risk Management Plan

DRFI - Disaster Risk Financing and Insurance

DRM - Disaster Risk Management

DRR - Disaster Risk Reduction

EPA - Environmental Protection Agency

ETI - Engineering and Technology Institute

EU - European Union

FY22 - Fiscal Year 2022

FWG - Facilitative Working Group

GDP - Gross Domestic Product

GBDMA - Gilgit Baltistan Disaster Management Authority

GLAD - Ghulkin Nature Conservation

GLOF - Glacial Lake Outburst Floods

GOLD - Gulmit Organization for Local Development

HKH - Hindu Kush-Himalayan

HKPL - Human Kinetics and Physical Literacy

HOLD - Hussaini Organization for Local Development

IFAD - International Fund for Agricultural Development

INFORM - Index for Risk Management

INGOs - International Non-Governmental Organizations

KKH - Karakoram Highway

KVO - Khunjerab Village Organization

LCIPP - Local Communities and Indigenous Peoples Platform

NASA - National Aeronautics and Space Administration

NHN - National Humanitarian Network

NDMA - National Disaster Management Authority

NDRMF - National Disaster Risk Management Fund

NGOs - Non-Governmental Organizations

NSP - Nature Stewardship Program

PAR - Participatory Action Research

PDO - Passu Development Organization

PHF - Pakistan Humanitarian Forum

PNDA - Post-Disaster Needs Assessment

RCC - Reinforced Cement Concrete

SDGs - Sustainable Development Goals

SFDRR - Sendai Framework for Disaster Risk Reduction

SNT - Shimshal Nature Trust

SLF - Snow Leopard Foundation

SMP - Shimshal Mountaineering Program

SPHF - Sindh People's Housing for Flood Affectees

UAE - United Arab Emirates

UIB - Upper Indus Basin

UN - United Nations

UNDP - United Nations Development Programme

UNFCCC - United Nations Framework Convention on Climate Change

USA - United States of America

USD - United States Dollar

WWF - World Wide Fund

Chapter 1

1 Introduction

Pakistan is the fifth most populated country globally. As of 2023, the population has reached 241.5 million, marking a significant increase of 33.82 million from the 2017 census (MoI 2024). The total land area of Pakistan covers 770,875 square kilometers and features a diverse landscape. Approximately 5% of this area is covered by forests, while rainfed and rodkohi agriculture, as determined through spectral reflectance of crop cover, accounts for around 20%. Rangelands cover over 27% of the country, with snow/glacier coverage recorded at about 2%. Deserts occupy about 10% of the total area, and rock outcrops make up another quarter. The remaining portion of the land is utilized for various purposes, including built-up areas, waterlogged and saline land, and water bodies, constituting a little more than one percent.

The country's diverse topography and demographic settings make it particularly vulnerable to climate change and induced disasters. Projections suggest that temperature changes in Pakistan are likely to exceed global averages in the long run. The implications of climate change are extensive, affecting social, environmental, and economic aspects. The country is consistently exposed to natural hazards such as floods, droughts, and cyclones. When these hazards intersect with vulnerabilities such as poverty, exclusion, and inadequate political decisions, the population becomes even more susceptible to their impacts (PAK EPA, 2016).

Pakistan's contribution to global greenhouse gas emissions is less than 1%, yet it is among the top 10 most vulnerable countries to climate change and natural disasters. The devastating floods of 2022 are the manifestation of Pakistan’s vulnerability to climate change and induced disasters. These floods caused significant damage to Pakistan's agricultural sector, infrastructure, and livelihood sources. The floods submerged one-third of the country, displacing approximately 8 million people and affecting 33 million. The impact on human lives was devastating, with over 1,700 lives lost, including a third of them being children. The economic repercussions were equally severe, with estimated damages amounting to 4.8% of the Gross Domestic Product (GDP) for the fiscal year 2022. The recovery and reconstruction efforts are expected to be 1.6 times the budgeted national development expenditure for the fiscal year 2023. Sectors such as Housing, Agriculture, Livestock, Transport, and Communications bore the brunt of the damage, incurring losses of US$5.6 billion, US$3.7 billion, and US$3.3 billion, respectively. The floods are projected to result in an overall decline in GDP, with a direct impact of around 2.2% on the fiscal year 2022 GDP. The national poverty rate is expected to rise by 3.7 to 4.0 percentage points, pushing an additional 8.4 to 9.1 million people into poverty. The estimated overall damage is assessed at US$14.9 billion, with a total loss of US$15.2 billion, and total recovery needs reaching US$16.3 billion. These significant figures highlight the immediate need for comprehensive and sustained actions to address the consequences and strengthen resilience against future climate-related challenges (PDNA 2022).

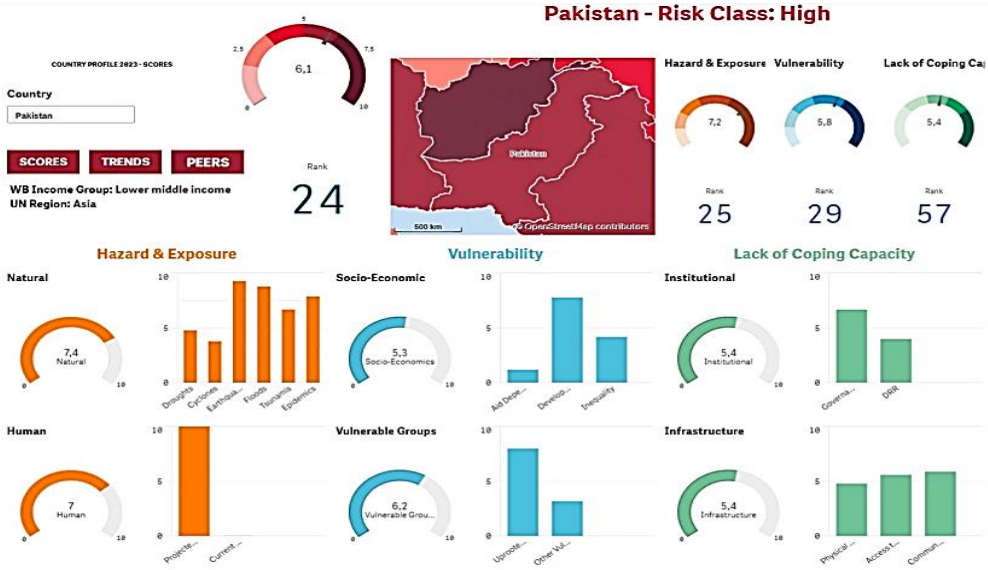


Figure 1. European Commission Inform Risk Index 2022

The northern areas of Pakistan are extremely vulnerable to natural disasters due to their limited coping capacities (Shah, S.S., Rana, I.A. and Ali, A., 2023). "Gilgit-Baltistan (GB)" is particularly at risk of disasters, facing various natural hazards such as flash floods, GLOFs and landslides (Baig, S.S., Khan, G. and Alam, M., 2023). Furthermore, the area is located in seismic zone 3 and is highly exposed to earthquakes with a potential magnitude of 6 to 7 on the Richter scale (Hussain et al., 2023). The "Upper Indus Basin (UIB)" is home to about 5000 glaciers, and the "Hindu Kush-Himalayan (HKH)" region contains roughly 20,000 glaciers. UIB's sub-basins comprise several rivers, including Hunza, Shigar, Shyok, Gilgit, Shingo, Astore, and other tributaries. About 50% of UIB's water originates from snow and ice. In the last 200 years, the Karakoram region has witnessed 35 hazardous floods, while the Upper Indus and Himalayas have experienced 17 and 20 floods, respectively. Since 2010, the Karakoram has seen the emergence of new GLOFs due to rapid melting and environmental changes, posing potential threats to downstream settlements and infrastructure. A total of more than 36 glacial lakes in the area have been identified as vulnerable to GLOF (Ashraf, A., Naz, R. and Roohi, R., 2012).

Hunza district is a mountainous valley located in the Gilgit-Baltistan. The total area of the Hunza territory covers approximately 7,900 square kilometers. The main town of Karimabad serves as a prominent tourist destination in the region. Hunza is home to a significant number of glaciers, totaling 1,384 and covering an area of 2,754 km2 (Bajracharya, S.R., Maharjan, S.B. and Shrestha, F., 2019). On January 4, 2010, Hunza Valley experienced a significant landslide that obstructed the flow of the Hunza River. The debris and stones from the landslide blocked both the river and the Karakoram Highway, leading to widespread damage. As the blocked river began to accumulate water, nearby villages faced inundation. Over time, water accumulation along the river continued to rise, resulting in further flooding of villages upstream along the Karakoram Highway. Within six months, a section of the Karakoram Highway became submerged as the newly formed lake expanded. This inundation affected nearby villages including Bulchi Das, Chamangul, Gulmit, Andare, Ghulkin, and Husaini

(Jilani, R., et al., 2010). The frequency of these disasters shows that the area is highly vulnerable to various hazards. Therefore, it is essential to evaluate how people perceive these risks to ensure that appropriate preparedness measures are implemented (Shah, S.S., Rana, I.A. and Ali, A., 2023).

With this foundation, this research aims to evaluate the "Community Approaches to Climate Change Adaptation and Disaster Risk Reduction (DRR)" in the Hunza District of Gilgit–Baltistan. It involves a thorough evaluation of the community interventions and the effectiveness of current strategies and policies in facilitating and hindering recent disaster risk reduction (DRR) and climate change adaptation (CCA) efforts in the region. Furthermore, the study seeks out alternative approaches to enhance community resilience and mitigate risks stemming from future climate change impacts. Through detailed analysis, the research also aims to identify and understand the constraints and opportunities surrounding climate change adaptation and resilience-building initiatives in Hunza District amidst the evolving climate scenario.

1.1 Problem Statement

Mountainous communities in Hunza and Gilgit-Baltistan are increasingly vulnerable to climate change-induced hazards, such as floods, glacier lake outburst floods (GLOFs), and landslides. The rapid melting of glaciers in northern Pakistan has led to the formation of over 3,000 glacial lakes, with approximately 33 identified as high-risk, endangering around 7.1 million people (Azhar, A., 2022). While Pakistan's government has established a disaster risk reduction (DRR) governance system, its local-level effectiveness remains limited, focusing primarily on response measures and neglecting critical anticipatory, prevention, and mitigation approaches. Indigenous knowledge is increasingly recognized for enhancing resilience, yet current top-down management strategies often overlook the active involvement of local communities, who possess valuable insights into their vulnerabilities and adaptive capacities. Despite ongoing efforts, disaster frequency and economic losses continue to rise, highlighting the need for more effective, community-driven climate change adaptation and DRR strategies. Engaging communities in planning and decision-making processes develops a sense of ownership, empowerment, and resilience, and enhances long-term sustainability. Therefore, it is essential to identify the factors that influence the effectiveness of climate change adaptation,d disaster risk reduction,n and responses by local communities

1.2 Significance of the Study

UN agencies and other environmental actors across the globe are keenly working on climate change and indigenous approaches to combat and adapt to climate change and its induced impacts. Hunza District is vulnerable to climate change and climate-induced disasters. However, very few studies have been conducted in the context of Hunza District in the Gilgit Baltistan region of Pakistan to anticipate the "Community Approaches to Climate Change Adaptation and Disaster Risk Reduction for Building Resilience". Therefore, the current study aims to evaluate the "*Community Approaches to Climate Change Adaptation and Disaster Risk Reduction for Building Resilience in the Hunza District of Gilgit–Baltistan"*. It

also evaluates the strategies and policies that have promoted and hindered recent climate change adaptation and disaster risk reduction efforts in the region and searches for alternative strategies to enhance community resilience and reduce risks from future climate change.

The study holds immense significance in the face of growing environmental challenges. As the world grapples with the impacts of climate change and increasing disaster risks, understanding and implementing community-based approaches to adaptation and resilience-building have become vital for sustainable development. One of the key aspects of this study is its emphasis on community involvement. Recognizing that communities are at the forefront of climate change and disaster risks, involving them in the decision-making and implementation processes is important. Community participation ensures that local knowledge, needs, and aspirations are integrated into adaptation and risk-reduction strategies, making them more effective and locally relevant. By focusing on community approaches, the study promotes a bottom-up perspective, which complements top-down approaches undertaken by governments and international organizations. Local communities possess unique insights into their vulnerabilities, capacities, and adaptive practices, making them key stakeholders in resilience-building efforts.

The study's significance also lies in its contribution to the broader global agenda of sustainable development. Building resilient communities not only enables them to cope with climate change impacts and disasters but also enhances their overall well-being and prosperity. Resilient communities are better equipped to safeguard livelihoods, protect natural resources, ensure food security, maintain social cohesion, and promote economic growth. They become pillars of sustainability and a resilient inclusive society.

The study acknowledges the importance of knowledge sharing and capacity building. It emphasizes the need for collaborative learning, technology transfer, and skill development at the community level. Strengthening local capacities empowers communities to adapt to changing circumstances, innovate, and develop context-specific solutions. This approach enhance self-reliance and reduces dependency on external support, creating sustainable and scalable models for replication in different contexts. It can help identify the most effective ways to reduce the risks of climate change and natural disasters by involving communities in the process. It can also help identify the most vulnerable communities and provide them with the necessary resources and support to build resilience against climate change and natural disasters. It will also help policymakers and decision-makers develop policies that are more effective in addressing climate change and natural disasters by considering the needs and perspectives of communities.

1.3 Objectives of the Study

The main objectives of the study are:

1. To evaluate the "Community Approaches to Climate Change Adaptation and Disaster Risk Reduction for Building Resilience in the Hunza District of Gilgit–Baltistan".

2. To perform a SWOT analysis to identify the strengths, weaknesses, opportunities, and threats related to climate change adaptation and resilience, focusing on the constraints and opportunities for improving the resilience of the people of Hunza district in Gilgit–Baltistan amidst the evolving climate scenario.

1.4 Expected Outcome

The proposed study can lead to several expected outcomes that contribute to enhancing community resilience to climate change and induced disasters.

The study will help to understand the probing questions such as:

1. How have climate hazards recently impacted the Hunza District in Gilgit Baltistan?

2. How has Hunza district responded to climate hazards/ what approaches the community has adopted to respond to climate change?

3. What are the constraints to responding to climate-induced disasters?

4. What strategies can provide opportunities to enhance community resilience and reduce climate-induced risks?

The study will help to deeply understand the vulnerabilities, adaptive capacities, and risk perception of communities in the face of climate change and disasters. It will also help and provide evidence and reasons for encouraging engaging communities in decision-making processes related to climate change adaptation and disaster risk reduction.

The study can provide evidence-based insights and recommendations to inform policy and decision-making processes at various levels. It can contribute to the development of inclusive, participatory, and community-centered policies that prioritize resilience-building and sustainable development. The study's findings can also help mobilize resources and support from government agencies, non-governmental organizations, and international institutions.

Chapter 2

2 Literature Review

The concept of climate change is commonly defined by the mean and fluctuations in temperature, precipitation, and wind over a timeframe that spans from months to millions of years, traditionally encompassing 30 years (Le Treut, Hervé, et al. 2006). It denotes the modification in climate patterns, primarily propelled by the emission of greenhouse gases into the atmosphere from both natural procedures and human activities. Presently, human activities have led to an approximate 1.0 °C global warming as compared to pre-industrial levels. If the current emission rates persist, it is projected that global temperatures could increase by 1.5 °C between 2030 and 2052 (Fawzy, S., et al., 2020).

The CO_2 released from burning fossil fuels accumulates in the atmosphere, forming an insulating blanket that traps more of the Sun's heat. This contributes to a rise in global temperatures. The key sectors driving these emissions include industry, energy, transport, buildings, agriculture, and land use (USEPA 2023). The Earth's average global temperature has increased by at least 1.1°C (1.9°F) since 1880. The warming trend has been most prominent since 1975, increasing at the rate of approximately 0.15 to 0.20 degrees Celsius per decade. The past nine years have been the hottest since modern record-keeping began in 1880, with 2022 global temperature anomalies tying the fifth warmest on record. It is essential to note that global warming does not lead to uniform temperature increases everywhere; while one region might undergo a 5-degree surge, another might witness a 2-degree decline (NASA 2023).

Climate change can lead to prolonged periods of low precipitation, resulting in severe droughts and water shortages in affected areas. This can increase the risk of wildfires and contribute to sea level rise, which may lead to flooding in coastal regions. Additionally, climate change can cause polar ice melt, leading to changes in global ocean currents and impacting biodiversity. Furthermore, it can also result in the intensification of powerful storms, threatening both human settlements and natural habitats (Watts, Nick, et al., 2015). Prolonged droughts are additionally endangering communities, pushing them towards the threat of famine. The expected climate trajectory suggests a rise in the displacement of people due to weather-related events in the coming years (UN, 2023).

Disaster

Defining a disaster requires careful consideration, especially regarding whether it includes natural or anthropogenic hazards. Disasters are often defined as the result of the interaction between exposure to a hazard, pre-existing vulnerabilities, and a lack of capacity or measures to manage the potential negative consequences. Disaster is a *"serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources"* (UNISDR, 2009).

Emergency and Disaster Distinctions: Navigating Terminology and Assessing Impact

The United Nations Office for Disaster Risk Reduction (UNDRR) has defined the terms "Emergency, Disaster Damage, and Disaster Impact." Sometimes, the term emergency is used interchangeably with disaster, especially in the context of biological or health emergencies and technological hazards. It's important to understand that emergencies can refer to hazardous events that may not necessarily cause significant disruptions to a community or society. Disaster damage occurs during and immediately after a disaster and is usually measured in physical units. It includes complete or partial destruction of physical assets, disruption of essential services, and harm to sources of livelihood in the affected area. Disaster impact covers the overall effects of a hazardous event or disaster, including negative and positive aspects such as economic, human, and environmental impacts (UNDRR 2023).

Resilience

Resilience is a relatively recently entered vocabulary of Disaster Risk Management (DRM), originally stemming from an ecological context. It has been adopted in various fields such as sociology, psychology, structural and engineering science, corporate strategy, and climate change adaptation (CCA), along with DRM. The term acknowledges the interconnected and interdependent nature of the systems that uphold communities, covering social, economic, natural, and man-made systems. It also acknowledges that achieving resilience necessitates collaborative efforts involving different disciplines and actors at various levels, who collaborate with shared responsibility and a diverse range of tools and methods. This collaboration aims to address various needs and resources, including environmental, social, and economic aspects. Resilience has been widely accepted, especially in explaining the intersection of disaster risk management, climate change adaptation, poverty, and development (Benson, 2013).

I have chosen to adopt the definition employed by experts at the Resilience Alliance, an interdisciplinary group, as it is fitting for all the systems that are examined here. This definition defines resilience as “the ability of a system to absorb disturbance, undergo change, and maintain its essential functions, structure, and identity” (Longstaff, Patricia H., et al. 2010). Resilience refers to the dynamic ability of a system, community, or society to adapt and cope with stress and adversity while also maintaining normal psychological and physical functioning. It represents the capacity of a system, community, or society facing hazards to withstand, absorb, adjust to, and quickly recover from their impacts effectively. This covers the preservation and reconstruction of essential structures and functions (Wu, Gang, et al 2013).

Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA)

Disaster Risk Reduction (DRR) aims to prevent new disaster risks, reduce existing ones, and manage residual risks. Climate Change Adaptation (CCA) involves adjusting to current or anticipated climate conditions and their effects to minimize harm or capitalize on beneficial opportunities (Rao, 2023). This includes adapting natural systems to cope with present and future climate impacts and understanding the role of human intervention in facilitating these adaptations (Choi, Seonmi, et al., 2023).

While DRR and CCA both address hazards and impacts, they typically operate through separate risk assessment and management approaches, institutions, and financing mechanisms (Venton & La Trobe, 2008). There is an increasing call for a unified approach to integrating DRR and CCA efforts to meet the "Sustainable Development Goals (SDGs)", the "Paris Agreement", and the "Sendai Framework for Disaster Risk Reduction". Strengthening synergies and coherence between DRR and CCA policies and financing is essential for effective climate and disaster risk management and the loss and damage finance framework (Sushchenko & Schwarze, 2020; Choi, Seonmi, et al., 2023).

Adapting to climate change comes in different forms, customized to the particular requirements of societies, businesses, groups, regions, and countries. There is no one-size-fits-all solution; adaptation actions may involve building flood barriers, establishing early warning systems for hurricanes, cultivating drought-resistant crops, and rethinking communication networks, business tactics, and government regulations. Numerous countries and communities are already taking measures to reinforce their societies and economies. However, more decisive action and greater ambitions are needed to effectively tackle current and future economic risks.

Successful adaptation is not solely dependent on governments; it requires active and ongoing engagement from stakeholders. This includes local communities, national and international organizations, public and private sectors, civil society, and other pertinent contributors. In addition, effective knowledge management plays a crucial role. Acknowledging that adaptation is a global challenge with diverse facets, parties to the UNFCCC and the Paris Agreement stress the importance of collaborative efforts at the local, national, regional, and international levels. Moreover, they emphasize that adaptation strategies should draw from traditional and indigenous knowledge where applicable. The aim is to seamlessly integrate adaptation into socioeconomic and environmental policies and actions (UNFCC, 2023).

2.1 Community Approaches to Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) for Building Resilience

The vulnerable communities to climate change impacts have been experiencing the negative impacts of climate change for many years and possess valuable knowledge on how to adjust. Community-based adaptation to climate change aims to empower communities to utilize their traditional knowledge and decision-making processes. This approach is community-driven

and relies on the priorities, needs, knowledge, and capabilities of communities to enable them to plan for and manage the effects of climate change (Reid, H., 2016).

Community-based adaptation approaches play a crucial role in enhancing resilience and lessening the impacts of climate change. These approaches entail the active participation of local communities in identifying and carrying out measures to adjust to shifting climate conditions and minimize the risks linked to natural disasters. Often known as a bottom-up approach, this method emphasizes the active engagement of local communities in decision-making processes to ensure that their knowledge, requirements, and capacities are taken into account in developing effective strategies.

The foundation of community-based approaches to climate change adaptation and disaster risk reduction is based on the principle of integrating policies and practices for disaster risk reduction and climate change adaptation (Network, P., 2008). By merging these two approaches, communities can achieve combined effects and reciprocal benefits in their efforts to bolster resilience and lower vulnerability. While climate change adaptation and disaster risk reduction share similar goals and objectives, their integration is a relatively recent area of focus (Venton, P. and La Trobe, S., 2008).

Efforts are being made to improve coordination and cooperation between climate change and disaster risk reduction initiatives to maximize their effectiveness and ensure a comprehensive approach to building resilience. The Paris Agreement of 2015 established a significant global goal on adaptation, setting a precedent. This goal aims to enhance our ability to adapt, build resilience, and reduce vulnerability to climate change. The primary objective is to contribute to sustainable development while ensuring an appropriate response to adaptation needs within the context of the mitigation goal of limiting temperature rise to a maximum of 2°C or 1.5°C (UNFCC 2023).

The UNFCCC has established several bodies and initiatives to enhance adaptation responses and strengthen both societal and environmental resilience against climate change. A significant advancement occurred at CMA 5, where Parties endorsed the “UAE Framework for Global Climate Resilience”. This framework marks a crucial step forward in adaptation efforts under the “Paris Agreement”. It is designed to propel progress toward achieving the global adaptation goal by systematically assessing and addressing the escalating adverse impacts, risks, and vulnerabilities associated with climate change. The framework aims to refine adaptation actions and support, ensuring that efforts are effective and responsive to the evolving challenges posed by climate change.

The Adaptation Committee (AC), established in 2010, acts as a leading advocate for global adaptation. It strives to promote cohesive UNFCCC action on adaptation by providing expert guidance, expanding outreach, and facilitating the implementation of the Paris Agreement. Since 2018, the Facilitative Working Group (FWG) has been focused on operationalizing the “Local Communities and Indigenous Peoples Platform (LCIPP)”, assisting in knowledge

dissemination, engagement capacity-building, and the formulation of climate change policies and actions (Leiter, T., 2023).

The LCIPP functions as an all-encompassing platform, bringing together individuals and their knowledge systems to guarantee a world that is resilient to climate change for everyone. Aligned with the principles of the "Paris Agreement and Decision 1/CP.21", it acknowledges climate change as a concern that affects all of humanity. Therefore, any measures taken to tackle climate change should take into account and respect the rights of indigenous peoples and local communities.

Acknowledging the efforts of local communities and indigenous peoples in addressing climate change, the COP has stressed the significance of the LCIPP. Designed to facilitate the sharing of experiences and best practices related to both mitigation and adaptation, the LCIPP operates in a comprehensive and integrated manner (UNCCC 2024).

Community-based approaches to climate change adaptation and disaster risk reduction are also recognized at the national level in Pakistan. The Government of Pakistan has prioritized "Community-Based Disaster Risk Management (CBDRM)" initiatives as part of its "National Disaster Management Plan (NDMP)". These initiatives seek to strengthen the resilience of local communities to disasters. The implementation roadmap introduced by the "National Disaster Management Authority (NDMA)" in 2015 focuses on four key domains, with one being the implementation of CBDRM up to the Union Council level. This entails involving all constituents of the Union Council in disaster risk management activities.

