

GLACIAL LAKE OUTBURST FLOODS: IMPACT ON THE
ENVIRONMENT AND SOCIOECONOMIC CONDITIONS OF
HUNZA



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CERTIFICATE

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ABSTRACT

This study is based on Glacial Lake Outburst Flood (GLOF) occurrences in Hassanabad, Pakistan, over the last five years. The study examines the impact of GLOF on households and understands indigenous knowledge along with community-based risk mitigation techniques to reduce the intensity of GLOF-related damages. The asset pentagon of sustainable livelihood framework of the Department for International Development (DFID) provided the fundamental concepts for carrying out this research. In addition, this study tapped upon the approaches currently used by stakeholders to mitigate GLOF-induced hazards and the lessons for perceived cataclysm. To achieve this, primary data sources, i.e., Focus Group Discussions (FDGs); the questionnaire-based Key Informant Interviews from the households; stakeholders and representatives from NGOs were utilized, and the gathered data was analyzed using SPSS. The data division was such that quantitative information was converted into percentages and frequencies. At the same time, the primary qualitative data was used to assess community resilience, disaster risk reduction, and GLOF management. According to 74.1 percent of the total respondents, there is a significant loss of cultivable land due to GLOF. Drinking water facilities and irrigation channels are disrupted, which causes 50.3 percent of households to fetch water from outside. This scarcity has limited the agricultural yield by several folds in the past three years. The local communities have been sustained by shifting from natural to social and human capital. Although the indigenous knowledge of the community suggests certain religious rituals to manage disasters like GLOF, the frequency and intensity of such catastrophes remain the subject of research across the region. The current socio-economic and environmental study is a reference for future research work.

Keywords: GLOF, Households, Stakeholders, Disaster, Socio-economic

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LIST OF ABBREVIATIONS

AKAKH	Aga Khan Agency for Habitat
AKRSP	Aga Khan Rural Support Program
BHU	Basic Health Unit
CBDRMC	Community Based Risk Management Committee
CCTV	Closed-Circuit Television
CERT	Community Emergency Response Team
CMS	Civic Management Society
CPEC	China Pakistan Economic Corridor
DC	Deputy Commissioner
DDMA	District Disaster Management Authority
DFID	Department for International Development
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EWS	Early Warning System
FAWS	Flood Automatic Weather Stations
FGD	Focus Group Discussion
FWO	Frontier Works Organization
GB	Gilgit-Baltistan
GBDMA	Gilgit Baltistan Disaster Management Authority
GLOF	Glacial Lake Outburst Floods
HA	Hectares
HH	Household
HHH	Head of Household
HKH	Hindu Kush Himalayan
HRB	Hunza River Basin
ICIMOD	International Center for Integrated Mountain Development
INGO's	International Non-Governmental Organizations
IPCC	Intergovernmental Panel on Climate Change
KKH	Karakoram Highway

MSPs	Multi-Stakeholder Platforms
MW	Megawatt
NAPWD	Northern Areas Public Work Department
NGO's	Non-Governmental Organizations
NHA	National Highway Authority
PMD	Pakistan Meteorological Department
PRA	Participatory Rural Appraisal
RCC	Reinforced Cement Concrete
RFT	Running Feet
SDRI	Stakeholder Disaster Response Index
UIB	Upper Indus Basin
UNDP	United Nations Development Program
UNISDR	United Nations International Strategy for Disaster Reduction

Chapter: 1

Introduction

1.1 Background of Study

Gilgit Baltistan, the northern part of Pakistan, possesses a fascinating bio-geographic position. Nature has gifted this region with lofty mountains, gigantic glacial masses, eminent streams, and beautiful valleys (Khan et al., 2013). The Himalayas, Karakoram, and Hindu Kush meet at the junction of the Gilgit and Indus streams, while the Karakoram Range is joined in the north by the Pamir and Kunlun ranges. A number of the world's most famous mountain peaks, including five peaks higher than 8,000 metres, dominate the area, which overlooks the natural richness of the locale. After the Polar Regions, Gilgit Baltistan has the most elevated grouping of ice sheets. The absolute most extended icy masses of the world are found in these mountain ranges; for instance, the Siachen Glacier is 78 km long (Virk et al., 2003). The Karakoram-Pamir region is heavily glaciated, with over 5000 glaciers total, with the 12 biggest accounting for about half of the total glacier area. The Karakorum range covers 28–50% of the glacial surface (Wu et al., 2014).