To support Community-Based Disaster Risk Management (CBDRM), a range of capacity-building activities has been undertaken for the government to raise awareness and advocate for a comprehensive disaster management approach. Both governmental and non-governmental organizations have been actively involved in implementing CBDRM initiatives across Pakistan. Key contributors include UN agencies, the "National Disaster Risk Management Fund (NDRMF)", "Sindh People's Housing for Flood Affectees (SPHF)", as well as various partner organizations within the "Pakistan Humanitarian Forum (PHF)" and the "National Humanitarian Network (NHN)". Additionally, Pakistan has carried out sector-specific risk assessments to enhance understanding of various disaster risks, such as droughts and earthquakes. These assessments are crucial for identifying vulnerable populations and prioritizing risk reduction actions.

Institutionally, Pakistan has established a strong framework for disaster risk management since the 2005 earthquake, including the creation of national, provincial, and local disaster management authorities. The NDMP, launched in 2012, provides a comprehensive strategy for disaster risk management over a decade, including guidelines for CBDRM implementation. Various programs, including "Disaster Risk Financing and Insurance (DRFI)", Climate-Smart Agriculture (CSA), and Building and Construction Codes, complement CBDRM efforts by lessening the financial impacts of disasters, enhancing agricultural resilience, and improving the structural safety of buildings against natural

hazards like earthquakes and cyclones (Danish, S.,et al., 2023) are devised to reduce the impacts of climate change and induced disasters.

However, there is still a significant challenge in adapting the existing framework, along with its associated minimum standards and tools, to the diverse array of contexts and stakeholders present in Pakistan. Additionally, the development process of the "Community-Based Disaster Risk Management (CBDRM) Framework" needs to employ participatory and consultative approaches to ensure its acceptance and replication by various entities such as communities, civil society, local government, and the development sector.

Another common obstacle faced is the presence of gaps in Disaster Risk Reduction (DRR) knowledge and technical capacity among stakeholders, including project implementing partners. Local government agencies, which are crucial for effective disaster preparedness and response, often lack the necessary support to enhance their knowledge and competencies in Disaster Risk Management (DRM). This challenge is worsened by weak local management structures, high staff turnover rates, and sometimes inadequate financial and infrastructural resources (Katastrophenhilfe. D., 2022).

2.2 Community-Based Disaster Risk Management (CBDRM) in Gilgit Baltistan

Community-based disaster risk management (CBDRM)" is acknowledged to play a critical role in disaster response efforts. It serves as the frontline response mechanism during disaster situations (Shah, A.A., et al., 2020). However, CBDRM has not received adequate attention in Pakistan, including in Gilgit-Baltistan (GB), where only a few organizations, such as "Aga Khan Agency for Habitat (AKHA)" and "Pakistan Red Crescent Society", are actively engaged in implementing the CBDRM model. To address this gap, GB's "Disaster Management Authority (GB-DMA)" needs to develop a standardized CBDRM program, drawing insights from existing models. The responsibility for managing and implementing the CBDRM component could be entrusted to "District Disaster Management Authorities (DDMAs)" and "Disaster Management Committees (DMCs)". Committee formation and training should adhere to standard operating procedures, but the content of training and equipment provision should be tailored to the specific hazards encountered in each area, considering their severity and nature. To ensure effective management of CBDRM activities at the local level over the long term, a robust administrative structure should be established, with active involvement from the "National Disaster Management Authority (NDMA)", GB-DMA, DDMAs, and DMCs.

However, the community-based disaster risk management approach often overlooks community knowledge and climate change adaptation strategies, which are crucial for success. The indigenous knowledge and climate adaptation strategies are not documented and are gradually eroding. Therefore, integrating these strategies into the overall disaster risk reduction mechanism is necessary to achieve a successful "Community-Based Disaster Risk Management (CBDRM)".

2.3 Country Profile

2.3.1 Pakistan

Pakistan is the world's fifth-largest population, totaling almost 243 million people. Its land area covers 770,875 square kilometers. Throughout history, natural disasters have posed a significant threat to people living in Pakistan. These disasters include flash floods, droughts, GLOFs, earthquakes, landslides, cyclones, and heat waves (Hussain, M.A., Zhang, S., et al., 2022).

The 2022 floods in Pakistan were catastrophic, submerging nearly one-third of the country. These floods displaced approximately 8 million people and affected a staggering 33 million individuals with total damages estimated at around 4.8% of the country's gross GDP for the fiscal year 2022. The projected costs for recovery and reconstruction are estimated to be 1.6 times the budgeted national development expenditure for the fiscal year 2023. The housing sector was the hardest hit, suffering losses amounting to US$5.6 billion. The agriculture and livestock sectors, vital for the livelihoods of millions, incurred damages of US$3.7 billion. Meanwhile, the transport and communications sectors, essential for connectivity and trade, faced losses totaling US$3.3 billion.

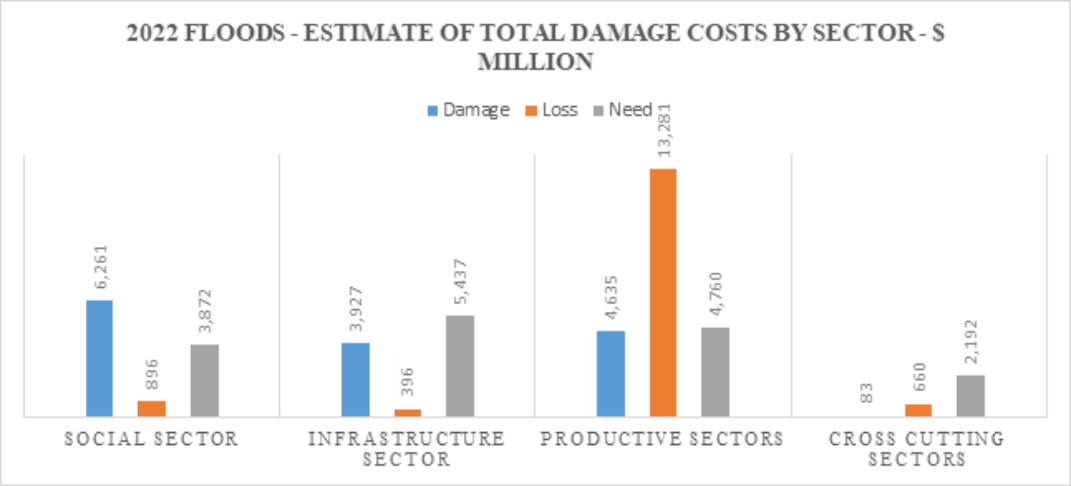


Figure 2: *Floods 2022- Estimated Total Damage Costs by Sector*
Source*: Post Disaster Need Assessment Report, 2022*

The 2022 floods are projected to have a significant impact on Pakistan's economy, with an estimated 2.2% decrease in GDP for the fiscal year 2022. According to the Post-Disaster Needs Assessment (PDNA), the national poverty rate is expected to increase by 3.7 to 4.0 percentage points, potentially pushing an additional 8.4 to 9.1 million people into poverty. The total estimated damages, losses, and recovery needs are substantial, amounting to US$14.9 billion, US$15.2 billion, and US$16.3 billion, respectively. Sindh province bore the brunt of the devastation, accounting for nearly 70% of the total damages and losses. This was followed by significant impacts in Balochistan, Khyber Pakhtunkhwa, and Punjab (PDNA 2022).

The 2010 monsoon floods in Pakistan were remarkably severe and unparalleled, resulting in widespread devastation. The report from the Federal Flood Commission in 2010 disclosed a staggering impact, including a financial loss of $10 billion, about 2000 fatalities, and the destruction of 17553 villages, affecting an area of 160,000 square kilometers. Over 20 million individuals were affected by the floods, which caused damage to infrastructure, homes, agriculture, livestock, and other assets, totaling billions of dollars.

The magnitude of the destruction was significant, with 392,786 houses damaged and 728,192 destroyed, along with 436 health facilities being harmed. The agricultural sector suffered considerable losses, with prominent crops such as sugar cane, paddy, and cotton experiencing a collective reduction of 13.3 million metric tons in production. More than 2 million hectares of standing crops were either lost or damaged, and the floods claimed the lives of over 1.2 million heads of livestock, excluding poultry. The impact was particularly severe in Punjab and Sindh, where 60 to 88 percent of farming households reported losses exceeding 50 percent for major crops like rice, vegetables, cotton, sugar, and fodder (Looney, R., 2016).

2.3.2 Disasters in Gilgit-Baltistan

According to the report "Gilgit Baltistan at a Glance – 2020, there are 2,759 public and private sector schools and 28 higher education institutions in Gilgit - Baltistan. Furthermore, it features 557 health facilities, 189 veterinary hospitals and dispensaries, 149 hydroelectric power stations, and 108 irrigation channels. In terms of agriculture, the total area under cultivation spans 3,938.78 square kilometers, with 894 square kilometers designated as a cropped area. The report also highlights that 09 % of the land is covered by forests, while 22.4% serves as rangeland. Access to essential services is relatively high, with 79% of the population having access to improved or piped water, and 98% enjoying access to electricity. However, the report also underscores vulnerabilities, particularly concerning the susceptibility of these critical facilities and infrastructure to disasters. Data from the disaster chronology of Gilgit-Baltistan reveals damages suffered by all the public and private facilities. Therefore, there is an urgent need to prioritize attention to Disaster Risk Reduction (DRR) measures through preparedness and mitigation strategies (P&DD-GB 2020).

In the Gilgit-Baltistan (GB) region, seismic activity, particularly earthquakes, presents a significant natural hazard due to its location in an active seismic zone. This susceptibility, combined with physical and socioeconomic vulnerabilities, poses grave risks, especially for communities near fault lines. There are eight active faults traverse the Gilgit-Baltistan region, including the Main Karakorum Thrust Fault and the Upper Hunza Fault. Recorded earthquake incidents in GB, have led to cascading risks like landslides, avalanches, and rockfalls, resulting in human suffering, economic disruption, infrastructure collapse, and environmental degradation (Rafi, M.M., Lodi, S.H., Ahmed, M., Kumar, A. and Verjee, F., 2016).

In terms of climate, Gilgit-Baltistan (GB) exhibits a semi-arid climate pattern characterized by an average annual precipitation of 84.04 mm, primarily influenced by westerly rains.

Analysis of rainfall and drought patterns spanning from 1981 to 2020 indicates varying degrees of drought severity across districts. Gilgit, Ghizer, and Hunza-Nagar frequently experience severe drought events, while moderate drought occurrences are observed in districts like Hunza, Nagar, and Ghanche. Hunza and Nagar districts have the highest overall number of drought events. Both droughts and floods are on the rise, with the prolonged effects of droughts setting them apart from other natural disasters, persisting long after the initial event has passed. (Atif, S., Umar, M. and Ullah, F., 2021).

Gilgit-Baltistan (GB) grappled with devastating floods throughout the year, spanning from June to September. According to the Gilgit-Baltistan Disaster Management Authority (GBDMA), the toll of these floods was severe, with 17 fatalities and six injuries reported. The economic losses incurred amounted to PKR 7,406 million across GB. The floods wreaked havoc on critical infrastructure, with 22 powerhouses, 49 roads, 78 drinking water supplies, 500 irrigation channels, and 56 bridges sustaining damage. (HRCP 2022).

Table 1. District-Wise Occurrence & Intensity of Extreme Weather/Erratic Monsoon – Gilgit - Baltistan

Hazards	**Gilgit**		**Hunza**		**Nagar**		**Ghizer**		**Astore**		**Diamer**		**Skardu**		**Ghanche**		**Kharmang**		**Shigar**	
	Probability	Impact	Probability	Impact	Probability	Impact	Probability	Impact	Probability	Impact	Probability	Impact	Probability	Impact	Probability	Impact	Probability	Impact	Probability	Impact
GLOF	2	2	3	3	3	2	2	2	2	2	2	2	1	1	2	2	1	1	3	3
Snowfall & hailstorm	2	2	1	1	2	2	3	3	3	3	3	2	2	2	2	2	1	1	1	1
Ext. weather/Err. monsoon	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3
Enhanced heat	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1	1	2	2
Shrinking/melting of glaciers	2	2	3	3	3	3	2	2	2	2	1	1	2	2	2	2	1	1	3	3

Legends: Low | Medium | High

Source: *Gilgit Baltistan Disaster Risk Management Plan 2023*

Table 1 shows the probability and intensity of impact associated with various climatic phenomena. It indicates a high probability and intensity of impact for both extreme weather events and erratic monsoon patterns. Additionally, the table highlights a notable likelihood of Glacial Lake Outburst Floods (GLOFs) occurring in the districts of Hunza, Nagar, and Shigar, with a subsequent medium probability and intensity of impact observed in Ghizer, Gilgit, Astore, Skardu, and Ghanche.

The exceptional meteorological conditions in the Karakoram mountain range have led to an unusual phenomenon concerning glacier behavior. While most glaciers worldwide are retreating due to climate change, the Shisper glacier stands out as one of the few in the region that is advancing. This advancement has resulted in the obstruction of a stream flowing from the Muchuhur glacier into the Hunza River in Hassanabad, creating an artificial lake.

During the summer months, as temperatures rise and the glacier begins to melt, the dammed lake releases accumulated water, posing potential risks downstream. This dynamic process underscores the intricate interplay between glacial dynamics and climatic factors, emphasizing the need for ongoing monitoring and adaptation strategies in vulnerable regions. According to the experts, extreme weather has caused heavy rainfall, snowfall, GLOF, excessive melting of glaciers, and recent forest fires during 2021 and 2022. Experts believe that the flow of water in rivers increased during the decade of 1990–2000 compared to 1975–1990, which indicates the melting of more ice upstream (DRMP 2023).

Table 2: Consolidated Data on Losses & Damages Due to Natural/Manmade Disasters, 2022

Human/physical casualties and losses/damages		**Economic and physical losses/damages**	
Item/description	Nos.	Item/description	Nos.
Deaths	8	Cattle sheds	30
Injuries	3	Ruminant livestock	685
Missing children	2	Bridges (transport)	34
Fully damaged houses	74	Bridges (pedestrian)	11
Partially damaged houses	375	Heavy machinery	2
Hotel (partially damaged)	1	Roads (different locations)	29
Headwork/protective walls	32	Water supply	19
Hydroelectric power station	32	Irrigation channels	66
Transmission lines KM (complete/partial)	32/10	Agriculture land/crops (several)	-
Distribution transformers	120	Non-fruit trees	11,778
Electric installed capacity/damage cap.	186/74	Shops	33
		Fish farms/fish (Gilgit & Ghizer)	16 / 06

Source: *Gilgit Baltistan Disaster Management Authority (GB-DMA - 2022)*

According to the Gilgit Baltistan Disaster Management Authority (GB-DMA), there were eight reported deaths and three individuals sustained injuries due to various disasters in 2022. Additionally, two children were reported missing, underscoring the human toll of these disasters. Property damage was also significant, with 74 houses destroyed and 375 houses suffering partial damage. Furthermore, one hotel experienced partial damage, highlighting the impact on infrastructure. The destruction extended beyond residential areas, with 32 protective walls or headworks and 32 hydroelectric power stations being affected. Moreover, significant damage was inflicted upon critical infrastructure such as transmission lines, with 32 kilometers completely damaged and an additional 10 kilometers partially damaged. Distribution transformers were also heavily impacted, with 120 units damaged, alongside 186 units of electric capacity affected, with 74 units experiencing damage.

Table 2 entails the details of economic and physical losses/damages. The data shows that thirty cattle sheds were damaged, affecting the livelihoods of livestock owners. Ruminant livestock also suffered, with 685 animals affected. The disruption to transportation infrastructure is evident, with 34 transport bridges and 11 pedestrian bridges damaged. Additionally, heavy machinery was impacted, with two units damaged. Roads in various locations were affected, with 29 reported cases of damage. The table also highlights damage to essential utilities, including 19 water supply systems and 66 irrigation channels. Agricultural productivity was affected, as evidenced by reported damage to agricultural land and crops. The environmental impact is notable, with 11,778 non-fruit trees affected. Furthermore, 33 shops suffered damage, underscoring the economic ramifications of these disasters. In specific regions, such as Gilgit and Ghizer, 16 fish farms and 6 units of fish were affected, highlighting the widespread nature of these incidents and their impact on various sectors of society.

Table 3: District-Wise Community Level Vulnerabilities with Intensity of Impact – Gilgit Baltistan

	Gilgit Division				Diamer Division		Baltistan Division			
Vulnerability (community level)	**Gilgit**	**Hunza**	**Nagar**	**Ghizer**	**Astore**	**Diamer**	**Skardu**	**Ghanche**	**Kharmang**	**Shigar**
Houses	3	3	3	3	3	3	3	3	2	2
Educational buildings/services	2	2	2	2	2	2	2	1	1	2
Hospitals/services	2	3	2	2	3	2	2	2	1	3
Power stations	3	3	2	3	3	3	3	3	3	2
Government buildings	2	2	2	2	2	2	2	1	1	2
Agricultural land	3	3	2	2	2	3	2	3	2	2
Crops and fruit trees	3	3	2	2	2	3	2	3	2	2
Bridges, roads, pathways	3	2	3	3	3	3	3	3	3	3
Market	2	2	2	1	2	2	1	1	1	2

Legends: Low | Medium | High

Source:*Gilgit Baltistan Disaster Management Authority (GBDMA) 2023.*

Table 3 illustrates various community-level elements that are susceptible to risks and therefore considered vulnerable. Across all districts in Gilgit-Baltistan (GB), houses, hydroelectric power stations, bridges, roads and pathways, agricultural land, crops, and fruit trees are identified as highly vulnerable elements. Additionally, hospital and medical services are highlighted as highly vulnerable in districts such as Hunza, Astore, and Shigar, while their vulnerability level in other districts is deemed to be at a medium level. Participants in focus group discussions (FGDs) stated that local hospitals face significant challenges in handling large-scale casualties due to constraints in staffing, space, equipment, and medication availability.

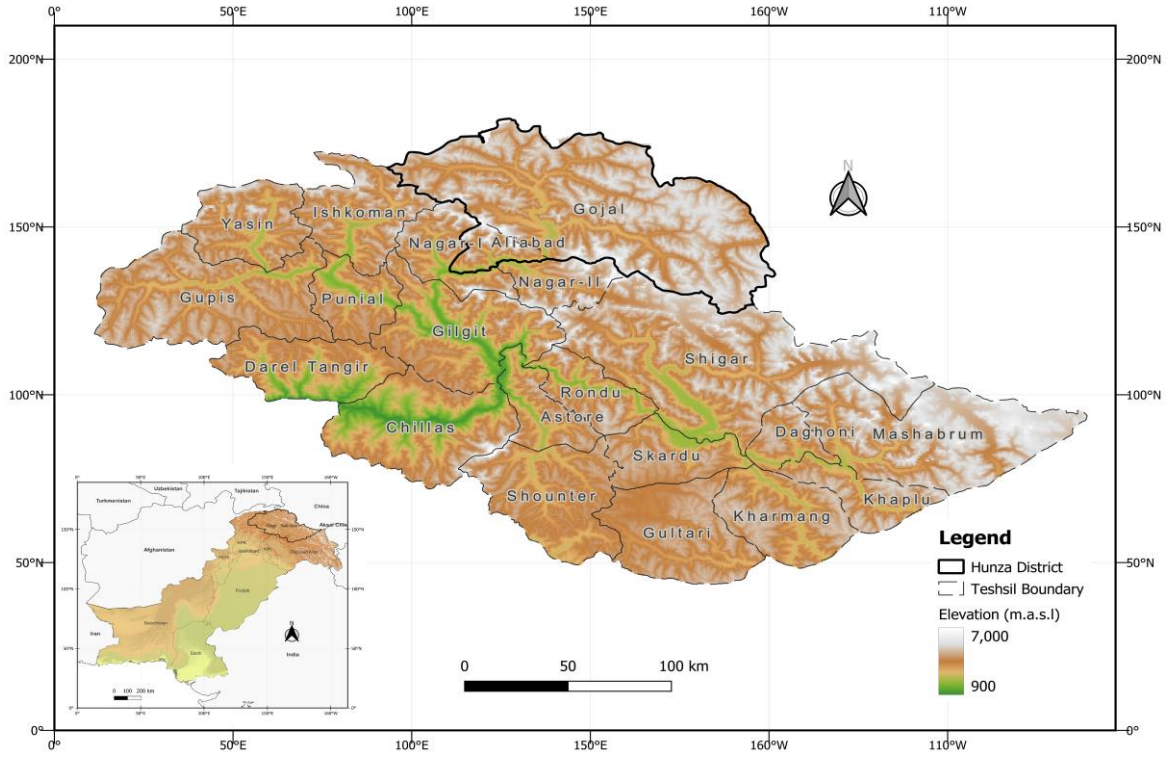
In 2023, devastating monsoon floods created destruction, resulting in the loss of seven lives and causing injuries to two individuals. The floods inflicted significant damage to infrastructure, including a 1.9 km stretch of road and a bridge. Moreover, the calamity left 37 houses partially damaged and destroyed 22 others. Additionally, the floods claimed the lives

of 37 livestock, aggravating the economic impact of the disaster on the affected communities (NDMA 2023).

2.3.3 Profile of Study Area

The Hunza Valley is located in the western Karakoram region of northern Pakistan and covers an area of approximately 11,000 km2 (Xie, F., et al., 2020). The valley has a population of 46,500 people and is divided administratively into two tehsils, the Aliabad Tehsil, and the Gojal Tehsil (Marwat, S.U.K. and Faryal, A., 2022). Most people in the region speak Brushaski and Wakhi, as well as English and Urdu (Parekh, 2018). The region has a diverse topography with varying altitudes, ranging from 1,341 to 7,831 meters above sea level. The valley is home to around 1,878 glaciers, covering an area of roughly 3,600 km2. These glaciers represent about 33% of the basin area, with approximately 12% of them exceeding 0.5 km2 in size (Muneeb, F., et al., 2021).

Figure 3: Map of Study Area – Hunza District



Hunza serves as a significant contributor to the Indus Basin River irrigation system, providing approximately 12% of the upper Indus flow before reaching Tarbela Dam. Interestingly, less than 20% of contributing areas are responsible for 80% of the dam's total inflow, mainly areas with heavy snowfall and glacierized basins above 3500 m elevation. Moreover, around 50% of the basin area has elevations higher than 4700 m (Shrestha, Koike et al., 2015).

The Hunza River is an important source of water for the Indus River due to its snow and glacier melt (Shrestha and Nepal., 2019). Most glaciers, such as the Hispar, Batura, and Barpu glaciers, are covered in debris and are presently undergoing surging and advancing stages. These debris-covered glaciers play a crucial role in initiating glacial lake outburst floods, which present a significant danger to nearby communities, their property, and essential infrastructure like the Karakoram Highway in the Hunza Valley (Saifullah., et al., 2020).

From a climatological perspective, the study area is characterized as arid to semi-arid and falls within the subtropical climate zone, resulting in significant fluctuations in precipitation (Garee et al., 2017). The mean land-surface temperature across the region stands at −12.9°C in January and rises to 20.1°C in July. Precipitation patterns are primarily influenced by the Indian monsoons and the westerlies, with average annual precipitation ranging from 180 to 690 mm. Winter months typically see snow covering approximately 80% of the basin's land surface, which diminishes to about 30% during the summer (Tahir et al., 2015).

The study conducted by (Suhaib Bin Farhan et al., 2018) highlights prominent trends in mean monthly temperatures in the Hunza basin spanning from 1966 to 2010. It indicates significant warming trends during winter and early spring months (October to March), with only slight warming observed in April and May. Conversely, there is a slight cooling trend in the Hunza basin's summer temperatures from June to September. During this latter period, the cooling rate in the Hunza basin was recorded at -0.08 °C per decade, while the observed warming for the other relevant months was +0.11 °C per decade. Additionally, the mean annual temperature (MAT) demonstrates a warming trend of +0.04 °C per decade in the Hunza basin. These temperature increases, particularly in annual and winter temperatures, appear consistent with the overall global temperature rise.

Hunza District is home to some of the world’s highest mountains and glaciers. The district is prone to various climate hazards such as GLOFs, landslides, avalanches, and flash floods. The vulnerability of Hunza to climate change is exacerbated by its socio-economic characteristics. The district has a predominantly agrarian economy, with agriculture being the primary source of income for many households. Traditional farming practices and limited access to modern technologies and resources make the communities highly dependent on climate-sensitive sectors. Changes in temperature, precipitation, and water availability directly impact crop production and livestock rearing, making them more vulnerable to food insecurity and economic instability.

It is important to note that Hunza's vulnerability to climate change is closely linked to the vulnerability of its communities. The socio-economic factors, including poverty, limited access to resources, and lack of awareness, further increase the challenges faced by the local population. These factors limit their capacity to adapt and respond effectively to the changing climate conditions. Understanding the vulnerability of the Hunza district to climate change is important for developing appropriate adaptation, and resilience-building strategies and responding to disaster emergencies.

2.3.4 Disasters in Hunza

The people of Hunza Valley in the "Upper Indus Basin (UIB)" are particularly vulnerable to natural disasters and GLOFs, which can cause significant harm to their livestock, infrastructure, human lives, and livelihood resources. In the northern areas, glacier melting is increasing, which escalates the risk of GLOFs. Although the Himalayan glaciers are melting rapidly, the Karakoram glaciers are stable and even gaining mass. Global warming and rising temperatures are the primary causes of glacier retreat in mountainous regions (Abbas Gilany, S.N., Iqbal, J. and Hussain, E., 2020).

The Hunza River Basin encompasses an expansive area of 13,730 km2. Approximately 30% of this land is adorned with around 1300 glaciers. These glaciers, along with their tributaries, play a crucial role in supplying meltwater to the Hunza River. The river meanders through the Khunjerab Valley, which stands as the highest altitude region within the Hunza River Basin and lies adjacent to Kashgar, China.

As the river descends to middle altitudes, it receives contributions from two main streams, namely Misgar and Chupurson, which feed into the Hunza River. Following these, the Shimshal stream also adds to the river's flow. These diverse water sources sustain the livelihoods and ecosystems of communities residing in the Hunza River Basin. Shimshal Valley, situated 80 km from Central Hunza Valley, is a remote region mostly covered by extensive glaciers. Known for its seasonal pasture settlements at elevations of 3,200 and 4,600 meters, the valley has experienced several glacial lake outbursts and floods throughout its history. These events have been reported by locals in various years, including 1904, 1920, 1942, 1960, 1979, 1999, and 2017 (Hussain, 2019). The valley is also fed by six major glaciers: Khurdopin Glacier (47 km), Virjerab Glacier (40 km), Mohmhil Glacier (35 km), Yazghil Glacier (31 km), Malangutti Glacier (23 km), and Lupghar Glacier (13 km).

These glaciers, located approximately 10 km from the upper Shimshal valley, experience significant movement, with the Khurdopin Glacier exhibiting a surge rate roughly 1500 times higher than average every two decades. The most recent surge, occurring in May 2017, resulted in the formation of a glacial lake, with the Khurdopin Glacier having previously blocked the Virjerab River on multiple occasions, leading to the formation of glacial lakes. Consequently, glacier-related floods in August 2017 caused extensive damage to farmlands, roads, water channels, bridges, and severed connectivity between the valley and the rest of the country (Iturrizaga & Lasafam, 1996).

The Shisper glacier surge led to the creation of an artificial lake, causing concerns about increased water release during summer melting. Particularly, the Shisper Glacier in Hunza and the Hisper Glacier in Hisper Valley experienced excessive runoff, as reported by the GBDMA in June 2022. The Hassanabad area of Hunza, where the Shisper Glacier is located, faced flooding since May 2018 due to the formation of an ice-dammed lake upstream, obstructing the Hassanabad stream. This obstruction affected several villages and

infrastructure, with an estimated value of property at risk ranging from $10 to $15 million (Baig et al., 2020).

In response to these risks, the Aga Khan Agency for Habitat (AKAH) in Gilgit-Baltistan has initiated proactive measures, including relocating communities to safer areas and providing eco-friendly prefabricated houses. While indigenous knowledge aids in predicting glacial lake dynamics, there's a push for advanced technology, such as establishing automatic weather stations in 16 valleys in GB under the GLOF-II project. Effective communication among relevant authorities like GB-DMA, the "Ministry of Climate Change", and the Pakistan Meteorological Department is crucial for enhanced forecasting and disaster risk management at provincial and district levels.

The mountainous region of Pakistan, where the China-Pakistan Economic Corridor (CPEC) is situated, is rich in glaciers and glacial lakes. Glacial activity poses risks to infrastructure and communities along the CPEC route, with events like glacier surges and outbursts affecting areas like Passu and Attabad. The formation of Attabad Lake, resulting from a massive landslide, caused significant loss of life and forced climate-induced migration in the village of Attabad. Such events underscore the need for proactive measures and collaborative efforts to mitigate risks and ensure the safety and resilience of communities in these vulnerable areas.

2.3.5 Historical Disasters in Hunza District

Between 1830 and 1900, various natural disasters afflicted several localities, leaving a trail of destruction and loss. In 1830/1833, Chupursan Valley faced a Glacial Lake Outburst Flood (GLOF), coupled with mudslides and landslides, resulting in widespread damage to all settlements. A similar GLOF event occurred in Badang in 1841, causing the blockage of the Hunza River near Garmasai. The year 1847 witnessed another GLOF in Bar, where a glacial surge prompted the abandonment of fields. Moving forward to 1858, Sarat experienced a devastating rockfall or rockslide, leading to the loss of village lands due to terrace undercutting, accompanied by flooding that affected all villages from Sarat to Pasu. In 1860, Gwachi suffered damage to settlement and village lands due to flooding, alongside another GLOF event in Matum Das that destroyed an irrigation channel.

Many of these disasters have been reported by various researchers; however, Dr. Hermann Kreutzmann has thoroughly documented these events in his book "Hunza Matters."

In 1873, Batura in Passu faced the brunt of a GLOF, resulting in damage to buildings at Passu and Matum Das. In 1882, Shimshal was inundated by a large flood in September, a similar event occurred in 1884, where Shimshal and Ganesh were affected. In 1888, Gojal faced unexpected high snowfall in mid-summer, leading to the destruction of several crops.

In 1893, tragedy struck Matumdas as a mudslide or landslide destroyed an irrigation channel and settlement, while the GLOF in Shimshal Valley damaged the terraces in Altit. The following year, Hispar was hit by mudslides and landslides, alongside thunderstorms causing

flash floods in Baltit, Sumayar, Gojal, and Ratal, resulting in widespread destruction and loss of life. In Hasanabad, a bridge was destroyed due to yet another GLOF event in 1894. Ganesh suffered the loss of cultivation at Shamets in 1895 due to GLOF, while avalanches in Hakuchar, Chalt, and Nilt claimed lives and caused damage to terraces, orchards, and tracks. Barpu witnessed the formation of a lake due to a GLOF event, while Hasanabad and Nilt faced bridge destruction in 1899 and 1900, respectively.

Between 1901 and 1908, a series of natural disasters wreaked havoc on various localities, leaving a trail of destruction and loss. In 1901, Chalt witnessed a catastrophic event involving rockfall, rockslide, and mudslide/landslide, destroying the Nomal-Chalt track. Shimshal faced multiple Glacial Lake Outburst Floods (GLOFs), leading to the breaking of a dam and the destruction of the bridge at Ganesh, as well as damage to bridges in Hasanabad. The following year, Hasanabad experienced further devastation with another bridge destroyed, alongside glacier advances posing a threat to cultivation.

In 1903, Hasanabad was hit by a glacier surge, resulting in a 30-meter glacier surge and the destruction of a canal, while Miachar faced an avalanche that blocked a road. Ahmedabad and Hasanabad were both affected by GLOFs in 1904, with glacier surges destroying canals. Additionally, Khurdopin suffered damage to terraces in Shimshal following the emptying of a two-year-old lake in 1902. Moving to 1905, Hasnabad witnessed a tragic event where two flocks of goats were covered by rocks and a mudslide/landslide. The Shimshal Glacier destroyed the Chalt bridge and Gilgit-Chalt track, resulting in the loss of fields in Pasu and Shimshal.

In 1906, Nomal was struck by a thunderstorm causing a flash flood, destroying roads, and the loss of one woman and livestock. Shimshal and Pasu were once again hit by GLOFs, causing extensive damage to bridges, houses, harvests, and village lands. The devastation continued in 1907, with Khurdopin experiencing the effectiveness of a local alert system amidst GLOF threats. Finally, in 1908, Minapin/Miachar faced the wrath of a thunderstorm causing flash floods, resulting in damage to roads and bridges.

From 1910 to 1990, a significant timeline of natural disasters took place, leaving devastating impacts on various localities. In 1910, Sikandarabad experienced the destruction of a new bridge by high winds, while Shayar witnessed the collapse of the Shayar bridge due to rockfall and rockslide. Additionally, GLOFs struck Ahmedabad, causing the loss of irrigation channel heads due to the advance of the Gurpi Glacier, and Batura and Passu suffered damage to houses, terraces, and fruit trees. In 1911 Batura witnessed a significant glacier advance. The year 1913 brought more destruction as GLOFs destroyed bridges in Hassanabad. In 1922, Shimshal incurred losses as farms were destroyed, and in 1923, a glacial lake formed, exacerbating the situation. Minapin faced a combination of avalanche, rockslide, and wind action in 1925, destroying all fruit trees. Moreover, GLOFs in Murkushi/Misgar led to the destruction of bridges in 1925, while Shinaki/Khanabad witnessed casualties due to mudslides/landslide in 1926. In 1927, Khurdopin suffered damage to bridges and farms, and a local flood originated in Kilik Pass in 1928.

The impact of natural disasters continued to unfold in subsequent decades. Shimshal faced losses of habitations and orchards in Rezgineben (Farmanabad) in 1930, while Ganesh suffered damage to cultivated lands in 1934. The 1940s brought more devastation, with GLOFs causing abnormally high floods and damage to terraces in Shimshal in 1941 and damage to terraces in Pasu in 1944. Additionally, the 1950s and 1960s witnessed numerous incidents of GLOFs, rockfalls, mudslides, and avalanches, causing extensive damage to infrastructure and agricultural lands in various localities.

The 1970s and 1980s continued to see a recurring pattern of natural disasters, including GLOFs, avalanches, thunderstorms causing flash floods, and mudslides. These calamities led to the destruction of bridges, roads, orchards, and houses, affecting the livelihoods of many communities. Moreover, the blocking of the Karakoram Highway due to avalanches and mudslides became a recurrent challenge, disrupting transportation and posing significant risks to travelers.

In 1991, KKH was blocked at multiple points due to avalanches, mudslides, landslides, and flash floods triggered by heavy rains and snowfall in Sost and Gilgit. Additionally, Minapin witnessed one fatality and the destruction of a house due to mudslides and landslides, while Hunza suffered from the destruction of bridges and paths caused by a combination of mudslides, landslides, rockfalls, rockslides, and flash floods. Hispar also faced damage to irrigation channels and village lands due to avalanches. In 1996, Ghalapan experienced damage to shops, irrigation channels, roads, and houses due to rockfalls, rockslides, and mudslides in 1998. Kirmin/Ispenj suffered damage to terraces due to rockfalls and rockslides in the same year. From 1998 to 2005, Haiderabad dealt with regular riverbank under-cutting, leading to the loss of agricultural land and orchards due to GLOFs (Herman Kreutzmann 1994).

In 1999, Misgar witnessed damage to houses due to rockfalls and rockslides. Between 2001 and 2019, various regions in the vicinity experienced an overabundance of natural calamities, affecting infrastructure, settlements, and agricultural lands. In 2001, Shimshal faced an avalanche that damaged the link road and irrigation channels in Wodthur. The year 2005 brought further devastation, with Miachar witnessing twenty houses partially damaged due to an avalanche and flash floods caused by thunderstorms. Moreover, Karimabad suffered livestock casualties due to avalanches, while Shimshal and Sumayar faced regular damage to infrastructure due to GLOFs and rockfalls.

From 2005 to 2010, Sikandarabad and Ahmadabad experienced recurrent mudslides, landslides, rockfalls, and rockslides, resulting in damage to irrigation channels, village lands, and link roads.

In 2008, floods in Ghulkin caused significant damage and psychological trauma, particularly after January 6th. The floods resulted in the loss of five lives—three in Hussaini, including two females, and two in Ghulkin, including a girl under 10 years old. The affected areas were primarily agricultural, leading to fewer casualties despite the extensive damage. The floods

destroyed 72 kanals of land, including 29 kanals of cropland, and 460 fruit trees valued at over 161,000 Pakistani rupees. Additionally, seven houses and four livestock sheds were demolished, resulting in the deaths of 15 cattle. Infrastructure damage included the destruction of approximately 760 meters of link road, two electricity poles, five water channels, 28 pipes, and two water storage tanks (Ashraf, A., Naz, R., and Roohi, R., 2012).

The following year saw further devastation, with landslides destroying houses and infrastructure in Aliabad, Gulmit, and Shimshal. The year 2010 was marked by widespread destruction, with numerous regions experiencing losses from thunderstorm-induced flash floods, avalanches, and landslides. Notably, the formation of Atabad Lake due to a major rockfall and subsequent landslides caused extensive inundation of infrastructure and village lands in Gojal.

The Shisper Glacier, situated in the Hunza Valley, has a history marked by surges, significantly impacting the region. In the period from 2017 to 2019, a surge of the Shisper Glacier led to the creation of an ice-dammed lake by blocking the proglacial river of the Muchuhar Glacier, culminating in a Glacial Lake Outburst Flood (GLOF) (Muhammad, S., et al., 2021). Subsequently, similar events have occurred, giving rise to multiple ice-dammed lakes in the region since 2018, consequently triggering GLOFs (Nasir Hussain, 2022). This surge also obstructed the meltwater channel of the adjacent Muchuhar Glacier, leading to the formation of another ice-dammed lake starting from mid-November 2018, thus causing significant alterations in the area.

According to the Pakistan Meteorological Department, this surge intercepted glacier-melt water from the adjacent Muchuhur glacier, leading to the formation of a glacier-dammed lake in November 2018, posing the threat of a GLOF. This collision resulted in the formation of a glacier-dammed lake, subsequently triggering four GLOF events on 23 June 2019, 29 May 2020, 18 May 2021, and 7 May 2022. Peak discharge from the dammed lake during these events reached 5500 and 5000 cusecs, causing damage to physical and natural assets (PMD, 2021). The lake expanded steadily, reaching its maximum area of 0.34 square kilometers on 20 June 2019. The following day, the first breach occurred, causing a GLOF that partially damaged the Karakoram Highway and caused minor infrastructure damage downstream. The lake continued discharging as subglacial flow until September 2019.

The summer outburst in May 2020 was likely triggered by an abnormal rise in temperature, resulting in significant glacier melt and lake expansion. The Hunza meteorological station recorded a noticeable temperature increase in late May 2020. Although the lake is still releasing water, the risk of outburst remains high due to potential blockages from debris. Monitoring of developments is ongoing at the nearby meteorological station, with satellite imagery being utilized to analyze the events leading up to the GLOF on 29 May 2020 (Muhammad, S., et al., 2021). On 7 May 2022, a significant flood outbreak occurred following the breach of the Shisper glacial lake. Experts attributed this breach to an unusual acceleration in the melting rate of the main glacier, caused by a sudden temperature increase of approximately 5°C (heat waves). Over the past 20 days, this temperature surge led to a

more than 40% increase in the lake's volume, ultimately resulting in the breach. The influx of meltwater from the parent glacier into the lake reached a peak of 5000 cusecs before the collapse (Mondal, S.K., et al., 2023). This GLOF event caused the collapse of the Hasanabad bridge on the Karakoram highway and swept away nine houses, further disrupting the area's drinking water supply in Aliabad and Hassanabad.

In 2017, Shimshal was again hit by flash floods, leading to road blockages, while Misgar faced a landslide blocking the Misgar Road in 2018. The year 2019 saw Shishpar grappling with the advancing glacier destroying infrastructure, including the intake for a hydroelectric plant and channel heads, underlining the ongoing challenges posed by natural disasters in the region. The most recent surge of the Khurdopin Glacier occurred in 2017, leading to the establishment of the Khurdopin glacial lake within the Shimshal Valley. These glacial surges and subsequent lake formations pose significant risks to the Shimshal and Hunza regions (ICIMOD, 2020).

Figure 4: Khurdopin Glacier Shimshal

Source: *NASA Earth Observatory Website, May 15, 2017*

Passu Lake is a significant concern for potential Glacier Lake Outburst Flood (GLOF) events in the Hunza district. The lake's volume has shown considerable fluctuations: it was 788,383.79 m^3 in 2016, increased to 892,910.494 m^3 by 2018, and then decreased to 526,771.3 m^3 by 2020. This variation is linked to the instability of the parent glacier, a common issue in the Karakoram region, known as the "Karakoram Anomaly." The 500-meter buffer zone around the lake is particularly vulnerable, encompassing agricultural lands, settlements, and infrastructure. Settlements downstream along the Hunza River and sections of the Karakoram Highway (KKH) are especially at risk (Iqbal, A. and Mahmood, S., 2023).

Table 4: Floods July 2022 - Damages Hunza District

Event	Location	Damage Status			
		Roads	**Bridges**	**Irrigation Channels**	**Water Supply Lines**
Flash Flood 02-07-2022	Gulmit, Xuchar Nallah	**Damages:** 800 ft approach road. **Cost:** 1.28 million	**Damages:** 02 wooden truss bridges. **Cost:** 3.8 million	**Damages:** 05 Irrigation Channels **Cost:** 1.93 million	
Flash Flood 02-07-2022	Sost Nallah			**Damages:** 04 irrigation Channels **Cost:** 3.2 million	
Riverine Flood (25-07-2022)	ZoodKhun Nallah	**Damages:** 200 ft approach road, 01 protective wall	**Damages:** 01 Wooden truss bridge & 01-foot bridge **Cost:** 19.45 million	**Damages:** 01 irrigation pipeline12 dia, 09 water channels **Cost:** 2.9 million	**Damages:** 01 drinking water supply line. **Cost**: 0.3 million
Flash Flood 23-07-2022	Misgar Nallah	**Damages:** Damaged Misgar Road			
Flash Flood (26-07-2022)	Ultar Nallah			**Damages:** 05 water channels **Cost:** 2.89 million	
Riverine Flood (26-07-2022)	Khyber			**Damages:** 01 water channel-damaged **Cost:** 1.47 million	
Riverine Flood	Chipursan	**Damages:** Road damaged at various points **Cost:** 12 million			
Riverine Flood	Shimshal	**Damages:** Road damaged at various points **Cost:** 24.48 million			

Source: *Hunza District Disaster Management Authority (DDMA 2022).*

The table 4 provides a detailed breakdown of flood damages in Hunza District during July 2022, categorizing the events by type (flash flood or riverine flood), location, and the extent of damage incurred across different infrastructure elements such as roads, bridges, irrigation channels, and water supply lines. On July 2, 2022, Gulmit and Xuchar Nallah experienced a flash flood resulting in significant damages. The approach road sustained 800 feet of damage,

amounting to a cost of 1.28 million, while two wooden truss bridges were damaged, incurring costs of 3.8 million. Additionally, five irrigation channels were affected, with a total cost of repair estimated at 1.93 million. Similarly, Sost Nallah witnessed damages to four irrigation channels, totaling 3.2 million in repair costs.

Later in the month, on July 25, a riverine flood hit ZoodKhun Nallah, causing damages to infrastructure. This included 200 feet of approach road and a protective wall, alongside one wooden truss bridge and one footbridge. The repair costs for the bridge structures amounted to 19.45 million. Furthermore, one irrigation pipeline and nine water channels were damaged, with repair costs reaching 2.9 million. Additionally, a drinking water supply line incurred damages amounting to 0.3 million.

Subsequent flash floods on July 23 and 26 affected Misgar Nallah and Ultar Nallah, respectively. The Misgar Road suffered damage due to the former, while five water channels were damaged during the latter, requiring repairs totaling 2.89 million. Riverine floods on July 26 also impacted Khyber, resulting in damages to one water channel, with repair costs of 1.47 million. Moreover, Chipursan and Shimshal experienced road damage at various points due to riverine floods, incurring costs of 12 million and 24.48 million, respectively.

It is devastating to see the recurring impact of natural disasters on various localities between 1830 and 2023. The timeline shows the vulnerability of these areas to climate-induced disasters such as GLOFs, mudslides, rockfalls, and flash floods. The loss of lives, infrastructure, agricultural lands, and livestock underscores the need for robust disaster preparedness and mitigation measures in these regions. The timeline shows that the frequency and intensity of natural disasters remained alarming, affecting the livelihoods of many communities.

2.4 Conclusion

The historical evidence around climate change and climate-induced disasters highlights the importance of taking proactive measures to mitigate risks and adapt to changing conditions. It is important to integrate resilience-building measures into disaster risk management and climate change adaptation strategies to enhance communities' ability to withstand and recover from adverse events.

Community-based approaches to climate change adaptation and disaster risk reduction are critical for building resilience, particularly for vulnerable communities. Global initiatives such as the Paris Agreement and frameworks like the UAE Framework for Global Climate Resilience emphasize the significance of adaptation and resilience-building on a broader scale. However, challenges persist, including the need to adapt existing frameworks to diverse contexts, bridging knowledge and capacity gaps among stakeholders, and strengthening local government support for effective disaster management.

In Pakistan, community-based disaster risk management (CBDRM) has not received sufficient attention, particularly in Gilgit-Baltistan (GB). The Disaster Management

Authority (GB-DMA) should lead the development and implementation of a standardized CBDRM program, drawing on insights from existing models and adapting them to address the specific hazards faced in each area. Empowering “District Disaster Management Authorities (DDMAs)” and “Disaster Management Committees (DMCs)” with the responsibility of managing and implementing CBDRM activities is necessary. It's also essential to recognize and incorporate indigenous knowledge and climate adaptation strategies into CBDRM initiatives for more resilient and adaptive communities. Establishing a robust administrative structure with active participation from the “National Disaster Management Authority (NDMA)”, GB-DMA, DDMAs, and DMCs is necessary for the effective management of CBDRM activities at the local level over the long term. There is a need to establish a dedicated DDMA at the district level.

The preservation of indigenous knowledge and climate change adaptation strategies is essential for effective climate change adaptation and disaster risk reduction. However, these valuable strategies are not well-documented and are at risk of being lost. It is important to integrate these approaches into the broader disaster risk reduction framework to achieve successful “Community-Based Disaster Risk Management (CBDRM)”.

Chapter 3

3 Methodology

The study employed a hybrid research approach, incorporating qualitative methodology complemented by the integration of "Participatory Action Research (PAR)" and "Community-Based Participatory Research (CBPR)" methodologies.

3.1.1 Qualitative Research Approach

The research employed qualitative data collection methods, including desk and document reviews, field observations, and interviews with a diverse range of stakeholders such as government officials, private sector representatives, NGOs, INGOs, donor institutions, community-based organizations, journalists, and academia. This qualitative data captured various aspects of community perceptions and experiences related to climate change impacts, local knowledge and practices, community attitudes and beliefs, governance insights, barriers and challenges, community engagement, adaptation efforts, and future aspirations. The data offers a holistic understanding of climate change adaptation and disaster risk reduction efforts in the Hunza district.

Qualitative research is valuable in exploring the complexities of community approaches to climate change adaptation and disaster risk reduction, providing rich, contextualized insights that inform the development of tailored interventions (Amaratunga, Baldry, Sarshar, & Newton, 2002). In the context of building resilience, this approach helps to uncover underlying factors such as cultural beliefs, social norms, and power dynamics that influence community resilience. It also sheds light on the strengths and weaknesses of current strategies, offering critical insights for enhancing adaptation measures (Carmen et al., 2022).

3.2 Participatory Action Research (PAR) and Community-Based Participatory Research CBPR

Community-Based Participatory Research (CBPR) is a field research method that actively involves the community throughout the research process. Defined by Minkler and Wallerstein (2008), it emphasizes respectful community engagement, integrating research, education, and action to promote change (Wilson, 2019). CBPR methodology, as applied in a study by Trung (2016), focuses on community resilience and disaster risk reduction, especially in coastal communities in Central Vietnam. Along with Participatory Action Research (PAR), CBPR collects diverse data through participatory mapping, focus group discussions, surveys, case studies, and policy analysis, ensuring the study reflects the community's priorities and helps them build resilience to climate change.

The core principles of CBPR and PAR—participation, action, and community involvement—focus on collaboration, coalition-building, and iterative planning. Researchers using these methodologies often integrate qualitative fieldwork, indigenous approaches, and facilitation techniques to create democratic, equitable, and empowering projects (Huffman, 2017). These methods enhance inclusivity by amplifying the voices of marginalized communities and

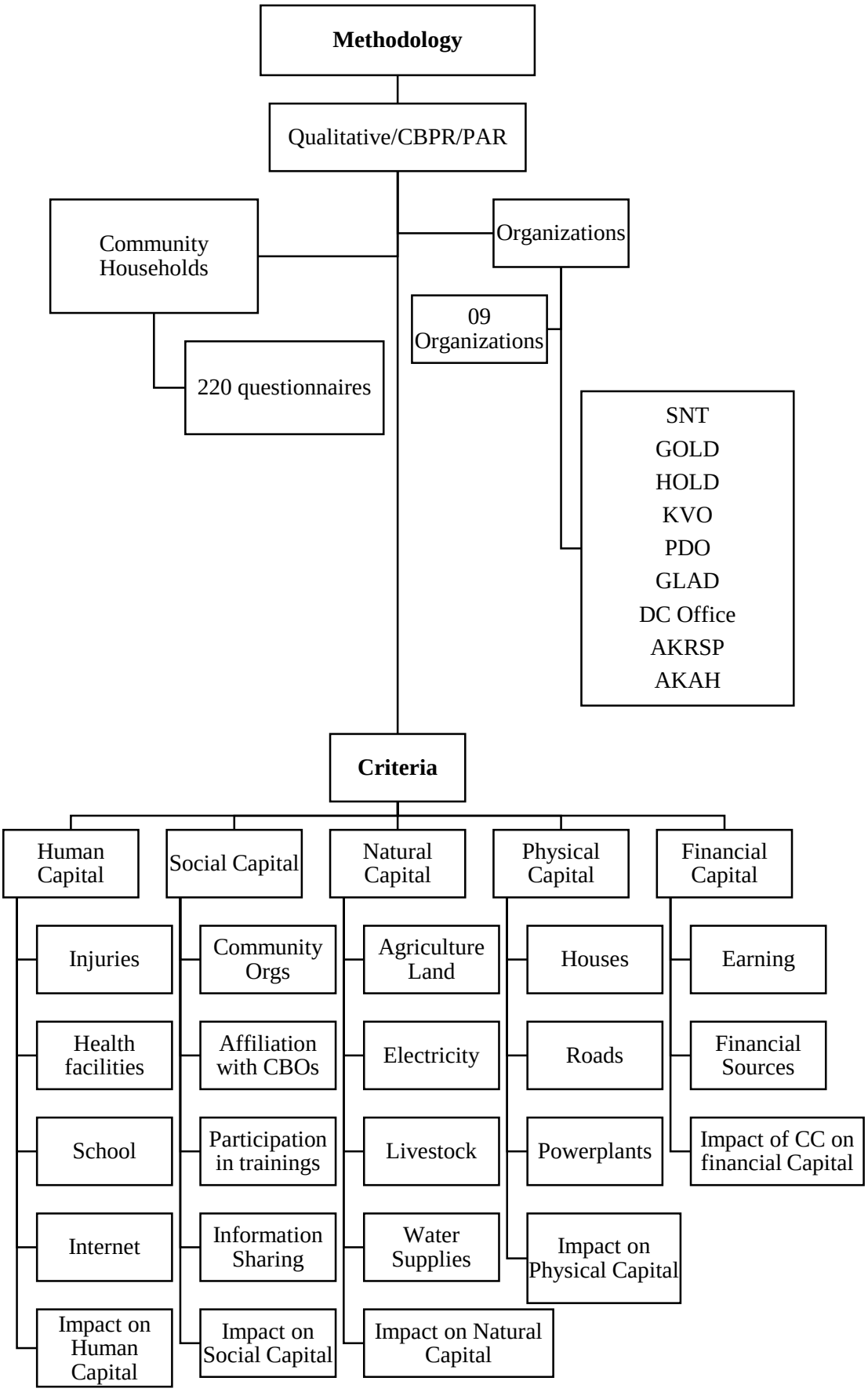
ensuring research findings are relevant and beneficial to their context (Wilson, 2019; Cornish et al., 2023).

For the study, a tailored questionnaire was developed for community-based organizations, addressing their perceptions of climate change and indigenous practices. By promoting collaboration between researchers and communities, CBPR and PAR lead to more effective interventions and policies that tackle social issues and improve public health outcomes (Tapp et al., 2013).

3.2.1 Stakeholders Identification

The Snowball Sampling Technique was applied in this study to identify the relevant stakeholders (Govt., NGOs, and INGOs). The snowball sampling method helps identify and determine the key informants, suited to the needs of the research through existing networks (Dwirahmadi, 2015). Based on these criteria, a total of 09 key stakeholders from NGOs, INGOs, and CSOs were identified, and 220 community households were selected for the survey.

Figure 5: Methodological Framework



3.2.2 Criteria of Community Resilience Evaluation

The Five Capitals Framework provides a comprehensive model for evaluating community resilience by identifying key resources—human, social, natural, physical, and financial capital—that contribute to overall well-being and adaptability in the face of climate change and disasters (Kais & Islam, 2016). Human capital encompasses skills, health, education, and leadership within a community, playing a fundamental role in sustaining livelihoods and maximizing the benefits of other resources. It directly influences the capacity of the workforce and their ability to adapt to challenges (Flores et al., 2020). Social capital refers to networks, relationships, and institutional connections that individuals rely on to achieve their livelihood goals. These connections, supported by government bodies, cooperatives, and NGOs, are essential for effective livelihood operations (Torres Vitolas, 2011). Natural capital consists of resources such as land, water, forests, and biodiversity, which are critical for the daily sustenance of rural communities. Climate change has a direct impact on these resources, and changes to the natural environment can significantly affect the resilience of communities reliant on them (Natarajan et al., 2022).

Physical capital, including infrastructure and essential services like transportation, water supply, and safe buildings, plays an important role in reducing vulnerability to disasters and supporting livelihoods. Well-designed infrastructure can withstand natural hazards and enhance community resilience during crises (Serrat, 2017). Finally, financial capital refers to monetary resources and income streams that enable communities to invest in disaster preparedness, infrastructure development, and recovery efforts. Financial capital is essential for funding resilience-building initiatives and promoting long-term sustainability (Evangelopoulos & Repousis, 2024).

The Five Capitals Framework emphasizes the significance of preserving all types of capital to promote sustainable development and build resilience against climate-related risks. Each form of capital is interlinked, and neglecting any one of them can have adverse effects on the environment, society, and the economy. By acknowledging and utilizing these diverse forms of capital, communities can improve their capacity to endure and bounce back from the effects of climate change and disasters.

3.3 Ethical Considerations

Before administering the questionnaires and conducting interviews, I obtained informed consent from all respondents, including community members, government officials, civil society representatives, and representatives from international and non-governmental organizations (I/NGOs). Additionally, the final report will be shared with the community and relevant stakeholders, enabling them to benefit from the evidence-based recommendations for strengthening resilience to climate change and disasters in development projects.

Chapter 4

4 Results and Discussions

4.1 Responses of Households in Hunza District

4.1.1 Profile of Respondents

The study aims to assess the impacts of climate change in the Hunza district and examine how the local community adapts to these changes and reduces disaster risks. The research specifically focuses on identifying changes in various forms of capital—Human, Social, Natural, Physical, and Financial—among the respondents.

The primary participants in this study were individuals aged 30 and above, both male and female, representing key demographics in the community. The survey involved a total of 09 key stakeholders from NGOs, INGOs, and Civil Society Organizations (CSOs), alongside 220 community households. During the household interviews, respondents provided answers collaboratively, with family members participating in the discussions. This approach ensured a comprehensive understanding of the community's perspectives on resilience, adaptation, and disaster risk reduction in the face of climate change.

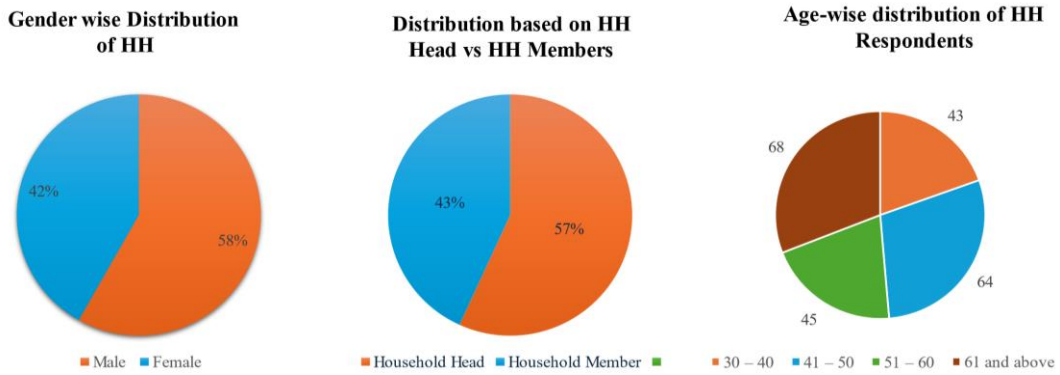


Figure 6: Distribution of respondents – Gender/Household Heads/Members

4.1.1.1 Distribution of Respondents: Gender, Household Head vs. Household Members and Age

Figure 6 illustrates the distribution of respondents based on gender, comparing household heads to household members, and grouped into four distinct age categories. Among them, 43 respondents accounting for 20%, were aged between 30 and 40 years. A larger segment, consisting of 64 respondents or 29%, fell within the 41 to 50 years age range. The 51 to 60 years age group included 45 respondents, making up 20% of the total. The highest frequency was observed in the 61 and above age group, with 68 respondents comprising 31% of the total sample. Altogether, these age groups sum up to 220 respondents, representing the entire 100% of the sample. In terms of gender distribution, males formed the majority, making up 58% of the total respondents, which equates to 128 male participants. To ensure inclusivity

and avoid gender bias, women were also included in the study, representing 42% of the total respondents, with 92 female participants.

Regarding household roles, the majority of respondents were household heads, with 125 individuals, or 57% of the total. The remaining 43% consisted of 95 respondents who were household members. This household distribution, like the age and gender breakdowns, totaled 220 respondents, reflecting the roles within the sampled population.

4.1.1.2 Education Status of Household Head and Household Members

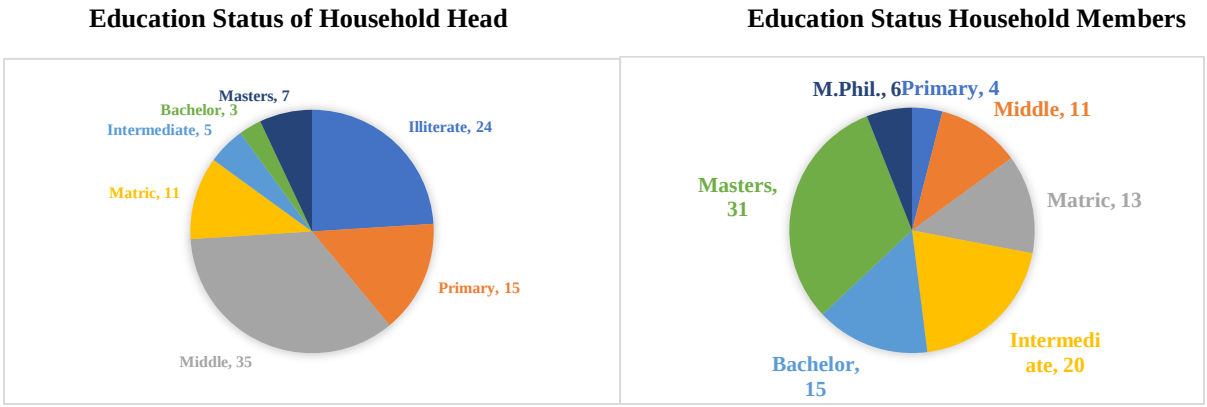


Figure 7: Education status of Head HH and HH Members

Figure 7 presents the frequency distribution of the educational status of both household heads and household members. Among the 125 household heads surveyed, 35 reported having completed education up to the middle school level, while 24 indicated they were illiterate. Additionally, 15 household heads had completed primary education. Smaller percentages of respondents reported having completed education up to the matric level, intermediate level, bachelor's degree, and master's degree, with the numbers being 11, 5, 3, and 7 respectively.

In contrast, the educational status of household members reveals a higher level of attainment. The largest percentage of respondents, 31, reported having a household member with a master's degree, followed by those with intermediate-level education at 20 and matric-level education at 13. Smaller proportions of respondents noted household members with education up to the bachelor's degree at 15, primary level at 4, and M.Phil. level at 6. This distribution indicates that household members tend to have a relatively higher level of educational attainment compared to household heads, with a significant proportion achieving education up to the master's degree level.

4.1.1.3 Sources of Income (Per Annum)

The community relies on various income streams like farming, tourism, raising animals, running businesses, providing services, and working both skilled and unskilled jobs. Additionally, locals have access to different financial services that can enhance their financial well-being. This means that their income, derived from agriculture, animal husbandry,

retirement funds, money sent from family members abroad, entrepreneurial ventures, and employment in both public and private sectors, is influenced by these factors and their access to credit markets.

In the Hunza district, agriculture serves as a vital seasonal source of income due to the region's unique climatic and geographical conditions. The harsh weather, with long, cold winters and relatively short summers, limits the growing season to just once a year. Despite these challenges, the resilient people of Hunza managed to cultivate key crops such as potatoes, vegetables, and wheat. These crops are primarily grown for subsistence, ensuring that families have enough food to last through the year. The rugged terrain and high altitude of the region further influence agricultural practices, making it essential for farmers to optimize the brief growing season. By carefully timing their planting and harvesting activities, the residents of Hunza sustain their livelihoods and preserve their agricultural heritage despite the environmental constraints they face.

Table 5: Status of Income of Respondents (Per Year)

Responses	**Groups**	**Frequency**	**%**
Income (Per Year)	100,000 – 500,000	87	40
	500,001 – 100,0000	76	35
	100,0001 – 1500,000	48	22
	1500,001 and above	9	40
	Total	**220**	**100**

Table 6 presents an overview of the income status of respondents per year, categorized into different income brackets. The data reveals that the majority of respondents fall within the income range of one lac to 5 lac per year, with 40% falling into this category. Following closely, 35% of respondents have an income ranging from 5 to 10 lac per year. Additionally, 22% of respondents fall into the income bracket of 10 to 15 lac per year, and 4%, have an income of 15 lacs and above per year.

Table 6: Sources of Income

Responses	Groups	Frequency	%
Earning family members	100,000 – 500,000	105	48
	500,001 – 100,0000	91	41
	100,0001 – 1500,000	13	6
	1500,001 and above	11	5
	Total	**220**	**100**
	Total	**51**	**23**
Mode of Saving	Banks	109	50
	Microcredit banks	67	30
	Total	**176**	**80**
Financial help from stakeholders	Yes	12	5
	No	208	95
	Total	**220**	**100**

Table 7 presents a comprehensive frequency distribution of sources of income among economically active members in the surveyed population, along with their corresponding percentages. Among economically active members, the majority, constituting 48%, reported an income falling within the range of One lac to 5 lac rupees annually, followed by 41% with incomes ranging from 5 lacs to 10 lac rupees. There were also respondents reporting higher income brackets, with 10% earning between 10 lac to 15 lac rupees, and 5% earning above 15 lac rupees annually. The majority of respondents, comprising 80%, reported saving their money in banks, while a smaller proportion utilized microcredit banks. Lastly, when asked about financial assistance from stakeholders, only a minority of respondents, accounting for 5%, reported receiving such help from the government.

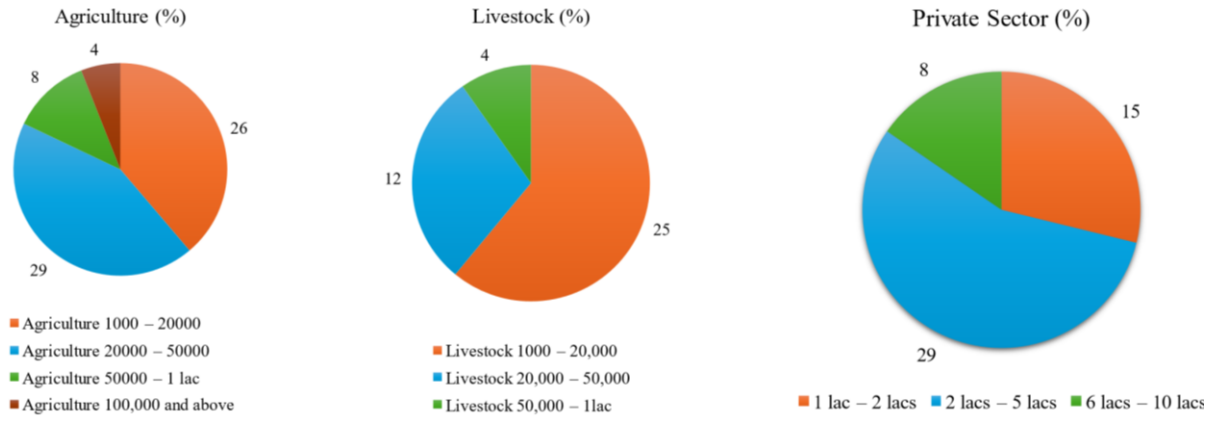


Figure 8: Income from Agriculture, Livestock and Private Sector

Regarding specific sources of income, agriculture emerged as a significant contributor, with 67% of respondents reporting income from this sector. Within agriculture, varying income ranges were reported, with 26% earning between 1,000 to 20,000 rupees, 27% between 20,000 to 50,000 rupees, and smaller proportions earning higher amounts as shown in Figure 8. Livestock plays an important role as a source of income in Hunza, where people rely heavily on agriculture and livestock rearing for economic activities. Livestock farming in Hunza is a traditional practice deeply embedded in the cultural and economic fabric of the region. The types of livestock commonly reared in Hunza include sheep, goats, cattle, and poultry. People raise sheep, goats, cows, and yaks for local consumption and for selling in the market.

Livestock farming was another notable income source, contributing to 41% of respondents' incomes. The Gilgit-Baltistan Climate Change Strategy and Action Plan – 2017 indicates that the rise in temperature in the northern alpine zone exceeds that in the plains. This temperature increase has pronounced impacts on the ecosystem at and above 3,500 meters. These impacts include the upward migration of the snowline, reduced vegetation, relocation of water sources, and an uptick in natural disasters, particularly affecting these high-altitude areas. Income from the private sector was reported by 53% of respondents, with the majority falling within the income range of 2 to 5 lakh rupees annually.

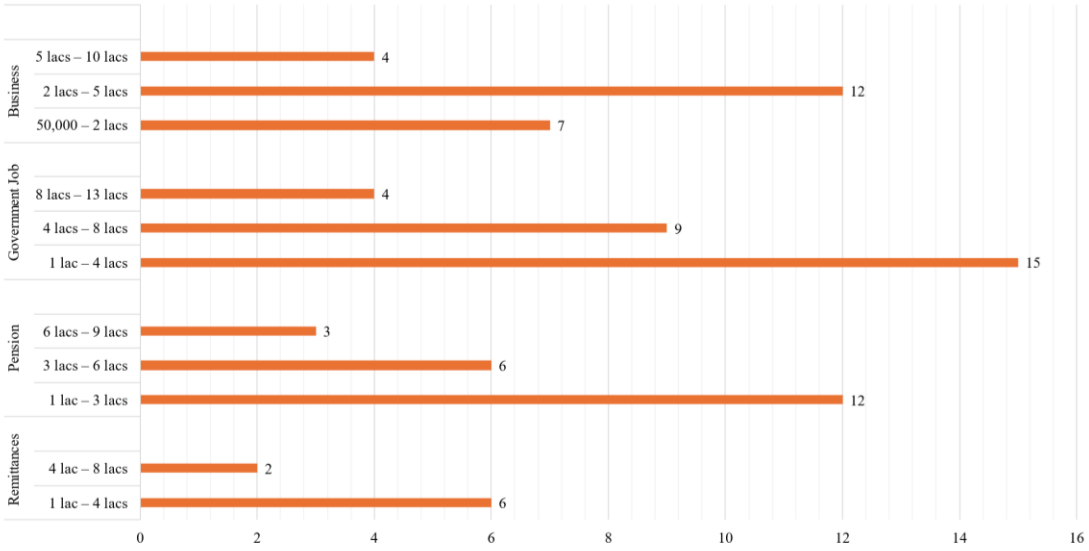


Figure 9: Income from Remittance, Pension, Government Jobs and Business (%)

Figure 9 provides an overview of income sources derived from remittances, pensions, and government jobs. For remittances, the most common income range is between 1 lac and 4 lacs, with 14 respondents, representing 6% of the total. A smaller group of 4 respondents, or 2%, falls within the income range of 4 lacs to 8 lacs, bringing the total number of respondents in this category to 18. In terms of pension income, 27 respondents earn between 1 lac and 3 lacs, which accounts for 12% of the overall total. Additionally, 13 respondents receive between 3 lacs and 6 lacs, and 6 respondents earn between 6 lacs and 9 lacs, resulting in a total of 46 respondents in this category. For government jobs, the primary income range remains between 1 lac and 4 lacs, representing 15% of the respondents, or 32 individuals. Following this, 19 respondents earn between 4 lacs and 8 lacs, and 8 respondents have incomes ranging from 8 lacs to 13 lacs, making a total of 59 respondents in this category. In the category of business income, 27 respondents earn between 2 lacs and 5 lacs, while 15 respondents earn between 50,000 and 2 lacs, and 9 respondents earn between 5 lacs and 10 lacs. This brings the total number of respondents in the business category to 51.

Housing Characteristics in Hunza

Firstly, concerning house structure types, the majority of respondents (82%) reported residing in "Pakka" (permanent) houses, while a smaller proportion (18%) reported living in "Kaccha" (temporary) structures as shown in Figure 10. This indicates that the majority of households have relatively stable and durable housing, which may provide better resilience against natural disasters.

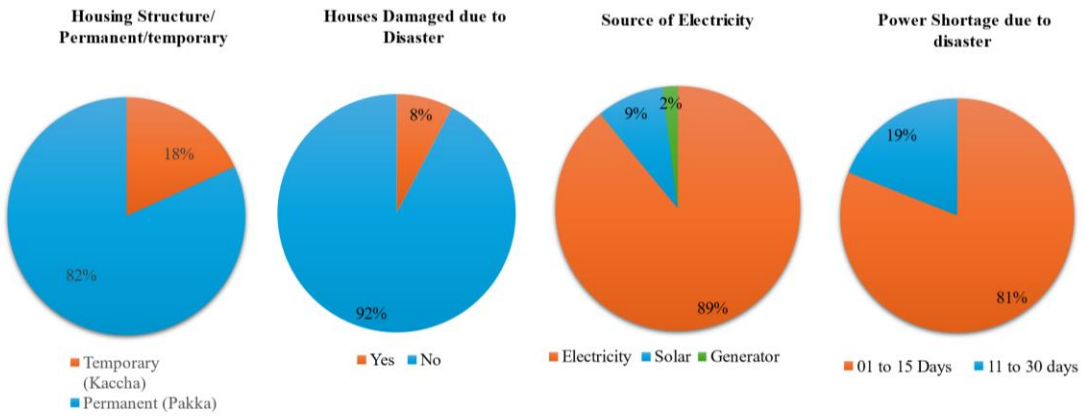


Figure 10: Housing structures, damages, and energy status in Hunza

Most of the Pakka houses are built with stone, concrete, and wood, and the Kaccha houses are made of stones, mud, and wood. The majority of the Pakka houses lack the use of iron rods in construction. Cement is used for plastering both sides of the walls and the roofs are prepared in a traditional manner - wooden. In Shimshal Valley, it was reported that using cement inside the walls of the houses causes watering in winter, and cracks also appear. The concrete walls also become intensely cold during winter while the mud and kaccha houses remain relatively warmer.

A small percentage of respondents, 8%, reported damage to their houses due to natural disasters such as floods, Glacial Lake Outburst Floods, rain, snowfall, or wind. Among those whose homes were affected, an additional 8% indicated they incurred financial costs related to the damage. The majority of these respondents reported expenses ranging from 100,000 to 1,000,000 PKR, highlighting the financial strain on affected households and the potential economic challenges associated with recovery and reconstruction efforts.

In terms of road conditions, all survey participants, 100%, encountered road damage. This highlights the susceptibility of transportation infrastructure to environmental risks and the difficulties in reaching essential services and resources due to road interruptions.

With regards to access to fundamental amenities, every respondent, 100%, stated that they have access to electricity as an energy source. Among them, 89% utilize electricity, while smaller proportions depend on solar panels at 9% or generators at 2%, as depicted in Figure 10. Additionally, 81 percent of participants noted energy shortages caused by disruptions in water channels. The majority experienced these shortages for 1 to 15 days, while 19% faced longer interruptions lasting between 11 and 30 days. This demonstrates the interconnectedness of water infrastructure and energy provision, as disturbances in water channels directly impact the availability of electricity for the surveyed population.

4.1.1.4 Distance and access of respondents to Basic Facilities/ electricity/ Main Road, Market/ Hospital/Schools/College/University in Hunza district

Figure 11 shows the the accessibility of basic facilities such as the main road, market, hospital, and schools/colleges/universities for residents in the Hunza district. According to

the data collected, a significant portion of respondents, accounting for 80%, reported residing within 1 to 10 kilometers of a concrete road.

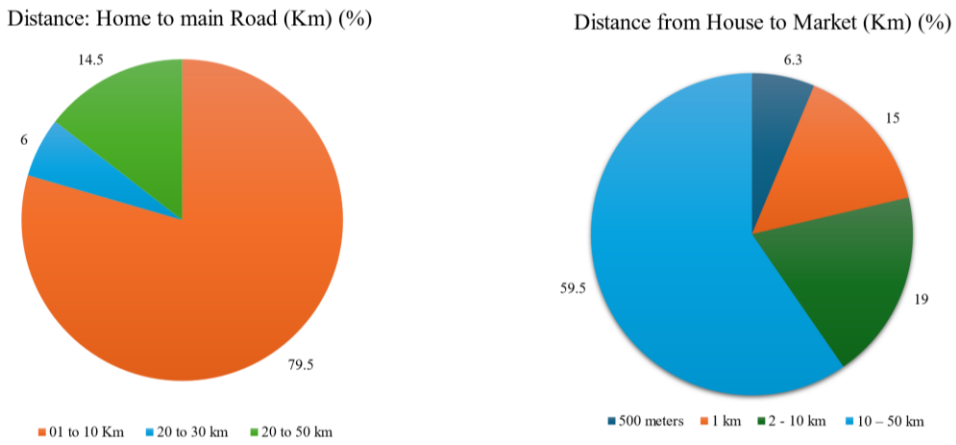


Figure 11: Distance from home to main Road and Market

Additionally, 15% of the total, lived within 1 kilometer of a market, while a substantial majority, constituting 60%, were situated within a range of 10 to 50 kilometers from the nearest market. In terms of healthcare accessibility, 46% of respondents had a hospital within 1 to 10 kilometers of their residence, with 42% living within 30 to 50 kilometers of a hospital.

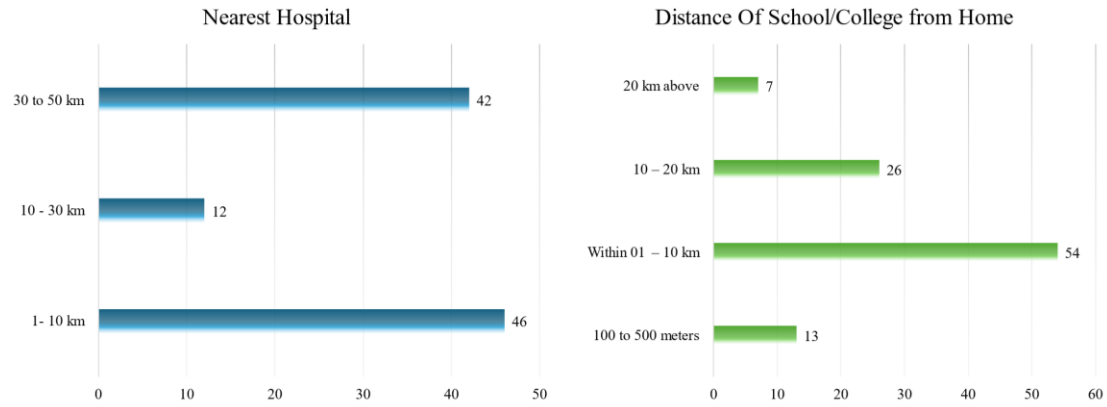


Figure 12: Distance from home to hospital and Distance from Home to School/College

Regarding educational institutions, the majority of respondents, 53.6%, had schools or colleges within 1 to 10 kilometers, while 26.3% were within a range of 10 to 20 kilometers.

4.1.1.5 Modes of transportation used by respondents

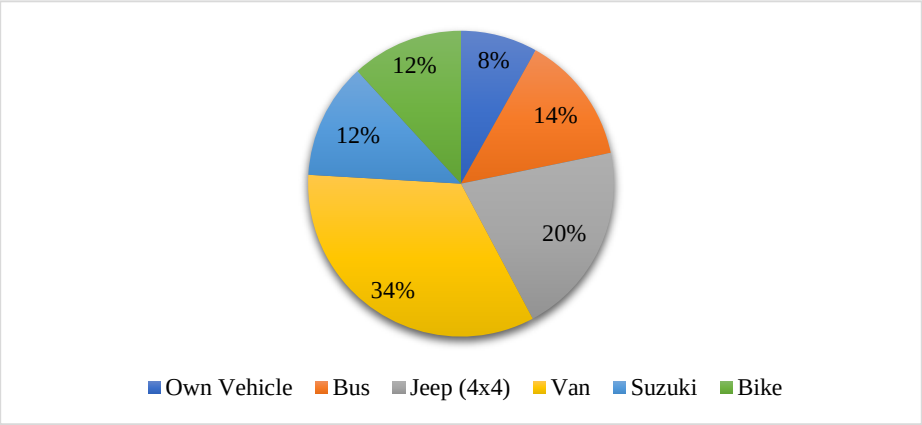


Figure 13: Mode of Transportation

Figure 13 illustrates the various modes of transportation utilized by respondents. The most popular mode is the van, used by 34% of participants. Following vans, the Jeep (4x4) is the second most commonly used mode of transportation, with 20% of respondents indicating its use. This suggests that a significant portion of respondents opt for Jeeps, likely due to their residence in remote areas characterized by rough terrain. Buses are the next most prevalent mode of transportation, utilized by 14% of respondents. Suzuki vehicles and bikes are each used by 12% of participants, while 8% of respondents report using their own vehicles for transportation.

Many of the villages in the region are connected through link roads to the Karakorum Highway (KKH). However, some communities such as Misgar, Chuperson, and Shimshal are difficult to reach during emergencies. These areas also lack basic health necessities, with the ten-bed hospital in Shimshal village remaining non-functional for the last two to three years. As a result, community members have to take patients to Hunza and Gilgit, which are more than 50 km away, even for minor treatments. Respondents from Gulmit also reported issues with basic facilities and electricity at their local hospital. Given these circumstances, hospitals and government dispensaries must be established and maintained in the villages to provide basic health facilities to the people.

4.1.2 Impact of Climate-Induced Disasters on Human Capital

Climate-induced disasters pose a significant threat to human capital by disrupting health, nutrition, education, and employment. According to a study by Rashid, M.U., et al. (2023), the health sector in Gilgit-Baltistan (GB) faces significant challenges. These include a severe shortage of paramedical staff, making it difficult to provide timely and effective healthcare services. Many hospitals are located far from communities, leading to accessibility issues, particularly during emergencies. The region also lacks the essential infrastructure and resources necessary for comprehensive medical care. Inadequate healthcare facilities and a notable deficit in surgical equipment further limit local healthcare capabilities, often requiring patients to travel long distances for treatment. The study also identifies five districts with a

higher prevalence of health issues, such as cardiac diseases, respiratory ailments, gastric disorders, high blood pressure, diabetes, visual impairments, and skin allergies.

Addressing these challenges requires comprehensive strategies, including investing in resilient infrastructure, improving healthcare and education systems, and supporting sustainable agricultural practices. By taking proactive measures, communities can better withstand the impacts of climate change.

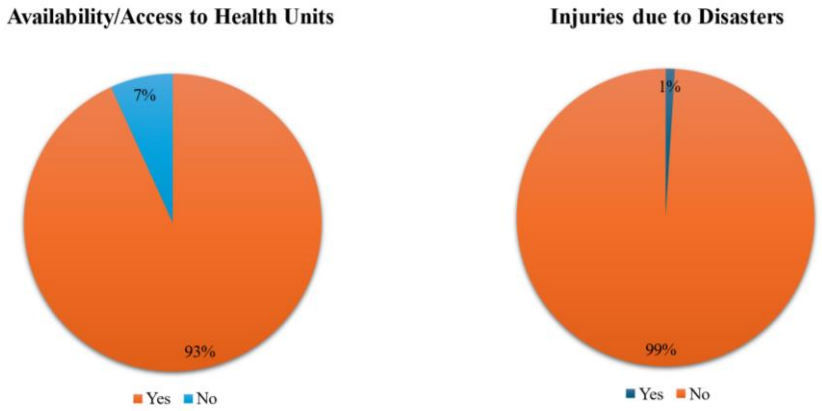


Figure 14: Availability/Access to Health Units and injuries due to disasters

Figure 14 shows that only 1% of respondents reported experiencing injuries due to climate-induced disasters such as GLOFs and landslides. Although this percentage is small, the impact of such injuries on affected individuals and communities can still be significant, underscoring the need for preparedness and effective response measures. In terms of access to health units, a large majority—93% of respondents—reported having access to healthcare facilities. This widespread access is crucial for addressing health needs, providing medical assistance during emergencies, and supporting the overall well-being of the community. Respondents reported a lack of basic medicines and health facilities in the region, including an insufficient number of medical staff. Private hospitals, though available, are expensive, and there is also a shortage of medical labs, limiting access to essential healthcare services.

The establishment of the KADO Internet Service (KIS) marked a significant milestone for the communities of Hunza and Nagar, fulfilling their longstanding aspiration to integrate into the global information society. KIS began providing internet services in these valleys and remained the sole provider from 2004 to 2008. Despite the introduction of subsidized internet services by SCO in 2008, KIS continued to maintain a strong demand due to its superior service quality. The project also offered substantial benefits such as fifty percent discounts on tariffs for educational institutions, and nominal charges for students of Allama Iqbal Open University and Virtual University, thereby enhancing access to educational resources in the region (KADO 2023).

Table 7: Access to Educational Facilities, Vocational Training Centres and Internet

Attribute of Respondents	**Group**	**Frequency**	**%**
Educational Infrastructure affected	Yes	24	11
	No	196	89
	Total	**220**	**100**
Missed school or college due to disasters	Yes	28	13
	No	192	87
	Total	220	100
No. of days missed school	01 to 15 days	18	8
	16 to 30 days	10	5
	Total	**28**	**13**
Internet Facilities Availability	Yes	95	43
	No	125	57
	Total	**220**	**100**
Available technical and vocational	Yes	52	24
	No	168	76
	Total	**220**	**100**

Table 8 provides the details of the distribution of educational infrastructure, internet facilities, and the availability of vocational centers, focusing on the impact of natural disasters, internet access, and access to technical education within the community.

Firstly, regarding educational infrastructure affected by floods, Glacial Lake Outburst Floods (GLOFs), or rain, a small proportion of respondents 11% reported that educational infrastructure in their area had been affected by these natural disasters. This indicates the vulnerability of educational facilities to environmental hazards, potentially leading to disruptions in learning opportunities for students.

Secondly, concerning missed school or college due to flood, GLOF, or landslide, a slightly larger proportion of respondents 13% reported missing school or college as a result of these

disasters. Additionally, among those who missed school or college, the majority 8% reported missing 1 to 15 days, while a smaller percentage 5% reported missing 16 to 30 days.

Thirdly, regarding internet facilities availability, the data shows that 43% of respondents reported having access to internet facilities, while 57% reported not having such access. This indicates a significant portion of the surveyed population lacking access to the internet, which may affect their ability to access online education resources, information, and communication platforms.

Lastly, concerning the availability of technical and vocational centers at the community level, a relatively smaller proportion of respondents 24% reported the presence of such centers in their community. This suggests limited access to technical education and vocational training opportunities within the surveyed population, which may impact their ability to acquire specialized skills and participate in the workforce.

The study (Pirzada, G.et al., 2022) states that despite growing acknowledgment and discussion surrounding Art & Design Education in the Gilgit-Baltistan province, educational research has inadequately addressed its contribution to regional development by engaging in enhancement initiatives. While these educational opportunities offer significant benefits such as income generation and job creation for many households, a segment of poor and marginalized individuals still lacks adequate support.

Addressing the challenges of improving health, nutrition, education, and employment in Hunza district requires a strategic approach. This approach should include safeguarding educational infrastructure, minimizing learning disruptions, improving digital access, and enhancing vocational training opportunities. It is important to upgrade infrastructure to make it more resilient to natural disasters such as floods and GLOFs. Most of the areas in Hunza are prone to disasters therefore the government and community buildings should be build by carrying out their environmental impact assessment reports. Additionally, there is need of expanding internet access in remote areas. Establishing community-based technical and vocational education centers tailored to local economic needs will empower individuals with relevant skills for the workforce and contribute to regional development and resilience in Hunza district.

4.1.3 Impact of Climate-Induced Disasters on Social Capital

Social resources refer to valuable communication means that enhance people's confidence and ability to work together effectively. These connections extend to larger entities like government bodies, international non-governmental organizations (INGOs), and non-governmental organizations (NGOs). During emergencies, individuals and communities rely on these social connections as an asset to both prepare for and address crises.

Table 8: Distribution of Social Capital

Responses	Groups	Frequency	%
Available Community-based organizations?	Yes	220	100
	No	0	0
Affiliation with Community-Based Organizations	Yes	167	76
	No	53	24
	Total	**220**	**100**
Have the community members participated in DRR/Climate-related trainings organized by government, NGOs & INGOs?	Yes	142	65
	No	78	35
	Total		**100**
Disaster-related information sharing at the community level?	Yes	220	100
	No	0	0
	Total	**220**	**100**
Available resources at the community level during emergency response?	Yes	172	78
	No	49	22
	Total	**220**	**100**

Table 9 presents the distribution of social capital within the surveyed community, focusing on community participation in disaster risk reduction (DRR) and climate-related training, information-sharing practices, and available resources during emergency response.

Firstly, concerning the availability of community-based organizations, all respondents (100%) reported the presence of such organizations within their community. This indicates a strong foundation of social infrastructure and collective action within the community, which can serve as valuable assets in addressing various social and environmental challenges. Many of the villages in Hunza Valley have established community-based organizations. For example, the community of Shimshal has established Shimshal Nature Trust (SNT) to manage their natural resources, and health issues and address their educational needs. Similarly, the Khunjerab Village Organization (KVO), Gulmit Organization for Local

Development (GOLD), and Hussaini Organization for Local Development (HOLD) are a few examples of CBOs in Hunza. These organizations work on various developmental projects at village levels. Secondly, regarding affiliation with community-based organizations, a significant majority of respondents 71% reported being affiliated with CBOs. This highlights the active engagement and participation of community members in collective efforts aimed at addressing community needs and challenges.

Regarding participation in DRR and climate-related training organized by the government, NGOs, and INGOs, a considerable proportion of respondents 65% reported participating in such training. This suggests a proactive approach to capacity-building and preparedness among community members, which can enhance resilience to natural disasters and climate change impacts. Most of the respondents got training from the "Aga Khan Agency for Habitat (AKAH)" in Hunza. AKAH provides training on disaster risk reduction and response at the community centers in different villages.

Fourthly, concerning disaster-related information sharing at the community level, all respondents 100% reported the practice of sharing disaster-related information within the community. This highlights the importance of communication and information exchange in facilitating effective disaster preparedness and response efforts. Most of the community members receive disaster-related information from the disaster-related departments, and community-based organizations and the community prayer halls are the major platforms for information dissemination. People also rely on TV, and SMS alerts for disaster alerts.

Lastly, regarding the availability of resources at the community level during emergency response, a significant majority of respondents 78% reported the presence of resources for emergency response within the community. This indicates the existence of local capacities and assets that can be mobilized in times of crisis, contributing to the community's resilience and ability to cope with emergencies.

4.1.4 Impact of Climate-Induced Disasters on Natural Capital

Natural resources play a vital role in the livelihoods of rural and mountainous regions, particularly those reliant on agriculture and animal husbandry. For many households in the Hunza, agricultural land has traditionally been the main source of income. Crops such as potatoes, cherries, and other fruits serve as cash crops, enabling families to support their children's education and meet their basic needs.

Gilgit-Baltistan is a region with limited arable land, as only about 2% of its vast area of 72,971 square kilometers can be used for farming. Despite this limited agricultural space, a significant majority of the population, over 80%, relies on farming to meet their daily needs. This type of farming, known as subsistence farming, focuses on growing food primarily to feed the farmer's family rather than for commercial sale. The farmers grow various types of crops such as cereals, fruits, and vegetables, and also produce fodder to feed their livestock. This practice is essential for the local economy and the livelihoods of the people, even though it might not generate a significant surplus for trade ((Shigri S., H. Khadim., 2017).

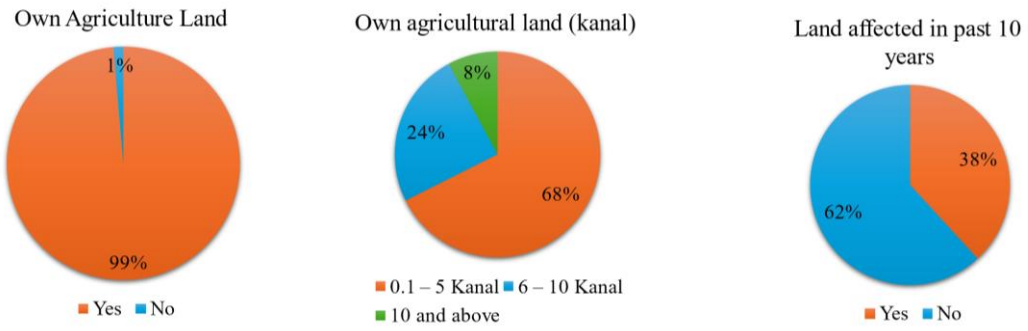


Figure 15: Land Ownership and Damage Statistics

Figure 15 shows the frequency distribution of agricultural land in the Hunza district and provides insights into land ownership, the extent of land owned, and the impact of climate change and disasters on agricultural practices. Among the respondents surveyed, a significant majority, comprising 99%, own agricultural land that they use for subsistence agriculture, highlighting the importance of agriculture in the local economy. Within this group, the distribution of land ownership reveals that a majority, representing 68%, own land ranging from 0.1 to 5 Kanals, indicating a prevalence of small to medium-sized agricultural plots. Additionally, 24% of respondents own land ranging from 6 to 10 Kanals, while 8% own land exceeding 10 Kanals, showing a diverse range of land sizes among farmers in the district.

Hunza is prone to climate change-induced disasters such as floods and GLOF. The district has faced many disastrous events such as GLOF events in Shimshal, Passu, and Hassanabad. The impact of climate change and disasters on agricultural land is also notable, with 38% of respondents reporting land affected by events like GLOFs or landslides in the past decade. Among these respondents, 33% reported land affected within the range of 0.1 to 2 Kanals, indicating a significant portion of agricultural land experiencing relatively minor impacts. However, 4% reported land affected within the range of 2.1 to 5 Kanals, and 1% reported land affected above 5.1 Kanals, highlighting the varying degrees of impact across different agricultural holdings.

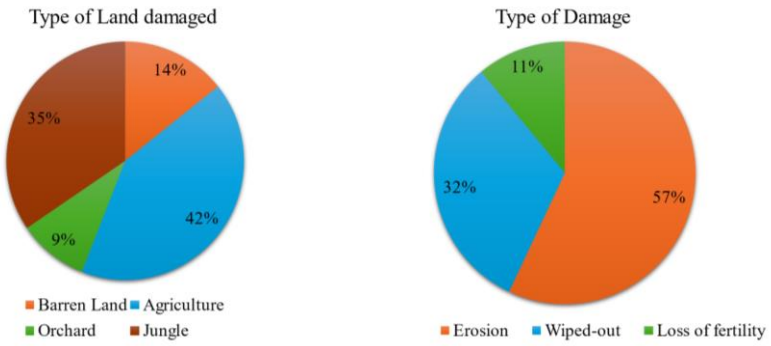


Figure 16: Category of land and damage type

The distribution of damages across different land types indicates that agriculture is the most affected category, with 42% of damages reported in this sector, emphasizing the vulnerability of agricultural land to environmental challenges as shown in Figure 16.

Furthermore, the types of damages incurred by agricultural land reflect the challenges faced by farmers in the region. Soil erosion emerges as the most prevalent type of damage, affecting 57% of agricultural land, followed by wiped-out areas 32% and loss of fertility 11%. Passu village is one of the most affected areas facing riverine erosion.

Agriculture plays a vital role in building community resilience to climate change and induced disasters. People in the Hunza district grow various crops and fruits for their use and supply some portions to the nearby markets. The far-flung areas such as Chupersan and Shimshal Valley grow and use agricultural products for their household use because of the high transportation costs.

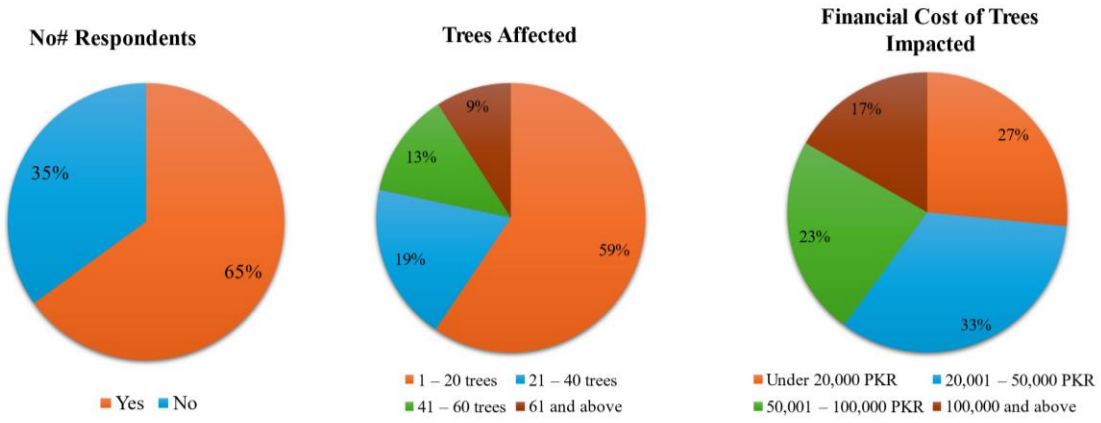


Figure 17: Impact of Disasters on trees and the total value of trees (lost) in PKR

Figure 17 shows the frequency distribution of fruit and non-fruit trees in the Hunza district, specifically focusing on the impact of floods and GLOFs on these trees. The figure presents the total number of trees and their respective values in Pakistani Rupees (PKR). Regarding the impact of GLOFs on trees, it is observed that 65% of the survey respondents reported that GLOFs had destroyed fruit and wild trees, while 35% reported no such destruction. This indicates a significant impact of natural disasters on the local vegetation.

The total number of fruit and wild trees, distribution shows that the largest proportion of respondents, which is 59%, reported owning 1 to 20 trees. The second-largest proportion of respondents, which is 19%, reported owning 21 to 40 trees. Additionally, 13% of respondents reported owning 41 to 60 trees, and 9% reported owning 61 trees and above. This suggests that there is a diverse range in the number of trees owned by respondents, with a significant proportion owning smaller quantities. Regarding the total value of trees lost in various disaster events, Figure 17 indicates that 27% of respondents reported their trees to be valued under 20,000 PKR, while 33% reported values between 20,001 to 50,000 PKR. Additionally, 23% reported values between 50,001 to 1 lac PKR, and 17% reported above 1 lac rupees.

This distribution reflects varying levels of economic significance associated with the trees owned by respondents, with a significant proportion having relatively higher-valued trees.

Households that possess larger agricultural land, orchards, and human resources typically manage more livestock than those with fewer resources. In Hunza, on average, residents maintain at least a few cattle and yaks to fulfill their household needs.

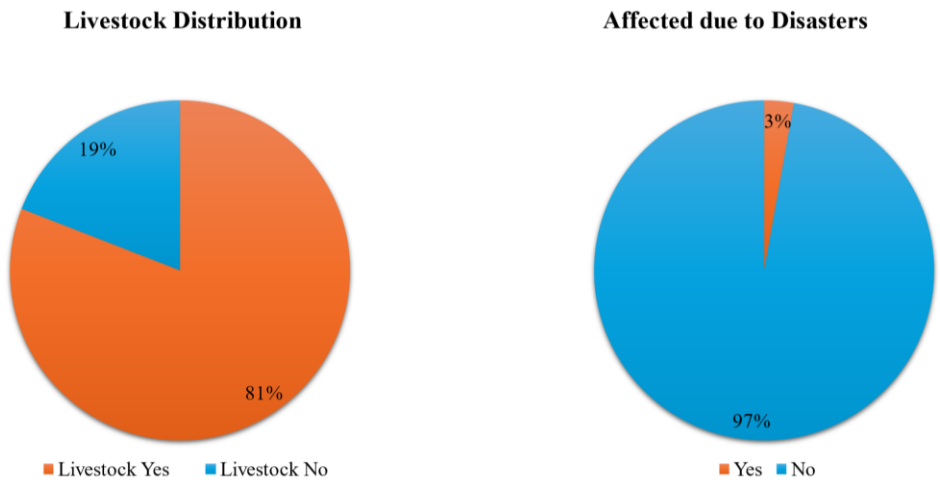


Figure 18: Distribution of livestock

Figure 18 represents the frequency distribution of livestock and pastures in the context of their susceptibility to natural disasters such as floods, Glacial Lake Outburst Floods (GLOFs), and landslides. Firstly, regarding the ownership of livestock, it's evident that the majority of respondents, comprising 81%, reported owning livestock, while 19% reported not owning any. This shows that livestock rearing is a prevalent practice among the surveyed population, playing a significant role in their livelihoods. Secondly, concerning the impact of disasters on livestock and pastures, only 3% of respondents, reported their livestock being affected by disasters such as floods, GLOFs, or landslides as shown in Figure 18. Conversely, the vast majority, comprising 97% of respondents, reported no such impact on their livestock or pastures. This indicates that the incidence of disasters directly affecting livestock is minimal among the surveyed population.

Agriculture has historically been the backbone of Gilgit-Baltistan's economy, with over 70% of the population relying on it. The agricultural sector faces significant threats from highly variable rainfall, which can lead to either droughts or floods, affecting crop yields, especially during critical stages like harvest and flowering. Livestock is also crucial, contributing 38% to the economy, with 95% of households owning livestock. However, health issues in livestock and reduced milk yields pose additional challenges (Habib, N., 2021).

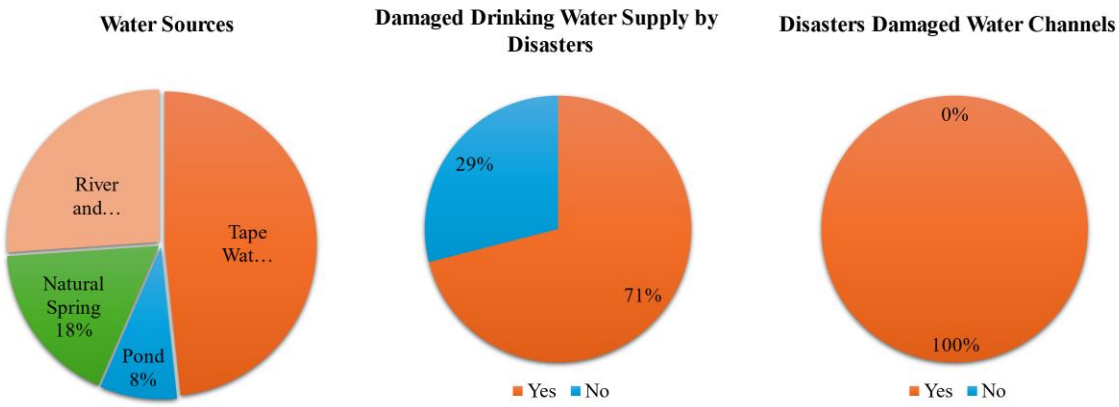


Figure 19: Water Sources, Water Channels, and Damages by disaster

Figure 19 presents the details of the availability, non-availability and access to water sources and energy shortages. Regarding sources of drinking water, the data highlights that 100% of respondents rely on tap water as their main source, but a significant number also use natural springs 36% and rivers/streams 54%, while a smaller percentage use ponds 17%. However, in some villages of the Hunza district, tap water is not available during extreme winters, and people have to fetch water from nearby streams and rivers for their household uses.

When it comes to natural disasters and their impact on water supply infrastructure, the majority of respondents 71% reported that their drinking water supply lines had been damaged by events like Glacial Lake Outburst Floods (GLOFs), floods, or landslides as shown in Figure 19. This shows that water supply infrastructure is vulnerable to natural disasters, which can lead to disruptions in access to clean drinking water for the affected population. Moreover, Figure 19 also shows that all water channels in the surveyed area were affected by floods, GLOFs, or landslides, which indicates the extensive impact of natural disasters on water distribution networks. This suggests a significant challenge in maintaining the integrity and functionality of water channels in the face of environmental hazards.

In 2008, the Ghulkin and Passu glaciers experienced five separate Glacial Lake Outburst Flood (GLOF) events, resulting in devastating consequences for the Passu village. These events caused extensive damage to infrastructure, settlements, and agricultural land, particularly impacting the village's irrigation-based agriculture. The destruction of the Passu main canal and the Murabadab canal severely disrupted the village's irrigation systems. Additionally, Passu has been grappling with persistent riverbank erosion issues since 1974, which have had a detrimental effect on agricultural land and irrigation canals. For example, in 2009, the Janabad irrigation canal and valuable land and trees were destroyed due to riverbank erosion. Similarly, in 2011, the destruction of the Lalzor, Khock, and Muradabad canals led to the erosion of 50,000 square meters of productive land (Dhakal, M.P., et al., 2021). It is necessary to consider the water-related issues of the communities before making any decision about their uses, as their survival is connected to it. Therefore, it is essential to consider water-related issues and their potential impacts on the communities before leasing nearby water areas for mining and other mega developmental projects.

4.1.5 Impact of Climate-Induced Disasters on Physical Capital

Physical capital encompasses key aspects such as the quality of housing and the availability of essential services, crucial factors particularly relevant in hazard-prone areas like those susceptible to floods, landslides, and GLOFs.

The Hunza district is facing significant challenges due to climate-induced disasters, particularly floods and GLOFs. These disasters have a profound impact on the physical capital of the region, including water and energy infrastructure, irrigation channels, and transportation systems. The traditional houses in Hunza village typically feature a central area of approximately 5.5 square meters, partitioned into six sections. The central part houses the cooking stove, known as a Bukhari, with a square opening in the roof above it for smoke ventilation and fresh air intake. The remaining space serves various purposes, including seating, sleeping, and storage. These traditional dwellings are constructed by indigenous masons, adhering to the climatic requirements of the region, and utilize mud, stones, and wood as primary building materials.

Following the completion of the Karakoram Highway (KKH), residents began migrating to cities in pursuit of educational and employment opportunities, exposing them to urban living standards. Consequently, there have been adaptations and improvements to local housing. Presently, most individuals employ cement, sand, and stone in construction, with some opting for cost-effective cement bricks. Unlike traditional structures, which typically lacked separate rooms and bathrooms for each household member, there is now a trend towards incorporating such facilities due to increased awareness of health and hygiene concerns.

Table 9: Impact on Physical Capital

Responses	Groups	Frequency	%
Financial cost of damaged houses	100,000 – 10,00000	16	8
	10,00001	1	0.45
	Total	**17**	**8.45**
Impact Power plant	Yes	62	28
Road damage	Yes	220	100

Table 10 provides insights into the financial costs of damaged houses, sources of energy, impact on power plants, and road damage experienced by respondents. In terms of financial cost, 16 respondents 8% reported damages to their houses ranging from One lac to 10 lacs units, while a single respondent 0.45% reported damages exceeding 10 lac rupees. The impact on power plants is acknowledged by 62 respondents 28%, suggesting that nearly a

third of the respondents have been affected by power plant issues. Lastly, road damage is a significant concern, as all 220 respondents 100% reported experiencing road damage. This highlights the widespread impact on infrastructure and the critical need for addressing road maintenance and repair.

The Hunza district faces significant challenges due to climate-induced disasters, especially floods and glacial lake outburst floods (GLOFs). These disasters have a profound impact on the region's physical infrastructure, including water and energy systems, irrigation channels, and transportation. A study on the effects of climate change on water resources in the Hunza district found that the geomorphology of the Hunza River is being affected, resulting in changes to both fresh and perennial water resources (Khan, K., Ashraf, C.M. and Faridi, R., 2011). Additionally, flash floods, landslides, and the subsidence of moraine areas caused by increased glacial melt have repeatedly disrupted critical irrigation infrastructure and diminished water supplies in the Hunza Valley (Dhakal, M.P., et al., 2021).

4.1.6 Impact of Climate-Induced Disasters on Financial Capital

Climate-induced disasters have a huge impact on the financial capital of Pakistan. These events disrupt economic activities, damage infrastructure, and strain public and private financial resources. The financial repercussions are multifaceted and extend across various sectors, creating both immediate and long-term economic challenges.

The 2022 flood assessment estimates that the total damages exceeded USD 15 billion, with economic losses reaching around USD 15.2 billion. The estimated cost for rehabilitation and reconstruction alone is at least USD 16.3 billion. This figure does not account for the additional investments needed beyond repairing the affected assets to help Pakistan adapt to climate change and improve the country's overall resilience to future climate-related shocks (PDNA, 2022).

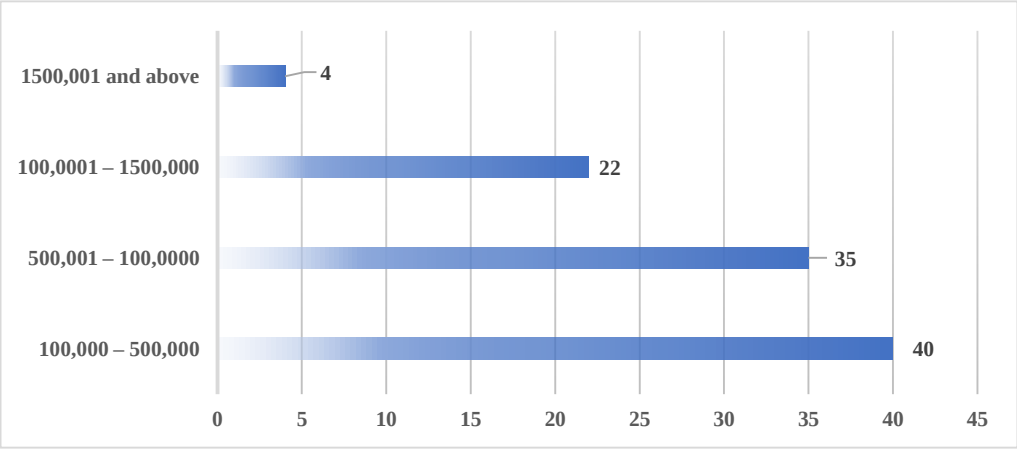


Figure 20: Impact of disasters on the income status of Respondents (Per Year)

Figure 20 provides a frequency distribution of income status per annum based on the responses gathered. Among the respondents, 40% reported an annual income falling within the range of 100,000 to 500,000 rupees, making it the most common income bracket.

Following closely, 35% reported an income ranging between 5 lakhs to 10 lac rupees annually. A smaller yet significant portion, constituting 22% of respondents, indicated an income range from 10 lac to 15 lac rupees per annum. Lastly, 4% of respondents reported an annual income of 15 lac rupees or above. This distribution of income status provides insights into the economic demographics of the surveyed population, indicating the prevalence of different income levels within the sample.

Disasters have significantly impacted the people of Hunza, affecting their livelihoods and economic stability in various ways. Natural calamities such as floods, landslides, and earthquakes have often caused extensive damage to infrastructure, agricultural lands, and local businesses, disrupting traditional sources of income. This disruption reduces household earnings and leads to economic uncertainty within the community. Furthermore, the reliance of Hunza's economy on sectors like tourism and agriculture makes it particularly susceptible to fluctuations caused by disasters, further worsening financial hardships for residents.

It is important to invest in infrastructure that can withstand disasters, along with early warning systems to minimize damage and speed up recovery post-disaster. Additionally, diversifying the local economy beyond tourism and agriculture in Hunza can create alternative sources of income, reducing reliance on vulnerable sectors. Access to financial services and insurance options can also help households prepare for and recover from economic shocks. Moreover, providing community-based disaster preparedness and response training can empower residents to actively contribute to disaster risk reduction efforts, promoting resilience at the local level.

4.2 Community Approaches to Climate Change and Induced Disasters in Hunza District of Gilgit - Baltistan

4.2.1 Indigenous Knowledge of Community

Noam Chomsky considers “indigenous communities as the last hope for survival on Earth. He argues that “*these so-called "primitive" or "uncivilized" people are working to protect us from catastrophes and disasters. Nations, tribes, and communities with large Indigenous populations are actively seeking to preserve our planet, while regions and nations where Indigenous populations are near extinction are rapidly moving toward their destruction by adopting lifestyles that have negative effects on the environment*” (Ishaq, M. and Ghilzai, S.A., 2020).

Traditional knowledge is nearing extinction due to a lack of recognition from the scientific community, increasing commercialization, urbanization, and the breakdown of traditional social networks. This neglect of traditional knowledge in policymaking is largely driven by the dominance of technocratic thinking and the disconnect between Indigenous communities and non-Indigenous external state officials and engineers (Rai, P. and Khawas, V., 2019).

Various studies show the significance of indigenous knowledge in shaping strategies and policies for climate change adaptation and disaster risk reduction. Indigenous knowledge

encompasses the wisdom and traditions cultivated by indigenous communities across generations, grounded in their intimate relationship with the environment and natural resources. Its value lies in its transferability and adaptability to communities encountering similar challenges, facilitating the implementation of efficient strategies. (Sithole, W.W., Naser, M. and Guadagno, L., 2015).

When local communities are engaged in decision-making and their traditional wisdom is integrated, policies and strategies become more finely tuned to address the community's unique needs and vulnerabilities. Moreover, indigenous knowledge offers invaluable insights into the local context. Traditional knowledge systems hold a deep understanding of ecosystem behaviors, weather patterns, and natural resources. This knowledge greatly enhances our ability to comprehend and anticipate the impacts of climate change (Leal Filho, W., et al., 2022). Efforts have been made to integrate indigenous and scientific knowledge in climate change adaptation and DRR in Pakistan (Ali, T., et al., 2021). There are various examples of the integration of indigenous knowledge in climate change adaptation and disaster risk reduction strategies. The 2004 Indian Ocean tsunami is recognized for initiating efforts to blend indigenous knowledge with science for disaster risk reduction, leading to numerous initiatives globally. For instance, in Vanuatu, collaborative programs for volcanic hazard awareness and education have been established, integrating traditional knowledge of volcanology into disaster preparedness planning. Similarly, in Washington State, USA, Native American oral traditions have been incorporated into education on earthquake and tsunami hazards. Mercer et al. have formulated a comprehensive framework for integrating diverse forms of knowledge for various disasters, drawing on experiences from Papua New Guinea (Hiwasaki, L., Luna, E. and Shaw, R., 2014). However, there is a shortage of data on Indigenous Knowledge and Disaster Mitigation in the context of Pakistan.

Respondent's Perception on Climate Change in Hunza

Climate change is drastically hitting that area. Glacier is melting as Batura has shifted from its range and has shrunken. Some communities consider that climate change is exerting good impacts on agriculture. There is an introduction of rotational cropping, and these practices allowed the sowing of other staple crops such as corn and potato. A decade ago, the wheat production rate was low as this crop didn’t get enough temperature to harvest on time but now it is ripening before time in some regions.

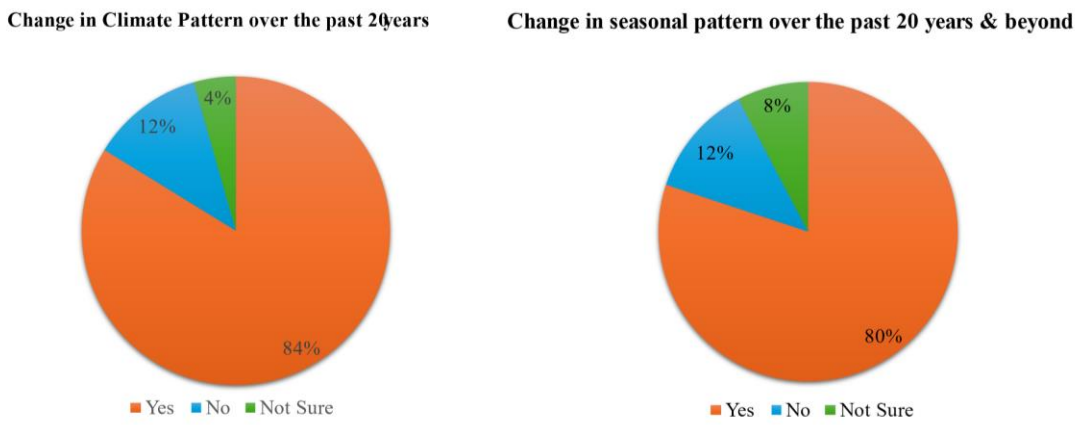


Figure 21: Change in Climate Pattern and change in seasonal pattern over the past 20 years & beyond

Regarding the change in climate patterns over the past two decades and beyond, 84% of respondents acknowledged noticing a shift, while 12% stated they had not observed any change, and 4% remained unsure. Similarly, in terms of alterations in seasonal patterns over the same period, 80% of respondents affirmed experiencing changes, with 12% reporting no discernible alterations, and 8% expressing uncertainty as shown in Figure 21.

Regarding the change in climate patterns over the past two decades and beyond, 80% of respondents acknowledged noticing a shift, while 12% stated they had not observed any change, and 4% remained unsure. Similarly, in terms of alterations in seasonal patterns over the same period, 80% of respondents affirmed experiencing changes, with 12% reporting no discernible alterations, and 8% expressing uncertainty.

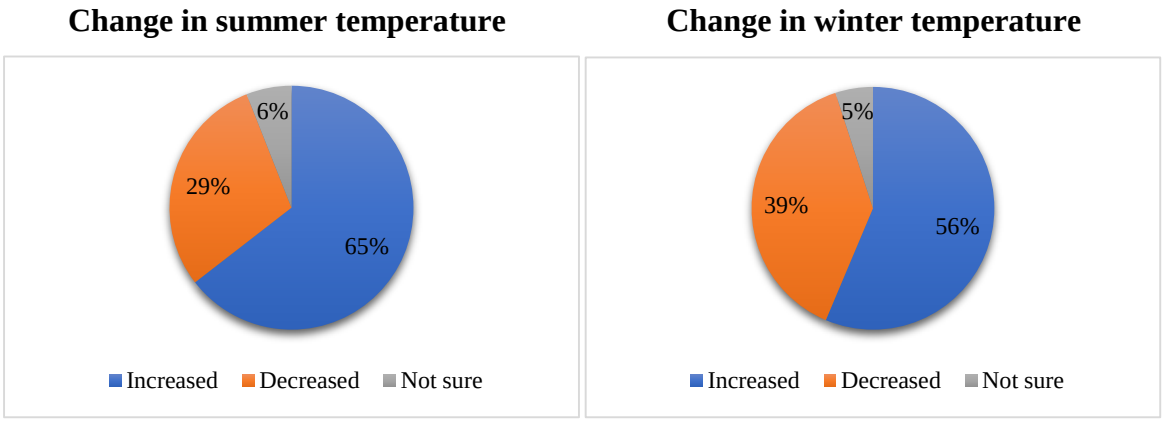


Figure 22: Change in summer and winter temperatures

Concerning temperature fluctuations, the majority of respondents noted increases both in summer 65% and winter 56% temperatures, though a substantial portion also reported decreases (summer: 30%, winter: 39%) as shown in Figure 22. A small percentage remained unsure about temperature changes in both seasons.

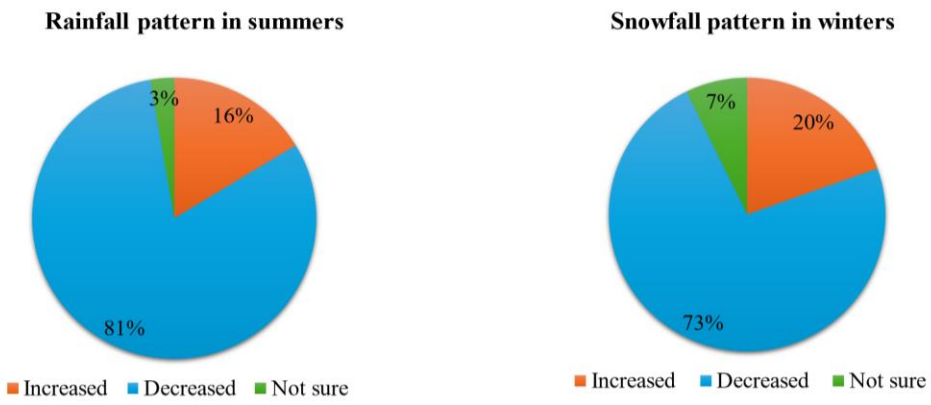


Figure 23: Change in Rainfall and Snowfall Patterns

The majority of respondents, 81%, reported witnessing a decrease in summer rainfall, while a significant portion also observed a decline in winter snowfall, as shown in Figure 23. The findings indicate that rainfall patterns have become unpredictable, with some respondents noting a slight increase in summer rainfall and an overall decline in total rainfall. Additionally, changes in snow patterns have been noted during both summer and winter, highlighting the shifts in seasonal weather conditions.

During August 2022, the region experienced four significant periods of heavy rainfall that resulted in flooding and other damages. The rainfall was exceptionally high, surpassing the average by 243%. This made August 2022 the wettest August since 1961. Sindh witnessed rainfall at 726% above average, Balochistan at 590%, and Gilgit-Baltistan at 233%. Over the past 30 years, data indicates an increase in average annual temperature by 0.5 degrees Celsius and a reduction in precipitation by 8.5mm each year in the region. These changes in climate patterns have resulted in sporadic events such as heavy rainfall, droughts, and rapid melting of snow and glaciers, which have had negative impacts on the residents.

The shifting climate patterns in the Hindu-Kush Himalayan (HKH) region have caused a decrease in glacial volumes, affecting well-known glaciers like Baltoro and Biafo. Passu Glacier, which supplies water to the Hunza River, is also retreating due to these climate changes. Snow cover analysis of Passu Glacier indicates a 6.18% reduction in the snow-covered area (3.0808 km2) from 1992 to 2016, translating to an annual reduction rate of 12.8% for the glacier. As a result of this glacial retreat, the vegetation-covered area has expanded by about 4% each year since 1992 and now covers nearly half of Passu village's area (0.981 sq. km), which relies on the melted water from Passu Glacier (Shahid, G. and Mirza, A.I., 2018).

The local weather has changed significantly in the last 30 years. Previously, Passu village received ample rainfall during the summer and monsoon season, but this has shifted dramatically. Winters and summers, which were once longer, have changed considerably in the last decade. The monsoon now arrives earlier, at times starting in April or May. This change has resulted in unpredictable rainfall patterns throughout the year, causing substantial disruptions to the community's annual agricultural output (Aaliya, A., 2018).

Respondents Perception of Disasters in Hunza District

For glacier retreat, the majority 84% of respondents answered "Yes," indicating that they believe glacier retreat is a significant issue in the region. Only a small percentage 12% responded "No," while 4 % were unsure. The distribution of response is illustrated in Figure 24.

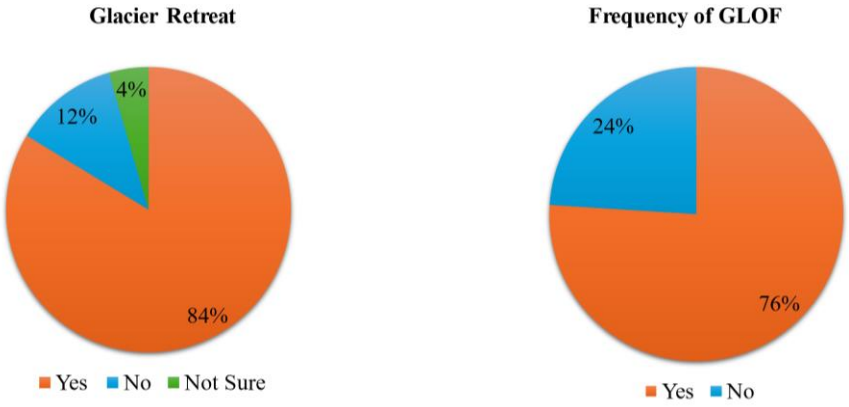


Figure 24: Respondent's perception on glacier retreat and frequency of disasters in Hunza District

Regarding the increase in the frequency of Glacier Lake Outburst Floods (GLOFs), the majority 76% of the respondents answered "Yes," suggesting that they perceive this phenomenon occurring more frequently in recent times. On the other hand, 24% responded "No" as mentioned in Graph 39. Respondents in Shimshal Valley reported that before the 1970s, the river from Dut towards Passu used to freeze in winter, and people could walk on it which has now vanished.

Similarly, for the increase in the frequency of flash floods, the majority 86% of respondents reported observing a rise in occurrences, while only 14% answered "No." For riverine erosion, the vast majority of 92% of the respondents perceived an increase in its frequency, with only 8% responding "No" as shown in Figure 25.

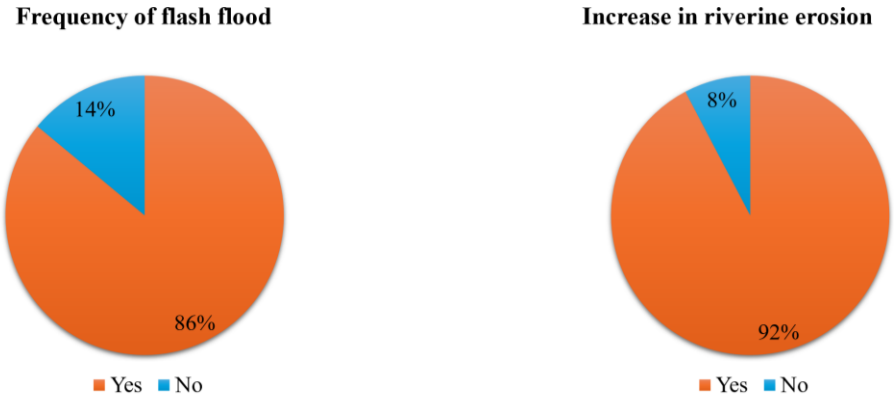


Figure 25: Respondent's perception on the frequency of flash floods and riverine erosions in Hunza

The area of Mayoon in Lower Hunza has faced numerous landslides, leaving it susceptible to natural disasters like avalanches, Glacial Lake Outburst Floods (GLOFs), rock falls, and flash floods. Since 2010, the frequency of landslides has notably increased. From 1994 to 2014, the region experienced 78 floods, 16 landslides, and 8 debris flows (Alam S., Afzal M., 2024). Additionally, a study (Din, K., et al., 2014) suggests that Gilgit-Baltistan has witnessed around 35 destructive GLOF events in the last 200 years, with the frequency and intensity of such events rising in recent years.

Respondents in Hunza widely agree on the perceived surge in natural disasters such as glacier retreats, GLOFs, flash floods, and riverine erosion in the Hunza District. The study, titled "Risks of Glacier Lakes Outburst Flood along China Pakistan Economic Corridor," reveals that the Batura glacier covered an area of 380 km2 in 1977, which decreased to 351 km2 by 2014, representing a loss of 7.63% over this period. However, between 1999 and 2014, the glacier area experienced a slightly lower rate of loss, amounting to 4.69%. More specifically, the glacier area was measured at 369 km2 in 1999, showing a reduction of 2.89% compared to 1977. The rate of glacier area loss accelerated to 7% from 1999 to 2014, with rising temperatures contributing to a 4% increase in glacier area loss during this period (Saifullah, M., et al., 2021).

The findings suggest that the Hunza District is highly aware of and impacted by environmental changes, particularly in terms of glacier retreat, GLOFs, flash floods, and riverine erosion. The unanimity in recognizing the increase in flash floods underscores the need to address and adapt to these environmental challenges. Locals in Passu and Shimshal Valley reported that glaciers are retreating at an accelerating rate. Passu Glacier has experienced a significant retreat in recent decades.

4.2.2 Indigenous Development Mechanism

Indigenous people living in remote mountainous valleys have developed unique ways to ensure not only their survival but that of their entire communities. For instance, the Shimshal community was isolated from the rest of the world until the construction of a link road that took eighteen years to complete. During a field study, the community's elders emphasized that their customs and traditions were key to their survival.

"The reason for our successful survival was due to the customs and traditions of philanthropy. The development of Shimshal is based on customary social philanthropy "Nomus". The community has built water channels, huts, and trails in the name of their family members (Karim Ullah Baig – Shimshal).

Nomus is a social philanthropy system that has become an integral part of the community of Shimshal. The word "Nomus" comes from the Wakhi language and means "showing concern for humanity." It embodies the idea of giving back to society and honoring family ties, and it has played a significant role in shaping the social fabric and development dynamics of this remote valley settlement.

Nomus has a far-reaching impact that extends beyond the physical infrastructure it helps build. It nurtures a culture of reciprocity and mutual support within the community, strengthening social bonds and builds a sense of collective responsibility. Through Nomus, individuals from diverse socioeconomic backgrounds come together, transcending barriers of wealth or status to work towards a common goal: the betterment of their shared home.

Throughout history, Nomus has played a pivotal role in the development of Shimshal. It has contributed to the construction of vital irrigation channels, established community buildings and played an instrumental role in shaping the landscape and livelihoods of its residents. The Shimshal Road in Hunza reflects the sustainable living system and the deep connection between people and their environment.

The valley was disconnected from the rest of the world until 2003, requiring a three-day hard and dangerous trip crossing three high passes (about 5,000 m) to access the village. Back in the 1980s, when President Zia Uu Haq was asked to allocate funds for the road's construction, governmental estimates deemed the task technically impractical and economically unviable, suggesting relocation of the entire Shimshal community instead. However, Shimshalis refused to leave their land and started constructing the 53 KM road on their own. Many families contributed their wealth, time, and lives to the construction of the road. The Aga Khan Rural Support Program (AKRSP) provided technical and financial support, and later the government helped in completing the remaining stretches. The non-metallic Jeep-able Road construction started in 1985 and was completed in 2003, 18 years of handwork finally becoming successful due to the hard work, dedication, and self-help of the community. Today, the Shimshal community faces hurdles and a lack of health and other facilities, but they own a beautiful valley, houses, and most importantly, a history. The Shimshalis' commitment to their land sends a powerful message about the deep bond between humans and nature, highlighting how this connection can ensure sustainable development and environmental conservation.

Nomus is revered by many as a foundation of the community's survival, preserving traditions of philanthropy that have sustained generations through adversity.

4.2.2.1 Construction of Houses

Baltit Fort and Altit Fort are two ancient forts that date back nearly a millennium. These forts are excellent examples of how culture and the need for survival and sustainability can come together. The forts' architectural features, such as short doors and hardwood pillars, along with walls made entirely of rocks bound by mud, are well-suited for inhabiting earthquake-prone areas.

The foundation of Altit Fort, which rests solely on a rocky mountain base with ridges no wider than the walls themselves, presented a significant risk of collapse due to the walls' centralized gravity distribution. To mitigate this danger, an ingenious technique called the Cator Cribbage system, or 'timber lacing,' was employed. This indigenous method of

earthquake-resistant construction utilized robust corner joints and a sturdy framework of wood and rock to support the roof during seismic events.

Today, some homes in Hunza, especially those located in rugged terrain, still use the Cator Cribbage system in their construction. This attests to its enduring efficacy in safeguarding against natural disasters.

It has become a common practice to use non-indigenous methods in building constructions without testing their feasibility and sustainability. In Hunza Gojal, most houses were built using mud bricks and stones as they help maintain room temperature during harsh winters and absorb earthquake shocks. However, we started using cement heavily in the construction of our houses and water channels. Unfortunately, this led to the appearance of cracks due to continuous freezing and thawing processes and earthquakes. Moreover, cement houses become much colder than mud houses in winter, and dew appears on the inside walls of the houses when it warms and freezes when the house becomes cold (Shahid Karim Shimshal, carpenter)

4.2.2.2 Construction of Irrigation Channels

Glacial lake outburst floods (GLOFs) and flash floods can have a direct impact on water resources by causing water channels to break, which in turn can disrupt the supply of water to farmers. In central Hunza, one of the four main tribes takes responsibility for water supply each year and must ensure that the water supply system is maintained efficiently. In Gojal, community members come together voluntarily in early spring to clean and repair the water supply system, as it is crucial for the Navroz (Persian new year) celebration. The construction and repair work is initiated with special prayers and the distribution of Brumhanik/Jerj Tabaq (a local word in Brushuski and Wakhi that means white food consisting of bread and butter), which symbolizes a positive attitude towards the task.

Irrigation channels are constructed uniquely. They start from the source and are built downwards, as opposed to from the bottom up. In spacious areas, the foundation is laid first with large stones and boulders, followed by smaller stones called "ǰeč̣h" in Wakhi. Gradually, smaller stones are added on top until the wall reaches the surface of the channel.

To prevent seepages and erosions in vulnerable spots, the community members put turfs inside the channel during construction. Thorns, either fresh or dried, are also used to reinforce these spots. Turfs and thorns are also utilized to strengthen the channel walls where necessary. Respondents recommend natural products, especially thorns, as they grow and spread their roots around the walls and holes. Thorns are also environmentally friendly and resistant to cold temperatures compared to man-made products like cement or plastic, making the channels more sustainable.

However, the use of cement in irrigation channels, whether for the wall or the inner part of the channel, doesn't hold up well in harsh cold weather, particularly at high altitudes. As a

result, the walls and inner part of the channels get damaged when warm weather comes. Most of the respondents strongly discourage the use of cement in channels.

The people living in Hunza valley have developed various ways to deal with natural disasters based on their past experiences and available resources. The most important factors in managing such situations are the community's social structure and income. The viable strategies employed by the community to mitigate and endure the aftermath of natural disasters are grouped into three categories: physical, social, and economic.

4.2.2.3 Natural Capital Approach:

The construction techniques employed in the Baltit and Altit Forts reflect a natural capital approach to indigenous development. By utilizing local materials such as rocks, mud, and wood, these structures demonstrate a sustainable use of natural resources. The integration of indigenous knowledge with the surrounding environment ensures resilience against natural disasters like earthquakes. Similarly, in the construction of irrigation channels, the use of natural products like turf and thorns strengthens the channels while maintaining environmental sustainability. This approach prioritizes the conservation and responsible management of natural resources, aligning with the community's ethos of living harmoniously with their surroundings.

4.2.2.4 Physical Capital Approach:

The physical capital approach to indigenous development is evident in the construction practices of the Hunza al community. The utilization of indigenous construction techniques, such as the Cator Cribbage system, ensures the resilience of structures against natural hazards, safeguarding physical assets and infrastructure investments. By investing in physical capital, the community strengthens its foundations for long-term sustainable development and resilience against environmental challenges.

4.2.2.5 Human Capital Approach:

Nomus serves as a manifestation of the human capital approach to indigenous development in Hunza and specially Shimshal valley. Through this social philanthropy system, community members actively contribute their skills, labor, and resources towards communal development projects. By harnessing the collective expertise and capabilities of its members, the community develops a culture of cooperation and mutual support, enriching its human capital. The construction and maintenance of infrastructure, such as irrigation channels, further enhance human capital by providing opportunities for skill development and knowledge sharing, empowering individuals to actively participate in their own development.

4.2.2.6 Financial Capital Approach:

Financial capital plays an important role in supporting indigenous development initiatives in Hunza. For example, the construction of vital infrastructure projects like the Shimshal Road requires substantial financial investments. The construction of the road linked the community

to the nearby markets, hospitals, academic institutions, and the rest of the world. Additionally, the Nomus system relies on the financial contributions of affluent community members to sponsor community development projects. By mobilizing financial resources effectively, the community ensures the sustainable funding of initiatives that promote social cohesion, economic prosperity, and environmental stewardship.

4.2.2.7 Social Capital Approach:

Social capital approaches are crucial to the Indigenous Development Mechanism in remote mountainous regions. The Shimshal community, which was isolated until the completion of an 18-year link road, highlights the central importance of customs and traditions in their survival. The indigenous developmental approach Nomus enables affluent community members to sponsor various development projects building collaboration and a sense of ownership. Its impact extends beyond physical infrastructure, nurturing reciprocity and collective responsibility that transcends socioeconomic barriers.

In times of crisis, social coping responses come into play, with support coming from relatives, neighbors, friends, organizations, and governmental entities. For instance, the Hunza community mobilized funds to aid families affected by the Shisper GLOF disaster, and neighbors often exchange goods with one another.

4.2.3 Development of Community-Based Organizations

Many villagers in the Hunza district have formed community-based organizations to carry out community development projects, protect their environment and resources, and increase their resilience to climate change and disasters. Some of the community-based organizations are discussed below.

4.2.3.1 Shimshal Nature Trust (SNT)

The Shimshal Nature Trust (SNT) was established in 1994 as a means of promoting organized community development in Shimshal. Despite the community's abundant natural resources, they had yet to harness them effectively for their benefit. To address this issue, a group of educated community members created a developmental plan aimed at implementing a structured approach to resource management through the establishment of SNT.

Since its inception, SNT has launched various programs to address different facets of community development. These initiatives include environmental education programs for students, the Nature Stewardship Program (NSP) to empower the community to safeguard their natural heritage, and the Culture and Tradition Program, which seeks to promote local customs. Additionally, the Self-Help Village Development Program (SHVDP) encourages voluntarism for projects such as constructing pony treks, local huts, and cable bridges. SNT continuously strives to improve its effectiveness in the future, with initiatives such as the Shimshal Mountaineering Program (SMP), which organizes summer training programs for youth under the guidance of local and international climbing experts. The Women

Development Program (WDP) provides women with equal opportunities alongside men to nurture their talents without gender bias. One of SNT's significant achievements is initiating community-based management of trophy hunting and wildlife protection, effectively banning hunting activities. This move significantly contributes to local income generation and Shimshal's development. Income generated through community hunting endeavors is reinvested into developmental programs such as enhancing tourist facilities, providing scholarships, and offering revolving loans to augment income-earning opportunities.

As a cornerstone institution within the village, SNT shoulders the responsibility of managing natural resources, coordinating collective developmental efforts, and devising implementation plans while monitoring initiatives. Furthermore, it serves as a platform for villagers to practice their leadership skills, developing a sense of ownership and empowerment within the community. In 2023 Shimshal Nature Trust (SNT) carried out various initiatives to safeguard the environment and build the resilience of the community to climate change and induced disasters. Some of the initiatives are as follows. In response to community needs and village development, Shimshal Nature Trust (SNT) has purchased an excavator. The excavator commenced operations, serving both the community and private households effectively. Subsequently, the excavator is also used for the construction of the Dutt water channel project site. This development has speeded up the progress and efficiency of the work.

Collaborating with the Forest Department, a significant plantation drive was initiated, with 170,000 non-fruit plants distributed among the local community for planting in Shilmin and Korband. Additionally, 1300 fruit plants were distributed and planted. The plantation drives also involved the repair and construction of water channels in Shilmin using the excavator. A forest ranger was hired to oversee the project. An MOU was signed with the Forest Department for the evergreen plantation in Shimshal, funded by GLOF-II. Furthermore, tendering processes were initiated for landscaping and land leveling work, with contractors selected for the task. Plants were transported from Shimshal to Shilmin in two trips, and landscaping and land leveling were completed by the contractors. A total of 1124 plants were planted by these contractors and subsequently handed over to SNT, with the project receiving approval from the SNT monitoring team after their site visit.

The Plantation Drive, in collaboration with the Forest Department, involved significant efforts aimed at environmental conservation and community development. Initially, 170,000 non-fruit plants were received and distributed among the local communities of Shilmin and Korband. Subsequently, these plants were successfully planted, alongside the distribution of 1300 fruit plants. To support this initiative, repairs and construction works were undertaken on the Shilmin mainline and supported line water channels, facilitated by the use of an excavator. In Rech Dasht, another significant endeavor was undertaken, involving water channel construction and plantation activities. The water channel was completed through contractor-led efforts, with community members engaged in additional pipe transportation work. Plantation activities commenced with the involvement of village representatives, progressing to area-wise initiatives across three villages. Contractors also contributed to the plantation drive, resulting in the completion of the targeted 55,000 plants for the year.

Despite these achievements, challenges such as the need for additional procurement to address damaged sections of the water channel and pending payments for cutting plants were encountered. Additionally, plans for the construction of a Deeqon House in Rech were underway, further enhancing the sustainability and impact of the initiatives in the region. The Dutt Water Channel project unfolded through a series of coordinated steps aimed at its successful implementation. Initially, a survey and design process was conducted under the auspices of IFAD, with active participation from the SNT Team. Subsequently, the GIS team was engaged to undertake mapping, designing, plotting, and completing layout work as per project requirements. However, the process of plotting and registration from the Magistrate's office remains pending.

Following these preparatory phases, a significant milestone was achieved with the signing of a Memorandum of Agreement (MOA) between ETI and the Shimshal Community, formalizing their collaboration on the Dutt Water Channel project. A dedicated Dutt Project committee was then established to oversee the project's execution, assuming responsibility for its management. ETI engineers, in conjunction with the Dutt project committee, conducted site visits to finalize layout plans, marking a critical stage in project planning. This progress culminated in a ground-breaking ceremony held in Dutt, attended by representatives from IFAD, ETI staff, and the Shimshal community, symbolizing the project's commencement.

Meanwhile, the Trophy Hunting activities of the season saw active participation, with seven trophy hunting groups received between February and April 2023. Impressively, six of these groups achieved successful hunts, highlighting the region's biodiversity and the effectiveness of wildlife management strategies. Additionally, SNT is actively engaged in SLF (Snow Leopard Foundation) programs, with progress noted in various areas. The insurance scheme work is underway, aimed at protecting local communities against losses incurred due to snow leopard predation. The Hussainabad Nallah experienced severe flooding, destroying bridges, electricity poles, and lines. In response, the community was mobilized to undertake repairs on the electricity lines, with support from the Shimshal Native Trust (SNT), which contributed to food and transport expenditures. The community worked diligently to restore electricity services independently. Additionally, Hussainabad Tanzeem sought assistance from the Aga Khan Rural Support Programme (AKRSP) to reconstruct the water channel damaged by the flood.

In parallel, AKRSP initiated a Greenhouse Project, collaborating with SNT to identify potential farmers for participation. Lists of interested farmers were developed and shared, and a need-based technical survey was conducted by AKRSP mobilization and engineering teams. Shortlisted farmers were contacted, and agreements were signed with three of them for the construction of greenhouses on a cost-sharing basis. Similarly, AKRSP embarked on an Animal Shed Project, initiating a pilot project in Shimshal as a test case. SNT finalized a list of potential beneficiaries, and agreements were signed with farmers on a cost-sharing basis.

The Department of Plant Protection's intervention in Shimshal was prompted by the community's request for assistance in controlling a locust attack. In response, a team comprising members from the Agriculture Department and the Plant Protection Unit visited Shimshal equipped with machinery and pesticides. Community volunteers were briefed on how to use the equipment and pesticides, following which they were handed over to the community for implementation. The community actively engaged in spraying activities across various locations to mitigate the locust threat. Subsequently, the community requested both departments to continue the exercise in May to ensure sustained control of the locust population. A Plant Protection representative revisited Shimshal to retrieve the machinery, indicating the conclusion of the immediate intervention. Plans are in place to conduct a locust spray exercise again next year in May, as the necessary application has already been submitted, underscoring the proactive approach toward pest management and agricultural sustainability. The Shimshal Multipurpose Cooperative Society was initiated and registered. With these foundational steps in motion, physical work on the society's initiatives is expected to commence shortly, signifying a concerted effort to empower the community through cooperative endeavors.

4.2.3.2 Hussaini Organization for Local Development (HOLD)

The Hussaini Organization for Local Development (HOLD) was established in October 1996 as a non-profit organization dedicated to promoting sustainable development and conserving the natural environment in the Hussaini village. HOLD addresses the social, cultural, and environmental needs of the local community, focusing on improving the quality of life for the people of Village Hussaini. HOLD works on sustainable resource management, environmental conservation, and community empowerment. The organization aims to promote agricultural development, forestation, and land management, while also enhancing education, healthcare, and social welfare. Women’s empowerment, sustainable livestock management, and improved pasture management are also key priorities. By fostering collaboration between government bodies, NGOs, and conservation committees, HOLD aims to implement initiatives that benefit the entire community, particularly marginalized groups.

In addition, HOLD is committed to promoting eco-tourism, cultural development, and capacity building within the valley. The organization actively works to create linkages with local and international institutions, ensuring that development efforts are gender-balanced and inclusive. Through training programs, participatory monitoring, and conflict mediation, HOLD ensures the equitable distribution of conservation and development benefits, ultimately contributing to the sustainable development of the Hussaini Valley (HOLD 2024).

4.2.3.3 Khunjerab Village Organization KVO

The Khunjerab Village Organization (KVO) is a collective NGO comprising seven villages: Galapan, Morkhun, Jamalabad, Gircha, Sartiz, Nazimabad, and Sost, working alongside the Government of Pakistan within the Khunjerab National Park. Its primary goal is to safeguard the diverse wildlife inhabiting these mountains. Positioned at an altitude of 3700 meters, the Khunjerab buffer zone falls under KVO's jurisdiction, managed locally. Following the

dissolution of the Hunza kingdom in 1974 and the subsequent handover of Khunjerab, previously utilized for wood collection, pastures, and hunting, KVO emerged to regulate these activities, though some areas continue to serve as pastures.

The Khunjerab Village Organization (KVO) Buffer Zone Project, initiated in 1995, involves a consortium of seven village organizations in upper Gojal. This project focuses on wildlife conservation and sustainable use within the buffer zone of Khunjerab National Park. Managed independently by KVO through self-help initiatives, the local community has implemented measures such as employing community guards, establishing wildlife checkpoints, and evaluating local wildlife resources with support from organizations like the IUCN and WWF. Initially funded through the GEF/UNDP small grants program and a presidential donation, KVO later sustained itself through a community-based trophy hunting program. With 80% of the trophy hunting fee allocated to KVO and 20% to the government, this initiative incentivized the community to actively manage wildlife biodiversity. Revenue generated from trophy hunting significantly contributed to conservation efforts, resulting in a notable decrease in poaching incidents and a positive impact on wildlife populations. Recently, KVO joined the MACP project under its Gojal conservancy, focusing on activities like establishing a Valley Conservation Fund, managing fisheries resources, promoting wildlife viewing and ecotourism, and conducting education and awareness programs at the village level. These efforts are anticipated to further enhance biodiversity conservation in the area (KNP 2024).

4.2.3.4 Passu Development Organization (PDO)

The villagers in Passu Gojal have established the Passu Development Organization (PDO), to support education, environmental conservation, conflict resolution, volunteerism, and women's empowerment. The PDO serves as an institution dedicated to advancing a holistic approach to village development in alignment with the diverse objectives outlined by the organizations. It also acts as the primary authority for decision-making and management during the implementation of village development projects. The coordinated efforts towards a shared goal and adherence to a predetermined plan underscore the importance of collective action in driving village development forward.

4.2.3.5 The Ghulkin Nature Conservation – GLAD

The Ghulkin Nature Conservation - GLAD and the Gulmit Organization for Local Development (GOLD) are also actively involved in environmental conservation and climate change resilience efforts in the region. They aim to protect the natural resources and promote sustainable development. While specific details about their work on climate change and disasters are not mentioned, it can be inferred that they contribute to the overall resilience of the community.

4.3 Key Interventions of Government Organizations in Hunza District

Multiple governmental entities, such as the administration of Gilgit-Baltistan and the Frontier Works Organization (FWO), have been actively responding to emergencies and repairing

infrastructure in the area. These organizations have implemented various projects, including reinforcing water and hydropower systems, constructing protective barriers, rehabilitating energy infrastructure, fixing the RCC bridge, and setting up CCTV cameras for surveillance. These services have been consistently provided over the past three years to meet the region's requirements. The Deputy Commissioner of Hunza has partnered with the Aga Khan Agency for Habitat (AKAH) Pakistan to conduct a survey aimed at enhancing access to clean drinking water for more than 5,500 families and institutions in central Hunza. The study specifically targets areas severely affected by recent floods and Shisper glacier lake outburst events. The FWO played a crucial role in reestablishing connectivity by building a temporary bridge to connect upper Hunza to the rest of the country after the damage caused by the Shishper glacier outburst. These interventions illustrate the collaborative efforts of government agencies to alleviate the impact of disasters and ensure the long-term resilience of the affected communities

4.4 Interventions of NGOs and INGOs

Various NGOs and INGOs are working in Hunza Valley on agriculture, water management and resource management to build the community resilience to climatic adversities.

4.4.1 Aga Khan Agency for Habitat (AKAH)

In 2004, the Aga Khan Agency for Habitat (AKAH) Pakistan introduced community-based Hazard and Vulnerability Risk Assessments (HVRAs) as a pioneering approach to disaster management. These assessments integrate local knowledge with scientific expertise to map risks, identify safe residential and economic zones, and develop comprehensive disaster management plans. AKAH's geologists utilize satellite imagery and advanced risk-mapping tools while actively involving local residents, who are trained to participate in the process. This collaborative approach not only guides the construction of structures in safer areas but also enhances community resilience against potential hazards.

AKAH has successfully conducted HVRAs in 785 settlements, primarily located in the mountainous regions of Gilgit-Baltistan and Chitral, which are home to over one million people. The project has provided technical assistance to more than 20,000 households, helping them maintain and enhance the safety of their homes. In addition, AKAH has constructed over 4,000 shelters for internally displaced people, ensuring their protection and well-being in the face of disasters. The organization has also developed 280 community disaster management plans, established weather monitoring posts, and implemented community-based early warning systems, which have been crucial in responding to over 200 disasters. Through these assessments, 50 settlements have been identified as extremely hazard-prone and are being considered for relocation.

To further strengthen disaster preparedness, AKAH has set up 190 community-managed emergency stockpiles across various villages in Hunza and Gilgit-Baltistan. These stockpiles are equipped with essential supplies such as tents, blankets, search and rescue tools, and first aid kits. In collaboration with the Gilgit-Baltistan administration, AKAH is also working to

enhance the region's response to natural disasters like floods and (GLOFs). A key component of this partnership is a comprehensive study aimed at improving the supply of drinking water to central Hunza, an area severely affected by recent flood events in Ultar Nullah and GLOF incidents in Hassanabad Nullah (Source: AKDN Website and Personal Contact).

4.4.2 Aga Khan Rural Support Programme (AKRSP)

The Aga Khan Rural Support Programme (AKRSP) is a non-profit organization established in 1982 by the Aga Khan Foundation to enhance the living standards of villagers in Gilgit Baltistan and Chitral. AKRSP prioritizes community empowerment, believing that with proper organization, skills, and resources, local communities can effectively manage their own development. Noteworthy achievements include increased incomes, the completion of over 4000 small infrastructure projects, extensive tree planting and land development efforts, and the establishment of numerous community organizations.

AKRSP's approach emphasizes social and economic progress through various themes, including institutional development, gender equality, youth empowerment, and poverty alleviation. Efforts are made to strengthen local governance and participation, especially through Women's Organizations (WOs) and Local Support Organizations (LSOs). Gender mainstreaming, youth development programs, and targeted poverty reduction initiatives are also key focus areas. In terms of economic development, AKRSP engages in productive infrastructure projects such as irrigation systems, roads, bridges, and micro-hydroelectric schemes. Market and value chain development initiatives aim to boost income and employment opportunities in sectors like agriculture, gems, crafts, and tourism. The impact of AKRSP's model has been substantial, leading to its replication within and outside the Aga Khan Development Network (AKDN). The organization has received recognition, including awards for its innovative development projects and sustainable energy efforts, notably through micro-hydroelectric plants. These initiatives have significantly improved living conditions, particularly in areas lacking access to electricity (AKRSP 2024).

4.4.3 UNDP “GLOF-II” Project

The GLOF-II project aims to build on the initiatives piloted in GLOF-I by enabling local communities to identify and mitigate risks associated with GLOFs (glacial lake outburst floods) and the impacts of climate change. Additionally, it seeks to strengthen public services to minimize the threat of GLOF-related disasters and improve community preparedness and response to such events. The project also endeavors to foster the development of sustainable livelihood opportunities in project areas, with a particular focus on involving women in ensuring food security and livelihoods (UNDP Pakistan 2019).

Stakeholders have implemented several measures aimed at safeguarding water, land, livelihoods, and infrastructure in the area. One significant step taken was the formation and training of a community-based active monitoring team, also known as the Community Emergency Response Team (CERT). This team was equipped with the necessary tools and

knowledge to conduct regular visits to the glacier site, with frequencies ranging from weekly to monthly, to monitor glacier conditions effectively.

Additionally, efforts have been made to evacuate vulnerable households during disasters and relocate them to safer locations, where shelter and provisions are provided. Furthermore, the installation of an early warning system plays a crucial role in providing essential information regarding risk assessment, monitoring, response capabilities, and communication of warnings. This system aids in protecting both land and infrastructure by facilitating timely actions such as the construction of protective measures like gabion walls.

4.5 Role of Religious Institutions in Building Community Resilience to Climate Change and Disaster Risk Reduction (DRR)

During times of disaster, religious institutions often play a crucial role in supporting affected communities. For instance, in the aftermath of the Attabad landslide incident in 2010, the Ismaili Local Council worked closely with Hunza and Gojal to monitor the situation, coordinate relief efforts, and organize community activities. Similarly, during the Shishper glacier outburst flood, the Local Council in Hunza provided essential services throughout the response and recovery phases and mobilized donations from individuals and organizations to aid those in need. The religious institutions also engaged both male and female volunteers in disaster preparedness and mitigation efforts, demonstrating their commitment to community welfare. By serving as intermediaries between different stakeholders, these institutions facilitate communication, coordination, and collaboration, ultimately enhancing community resilience and promoting unity during challenging times.

4.6 Focus Group Discussion

The purpose of this focus group discussion is to investigate the impacts of climate change and its induced disasters in Hunza. The participants include community members who are aware of potential disasters such as GLOF incidents, such as the Nambardar, senior community members, and representatives of community organizations. Two separate Focused Group Discussions (FGDs) were held, one in Shimshal Gojal and the other in Central Hunza.

The Shimshal Valley has been facing various natural disasters such as glacial floods and the formation of glacial lakes since 1830s. Over the last century, the valley has experienced around 20 glacial floods, some of which had devastating consequences. These floods occurred due to the frequent surging of Khurdopin Glacier, leading to the creation of Khurdopin Glacial Lake. The potential erosion caused by these floods is a significant concern for the Shimshal valley. Located in the Hunza River basin, the Shimshal valley's disasters have implications for the surrounding areas. The road connecting Hunza to Shimshal village has been a cause of concern due to its susceptibility to floods and landslides, posing a threat to the region's residents and infrastructure. The community has taken various steps to safeguard the community and their resources. In 2023 Shimshal Nature Trust (SNT) carried out various initiatives to safeguard the environment and build the resilience of the community to climate change and induced disasters. Some of the initiatives are as follows.

In response to community needs and village development, Shimshal Nature Trust (SNT) has purchased an excavator. The excavator commenced operations, serving both the community and private households effectively. Subsequently, the excavator is also used for the construction of the Dutt water channel project site. This development has speeded up the progress and efficiency of the work.

Collaborating with the Forest Department, a significant plantation drive was initiated, with 170,000 non-fruit plants distributed among the local community for planting in Shilmin and Korband. Additionally, 1300 fruit plants were distributed and planted. The plantation drives also involved the repair and construction of water channels in Shilmin using the excavator. A forest ranger was hired to oversee the project, and various monitoring teams, including those from Forest, GLOF-II, and UNDP, visited the site, expressing satisfaction with the progress. An MOU was signed with the Forest Department for evergreen plantation in Shimshal, funded by GLOF-II. Furthermore, tendering processes were initiated for landscaping and land leveling work, with contractors selected for the task. Plants were transported from Shimshal to Shilmin in two trips, and landscaping and land leveling were completed by the contractors. A total of 1124 plants were planted by these contractors and subsequently handed over to SNT, with the project receiving approval from the SNT monitoring team after their site visit.

The Plantation Drive, in collaboration with the Forest Department, involved significant efforts aimed at environmental conservation and community development. Initially, 170,000 non-fruit plants were received and distributed among the local communities of Shilmin and Korband. Subsequently, these plants were successfully planted, alongside the distribution of 1300 fruit plants. To support this initiative, repairs and construction works were undertaken on the Shilmin mainline and supported line water channels, facilitated by the use of an excavator. In Rech Dasht, another significant endeavor was undertaken, involving water channel construction and plantation activities. The water channel was completed through contractor-led efforts, with community members engaged in additional pipe transportation work. Plantation activities commenced with the involvement of village representatives, progressing to area-wise initiatives across three villages. Contractors also contributed to the plantation drive, resulting in the completion of the targeted 55,000 plants for the year. Despite these achievements, challenges such as the need for additional procurement to address damaged sections of the water channel and pending payments for cutting plants were encountered. Nevertheless, efforts were underway to address these issues, with the AKRSP monitoring team expressing satisfaction with the overall progress.

Additionally, plans for the construction of a Deeqon House in Rech were underway, further enhancing the sustainability and impact of the initiatives in the region. The Dutt Water Channel project unfolded through a series of coordinated steps aimed at its successful implementation. Initially, a survey and design process was conducted under the auspices of IFAD, with active participation from the SNT Team. Subsequently, the GIS team was engaged to undertake mapping, designing, plotting, and completing layout work as per project requirements. However, the process of plotting and registration from the Magistrate's office remains pending.

Following these preparatory phases, a significant milestone was achieved with the signing of a Memorandum of Understanding (MoU) between ETI and the Shimshal Community, formalizing their collaboration on the Dutt Water Channel project. A dedicated Dutt Project committee was then established to oversee the project's execution, assuming responsibility for its management. ETI engineers, in conjunction with the Dutt project committee, conducted site visits to finalize layout plans, marking a critical stage in project planning. This progress culminated in a ground-breaking ceremony held in Dutt, attended by representatives from IFAD, ETI staff, and the Shimshal community, symbolizing the project's commencement. Meanwhile, the Trophy Hunting activities of the season saw active participation, with seven trophy hunting groups received between February and April 2023. Impressively, six of these groups achieved successful hunts, highlighting the region's biodiversity and the effectiveness of wildlife management strategies. Additionally, SNT is actively engaged in SLF (Snow Leopard Foundation) programs, with progress noted in various areas. The insurance scheme work is underway, aimed at protecting local communities against losses incurred due to snow leopard predation. Furthermore, the SLF team has visited Shimshal and provided vaccination services, although the vaccination process itself is yet to be completed, reflecting ongoing efforts in the realm of wildlife conservation and community welfare.

The Hussainabad Nallah experienced severe flooding, destroying bridges, electricity poles, and lines. In response, the community was mobilized to undertake repairs on the electricity lines, with support from the Shimshal Native Trust (SNT), which contributed to food and transport expenditures. The community worked diligently to restore electricity services independently. Additionally, Hussainabad Tanzeem sought assistance from the Aga Khan Rural Support Programme (AKRSP) to reconstruct the water channel damaged by the flood.

In parallel, AKRSP initiated a Greenhouse Project, collaborating with SNT to identify potential farmers for participation. Lists of interested farmers were developed and shared, and a need-based technical survey was conducted by AKRSP mobilization and engineering teams. Shortlisted farmers were contacted, and agreements were signed with three of them for the construction of greenhouses on a cost-sharing basis. Similarly, AKRSP embarked on an Animal Shed Project, initiating a pilot project in Shimshal as a test case. SNT finalized a list of potential beneficiaries, and agreements were signed with farmers on a cost-sharing basis.

The Department of Plant Protection's intervention in Shimshal was prompted by the community's request for assistance in controlling a locust attack. In response, a team comprising members from the Agriculture Department and the Plant Protection Unit visited Shimshal equipped with machinery and pesticides. Community volunteers were briefed on how to use the equipment and pesticides, following which they were handed over to the community for implementation. The community actively engaged in spraying activities across various locations to mitigate the locust threat. Subsequently, the community requested both departments to continue the exercise in May to ensure sustained control of the locust population. A Plant Protection representative revisited Shimshal to retrieve the machinery, indicating the conclusion of the immediate intervention. Plans are in place to conduct a locust

spray exercise again next year in May, as the necessary application has already been submitted, underscoring the proactive approach toward pest management and agricultural sustainability. The Shimshal Multipurpose Cooperative Society was initiated and registered. With these foundational steps in motion, physical work on the society's initiatives is expected to commence shortly, signifying a concerted effort to empower the community through cooperative endeavors.

The Shimshal Valley is renowned as the birthplace of mountaineers. In addition to their mountaineering pursuits, these individuals also conduct life-saving training sessions in Shimshal and other villages throughout Hunza and Chitral to prepare for accidents and natural emergencies. Despite these efforts, there is still a need for assistance - whether in the form of increased capacity or financial support. While much of the community work is carried out voluntarily, a robust and sustainable system is required to carry out community-level development projects.

Participants emphasized that the community alone cannot cope with the adversities of climate change and natural disasters. The government, NGOs, and civil society organizations must also play a role in building community resilience to address climate change and related issues. During the second FGD in Hunza the representatives of the community stated that the community of Hunza is facing significant challenges due to Glacial Lake Outburst Floods (GLOFs) and other natural disasters. These challenges are affecting various aspects of daily life and infrastructure. One major issue highlighted by respondents is the disruption of water channels and irrigation systems caused by GLOFs, such as the Shishper GLOF disaster. The water channel that ran from Hassanabad Nallah to Aliabad, Dorkhun, and Hyderabad, which was built by (AKRSP) and the community, was an important source of irrigation but was destroyed by the GLOF event. This event led to the drying or loss of hundreds and thousands of fruit trees, particularly impacting poor and marginalized farmers dependent on horticulture and stockbreeding.

Furthermore, clean drinking water facilities pose significant challenges, with inadequate infrastructure and maintenance exacerbating water scarcity issues. Despite population growth, water facilities have not been upgraded proportionally, resulting in limited water supply hours and quality issues. Damages to pipelines due to natural disasters like landslides and poor engineering further compound the problem, leaving communities reliant on temporary solutions like water tankers. Initiatives like the "Ghumat water pipeline" in Dorkhun, funded through community contributions, aim to address water shortages but lack significant support from the government or stakeholders. In addition to water-related challenges, energy shortages also affect the community, particularly during peak tourist seasons when demand surges. Insufficient electricity supply, lasting only 4 to 6 hours per day, forces businesses, including hotels, to rely on backup sources like generators and solar panels. The lack of proper sanitation facilities for tourists further detracts from the tourism experience and highlights the broader infrastructural gaps in the region.

Interventions from the government, NGOs, and communities are essential to address these challenges effectively. This includes investing in resilient infrastructure, improving maintenance practices, and providing technical and financial support to community-driven initiatives. There is a need for greater coordination and collaboration between stakeholders to ensure sustainable solutions and equitable access to essential services like water and energy. Additionally, addressing issues of corruption, mismanagement, and poor engineering in infrastructure projects is crucial to building resilience and enhancing the overall quality of life for residents in Hunza.

The adaptation strategies to climate-induced changes and related disasters in the Hunza Valley vary among villages based on their location. Historically, migration and structural measures have been common strategies. The Warabandi committee was established to manage water distribution, but locals often resisted the schedule. Structural measures include relocating or modifying irrigation canal intakes, building sedimentation tanks, and using PVC pipes at vulnerable spots. However, some strategies have failed due to inaccessible locations, natural hazards, and socio-economic factors. Male migration has led to a shortage of manpower for maintaining irrigation systems and agricultural fields, resulting in increased barren land and women taking on tasks traditionally performed by men ((Dhakal, M.P., et al., 2021).

4.7 Key Findings

Adaptation Strategies in Response to Climate-Induced Changes

Adaptation strategies to climate-related changes and disasters in Hunza vary across villages depending on location. Historical strategies have included migration and structural interventions, such as relocating or modifying irrigation canal intakes, constructing sedimentation tanks, and reinforcing vulnerable areas with PVC pipes. However, some measures fail due to inaccessible locations, natural hazards, and socio-economic challenges. Male migration has also led to manpower shortages, affecting irrigation and agriculture, increasing barren land, and shifting responsibilities to women.

Limited Community Participation in Policy and Development

Indigenous practices and knowledge are often excluded from the broader disaster risk management frameworks, and local communities lack representation in decision-making, policy formulation, and development initiatives. This exclusion stems from limited political voice, financial constraints, and the challenging geography of remote locations. .

Absence of Indigenous Knowledge in Disaster Management Frameworks

The lack of indigenous knowledge integration within disaster management frameworks in Hunza significantly limits efforts to build local resilience. Indigenous knowledge is critical for constructing climate- and disaster-resilient infrastructure, such as houses, roads, and water channels. However, local communities face challenges due to limited financial resources, climate change impacts, and frequent natural disasters, which severely affect their coping capacities.

Need for Disaster Risk Management in Governance

To address these issues, it is essential to embed Disaster Risk Management (DRM) within governance frameworks and overall developmental projects. This requires legislative measures, strengthening organizational and community capacities, and increasing investment in mitigation efforts. Despite this need, political, administrative, and resource-related constraints—alongside institutional and community awareness gaps—hinder effective DRM implementation.

Role of Government, NGOs, and Civil Society

The community alone cannot cope with the effects of climate change and natural disasters. Effective resilience-building requires support from the government, NGOs, and civil society organizations. Their collaboration with local communities can strengthen resilience strategies and address climate change issues more comprehensively.

Water and Energy Infrastructure Challenges

The community faces severe challenges in accessing clean drinking water due to inadequate infrastructure and maintenance. Despite population growth, water facilities have not kept pace, leading to limited water supply hours and quality concerns. Natural disasters, like landslides, and engineering deficiencies further damage pipelines, forcing residents to rely on temporary solutions, such as water tankers. The region's limited electricity supply—available only 4 to 6 hours daily—forces businesses, including hotels, to depend on generators and solar panels. Inadequate sanitation facilities for tourists also show infrastructural gaps affecting the tourism sector.

Collaborative Interventions for Sustainable Solutions

Interventions by government, NGOs, and community organizations are necessary to address these challenges effectively. Investments in resilient infrastructure, improved maintenance, and technical and financial support for community initiatives are required. Greater coordination and collaboration between stakeholders are essential to ensure sustainable solutions and equitable access to vital services, such as water and energy.

In conclusion, enhancing resilience to climate change in Hunza requires a comprehensive approach that integrates indigenous knowledge, addresses infrastructure needs, and strengthens governance. Current adaptation strategies face challenges due to remote topography, socio-economic constraints, and the impact of male migration on the workforce. Limited community involvement in policy-making, along with the lack of indigenous knowledge in disaster management, hampers effective local engagement.

It is important to incorporate disaster risk management into governance and development projects, while also increasing legislative support and enhancing organizational capacities. Collaboration among government, NGOs, and civil society is essential for improving infrastructure and ensuring equitable solutions for sustainable development. This collective effort will ultimately build long-term resilience to climate change and natural disasters.

4.8 SWOT Analysis: Disaster Risk Management in Hunza and Gilgit Baltistan

The survey conducted in Hunza district was used to carry out a SWOT analysis. Community members, representatives of community-based organizations, government, NGOs and INGOs identified the strengths, weaknesses, opportunities, and threats.

Policy and Strategic Challenges: Opportunities include incorporating DRM into governance structures, legislative measures for sustainable land-use planning, and developing a multi-year master plan for disaster resilience. However, challenges include a lack of political will and synergies, absence of informed policies and strategies, coordination challenges, and operational limitations of GBDMA.

Organizational/Institutional Challenges: Creating DRM-related structures, capacity building, and enforcing policy decisions are crucial opportunities. However, challenges arise from low institutional capacity, community dependency syndrome, inadequate compensation mechanisms, and weak enforcement of policy decisions.

Operational and Capacity Challenges: Key opportunities in this sector include strengthening community coping capacity, integrating DRR into projects, and improving response quality. However, challenges such as the lack of comprehensive planning, absence of early warning systems, and low community awareness pose significant hurdles.

Geophysical and Socioeconomic Challenges: Opportunities in this sector include recognizing seismic activity, understanding sediment disaster risks, and identifying factors contributing to rockfall vulnerability. In contrast, threats from seismic activity, sediment disasters, glacier melting, vulnerability to rockfall, and socioeconomic challenges such as poverty and lack of resilience present significant hurdles.

Opportunities for Disaster Risk Management: Promising opportunities in this sector include recognition of DRM importance by parliamentarians, support from I/NGOs and UN agencies, youth engagement, community involvement, and investment in mitigation measures. However, challenges include the absence of systematic community-based DRM efforts, lack of capacity building, weak monitoring, limited awareness, and cooperation challenges in the private sector.

Table 10: SWOT Analysis: Policy and Strategic Challenges/ Organizational/Institutional Challenges/ Operational and Capacity Challenges in Hunza District

Sectors	Opportunities	Limitation/Issues
Policy and Strategic Challenges	Devolution of planning and authority to tehsil administration Urgent need for legislative, policy, and regulatory measures for sustainable land use planning Integration of climate concerns into government policies Development of a multiyear master plan for disaster resilience and prosperity in GB	Lack of political will and synergies in planning and action on DRR Centralized role of DDMAs at the district level Lack of disaster-informed policies and strategies Absence of DRM-related structures Capacity gaps among public and community representatives Lack of coordination among DRM actors Operational limitations of GBDMA due to lack of resources and capacities Overlaps and duplication of responsibilities among different departments.
Organizational/Institutional Challenges	Creation of DRM-related structures as per GBDMA Act 2017 Capacity building for grassroots-level workers Enforcing policy decisions regarding unplanned settlement and land conflicts	Lack of clarity regarding roles in DRM Low institutional capacity at grassroots levels Dependency syndrome at the community level Lack of verification and compensation mechanisms for community assets Weak enforcement of policy decisions by government/local administration
Operational and Capacity Challenges	Strengthening community coping capacity Streamlining DRR into development planning Integration of DRR into development projects Installation of hazard-specific early warning systems Improvement of flood response quality Increasing awareness among communities about hazards and climate change	Lack of comprehensive planning for development projects Absence of area and hazard-specific early warning systems Ineffective flood response due to low-quality planning Lack of awareness and seriousness among communities about hazards and climate change

Table 11: SWOT Analysis: Geophysical and Socioeconomic and Climate Change Challenges in Hunza & Gilgit Baltistan

Sectors	Opportunities	Limitation/Issues
Geophysical Challenges	Recognition of active seismic zone for better disaster preparedness Understanding of sediment disaster risks and mitigation strategies Awareness of glacial lake outburst flood (GLOF) vulnerabilities Identification of factors contributing to rock fall vulnerability	Threat of seismic activity near fault lines Risks of sediment disasters including landslides, debris flows, glacier movement, and avalanches Rapid melting of glaciers leading to GLOF events Vulnerability to rock fall due to geological and human-induced factors
Climate Change Challenges	Increased awareness and understanding of climate change impacts Identification of climate change-induced events for mitigation planning	Lack of serious consideration of climate change adaptation Erratic precipitation patterns, temperature rise, and extreme weather events causing floods Excessive glacier melting leading to GLOF events
Socioeconomic Challenges	Potential for strengthening social and economic resilience through cash grant instruments Opportunity to diversify livelihood options for communities Recognition of poverty as a driver for vulnerability.	Lack of DRM activities aimed at building social and economic resilience Shortage of financial resources for compensating disaster victims Poverty leading to vulnerability and inadequate coping capacity

Table 12: SWOT Analysis of Agriculture, Livestock and Tourism in Hunza District

Sectors	Opportunities	Limitation/Issues
Agriculture	Land available for cultivation Barren land is also available that can be brought under cultivation Plenty of water available More Fruit Trees can be planted Indigenous organic products can be marketed at international markets online	The agricultural land is shrinking with the rise in population Droughts The road conditions are not better to transport goods from farmlands to markets. Lack of internet services. Electricity is not available for storage/ refrigeration. Lack of labor force Migration (Due to the nonavailability of higher education institutions and job opportunities people migrate to other cities which is one of the reasons for low labor force in the area. Climate issue – Crops can be cultivated only once in a year.
Livestock	Shimshal, Chuperson, Boybar, Khunjerb, and Shmijerab have vast pastures in Hunza District favorable for yak, dairy farming	Harsh Winters Lack of access to the market Unavailability of Electricity for meat and dairy storage. No dairy industry in the region. Lack of infrastructure – roads and bridges to the pastures – makes movement hard.
Tourism	Best tourist destinations & historical places Winter Sports can be introduced Adventure sports can be introduced Cultural Festivals Music can be promoted	Lack of infrastructure (Road, Hotels in far-flung areas) Nonavailability of electricity/ water (mainly in Hunza). Lack of interest of locals Harsh climate (Tourism flow remains in Hunza from April to October but the flow stops during Muharram and Ramadan). Roads get damaged – flooding, land sliding, mudflow. Visa/tourist documentation processes are complicated.

Table 13: SWOT Analysis of Energy Sector in Hunza District

Energy source	Opportunities	Limitation/Issues
Hydropower	Available rivers and tributaries Opportunity to construct Mega Hydropower on Hunza River (The government has already planned to construct a hydel power station at Attabad Lake)	Gilgit Baltistan doesn't have an energy policy – the energy projects are designed/funded by the federal government. Stream water fluctuates in different seasons and freezes in winter. Natural Disasters (flooding, mudflow) Low efficiency (capacity vs generation) Lack of technical staff Snowfall damaged transmission lines.
Solar Energy	Wide areas available for solar panel installation	Low light intensity and duration during winters. High initial installation cost High maintenance cost Can only be used for lighting purposes. Lack of technical people.
Wind Energy	Wind energy is untapped and should be initiated on a trial basis to see the feasibility of wind energy, its efficiency, and generation power.	

Chapter 5

5 Conclusions and Recommendations

5.1 Conclusion

Pakistan's diverse topography and status as the fifth most populous country present both opportunities and challenges, particularly in the context of climate change. Regions like Gilgit-Baltistan, including the Hunza District, are particularly vulnerable to climate-related hazards such as glacier lake outburst floods (GLOFs), landslides, and earthquakes. This vulnerability highlights the necessity for community-focused approaches to climate change adaptation and disaster risk reduction (DRR).

This study highlights the important role of community involvement, emphasizing the value of local knowledge and capacities in building resilience to climate change and related disasters. The research identifies numerous opportunities across policy, organizational, operational, geophysical, and socioeconomic sectors for enhancing disaster risk management (DRM). However, these opportunities are often accompanied by significant challenges, including political, administrative, and resource-related constraints, institutional capacity gaps, and limited community awareness.

To effectively adapt to climate change and disaster risk reduction (DRR) in Hunza, a comprehensive approach is needed. This approach should integrate disaster risk management (DRM) into governance structures, enhance organizational and community capacities, and invest in mitigation measures.

Mountainous regions like Hunza face unique environmental and climate-related challenges. The people living in the valley have the indigenous knowledge and practices for coping with these challenges. However, this indigenous knowledge is not properly documented or incorporated into disaster management frameworks. Incorporating indigenous knowledge into disaster management and climate change strategies is essential for strengthening community resilience.

5.2 Recommendations

Based on the findings of the study, the following recommendations are made to improve disaster risk reduction policies and programs in Hunza. These recommendations focus on incorporating Indigenous knowledge and enhancing community resilience to climate change:

Climate change is a significant challenge that exacerbates the negative impacts on vulnerable segments of society. The people in Hunza have observed the changing climate patterns over the past decades, but there is a need for regular awareness campaigns and workshops to educate the community about the challenges posed by climate change and the potential

impacts on the region. Climate change is closely connected to human activities, so it is important to involve the community in preparedness and response plans to mitigate the effects of climate-related disasters. It is important for disaster risk reduction policies and programs to incorporate indigenous knowledge and climate change adaptation strategies. This includes documenting and preserving indigenous knowledge, as well as integrating it into decision-making processes related to disaster management and climate change adaptation. To effectively manage disasters and reduce risks, it is essential to integrate the indigenous knowledge and practices that help communities adapt to climate change and mitigate disaster risks into the "Community Based Disaster Management System (CBDRM)".

Community-Based Approaches: There is a need to emphasize on the importance of community-based approaches to climate change adaptation and disaster risk reduction. Engage local communities in the development and implementation of policies and programs, ensuring their active participation and ownership.

Address Knowledge and Capacity Gaps: Invest in capacity-building initiatives aimed at bridging knowledge and capacity gaps among stakeholders. Provide training and educational programs to enhance understanding of climate change impacts and effective disaster management strategies at the community level.

Improve Local Government Support: There is need to have improved support from local governments for effective disaster management. This includes allocating resources and establishing mechanisms to facilitate community involvement in disaster preparedness, response, and recovery efforts. There is also need of strengthening local government and DDMAs as they are more connected to local communities and their issues. There is a need to establish a dedicated DDMA (5-8 members) other than AC and DCs as they remain occupied in official tasks.

Enhance Coordination and Collaboration: There is a dire need to enhance and strengthen coordination and collaboration among stakeholders at all levels. Encourage partnerships between government agencies, NGOs, community-based organizations, and other relevant actors to enhance the effectiveness of disaster risk reduction and climate change adaptation initiatives.

Promote Proactive Measures: Prioritize proactive measures to mitigate risks and adapt to changing climate conditions. Invest in early warning systems, infrastructure improvements, and community resilience-building activities to reduce vulnerability and enhance preparedness for future disaster.

Incorporating DRM into Governance Structures: Establish dedicated DRM units within relevant governmental bodies at federal, provincial, and local levels. Ensure these units have clear mandates, adequate resources, and authority to coordinate DRM efforts across sectors.

Legislative Measures for Sustainable Land-Use Planning: Enact legislation mandating sustainable land-use planning practices that prioritize disaster risk reduction. This should include zoning regulations, building codes, and land-use policies informed by hazard and vulnerability assessments.

Development of Multi-Year Master Plan for Disaster Resilience: Formulate a comprehensive multi-year master plan for disaster resilience that integrates various sectors, stakeholders, and levels of government. This plan should outline specific objectives, strategies, and actions for enhancing resilience to natural hazards and climate change impacts.

Creating DRM-Related Structures: Establish DRM-related structures as mandated by the GBDMA Act 2017, ensuring clear roles, responsibilities, and coordination mechanisms. These structures should facilitate collaboration between government agencies, NGOs, communities, and relevant stakeholders involved in DRM.

Integrating DRR into Projects: Ensure that DRR considerations are mainstreamed into development projects across sectors such as infrastructure, agriculture, housing, and urban planning. This should include conducting risk assessments, incorporating mitigation measures, and building resilience into project designs.

Investment in Mitigation Measures: Allocate resources for investing in cost-effective mitigation measures, such as infrastructure upgrades, ecosystem restoration, and community-based DRR initiatives. Prioritize projects that offer long-term benefits in reducing vulnerability and building resilience.

5.3 Research Limitation

This research has limitations, as is common in research endeavors. Firstly, the study relies on interviewees' recollections of historical details from memory, as only a few individuals maintained written records. To enhance the validity and credibility of findings, the field research employed a combination of various data collection methods, aiming to cross-validate results across multiple approaches. Despite efforts to ensure consistency, it's important to acknowledge that the research findings were shaped by the subjective ideas and opinions expressed by the interviewees.

Caution must be exercised when attempting to generalize the research findings to other communities. Mountainous communities possess unique biophysical and socio-economic characteristics and face diverse types, severities, and patterns of climate hazards. Consequently, the specific results obtained from one community may be influenced by circumstances that differ significantly from those in other regions. Therefore, while the insights gleaned from this study are valuable within the context of the Hunza District, they may not necessarily apply universally to other geographical locations or communities facing distinct environmental challenges.

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