However, glaciers are receding worldwide due to global warming, and some areas may lose their glaciers this century. Nearly half of the world's population lives near watersheds fed by mountains with glaciers and snow (Kaltenborn et al., 2010). Glacial melt feeds four large storage reservoirs in Pakistan (Mangla, Chasma, Tarbela, and Warsak). These reservoirs are supported to the world's biggest irrigation system (the Indus Basin Irrigation System) (Qureshi, 2011). Changes in the upstream environment impact the lives and livelihoods of millions of people living downstream (Immerzeel et al., 2010).

According to IPCC's 5th Assessment Report (AR5), glaciers, permafrost, lake, snow, and river ice is home to roughly 10 % (671 million) of a global population of high mountainous regions. Climate change or its indirect effects are directly linked to changing mountain environments and increased variations in the cryosphere. Globally, the air temperature in mountainous areas rises at 0.30°C each decade (Pörtner et al., 2019). The main factor of the elevated surface air temperature is the emission of anthropogenic greenhouse gases. If the surface air temperature continues to increase at the current rate, then these glaciers will vanish by 2035 (Hock et al., 2019).

According to the 2021 sustainable development report, Pakistan has an achievement of fulfilling SDG 13: climate action (Cheema, 2021). Environmental Changes are posing genuine threats to fragile biological systems and vulnerable networks. The pristine environment of GB has lost its reliance on withstanding extreme climate changes. Subsequently, numerous native and migratory species have lost their habitats. The metrological stations in Gilgit, Skardu, Gupis and Bunji show an elevation in the absolute temperature over the most recent twenty years from 1980 to 2006 noticed to increase by 0.440 °C each year ((UNPO), 2013). Similarly, (UNDP, 2020) report shows that 3,044 glacial lakes have formed in Gilgit-Baltistan (GB) and Khyber Pakhtunkhwa (KP). Thirty-three glacial lakes have been identified as being vulnerable to risky glacial lake outbursts and flooding.

GLOFs are natural disasters that can release millions of cubic meters of water and debris, resulting in the loss of lives, land, and livelihoods in mountain communities that are remote and vulnerable. Over 7.1 million individuals in GB and KPK are vulnerable, where 26.7 percent and 22 percent of the populace are below the poverty line.

In the Upper Indus Basin (UIB), there are 5000 glaciers, whereas the Hindu Kush-Himalayan (HKH) area has around 20,000. The Hunza, Shigar, Shyok, Gilgit, Shingo, and Astore rivers, and

a variety of smaller and bigger tributaries, make up the UIB's sub-basins. Snow and ice account for half of the water in UIB. In the 1970s, the Karakoram and Himalayan glaciers reported retreating from the 1920s until the early 1990s (Ali et al., 2021).

Past 200 years, 35 hazardous floods have been recorded in the Karakoram area, 17 in the Upper Indus and 20 in the Himalayas. In the Karakoram, new GLOFs have been created since 2010 because of the quick dissolving or flooding of icy masses and environmental change, creating potential dangers to downstream settlements and foundations. More than 36 glacial lakes have been evaluated to be nearly upheavals with likely risky GLOFs. Mainly, Shimshal valley (Upper Hunza) in the Western Karakoram, Shyok stream bowl in the Eastern Karakoram, and Chitral Valley (KPK province) in the Hindu-Kush have known regions for disaster inclined GLOFs over the most recent twenty years (Baig et al., 2020).

With this foundation, the examination explores this issue with particular reference to Hunza Valley. It aims to examine the direct impact of glacial lake outburst floods on the environment and socioeconomic conditions.

1.2 Problem Statement

GLOF are some of the most frequent climate-related disasters in Hunza, GB. Since 1970, more than 20 GLOF incidents have been recorded in Hunza; however, frequency has increased in the previous two decades in central and upper Hunza between 2000 and 2022. According to (Khan et al., 2014), the majority of GLOF events were caused by extreme meteorological conditions, such as rapid temperature rises, heat waves, and rainfall just before or during the GLOF events. The total GLOF events in the past 50 years are represented graphically in Figure: 1.

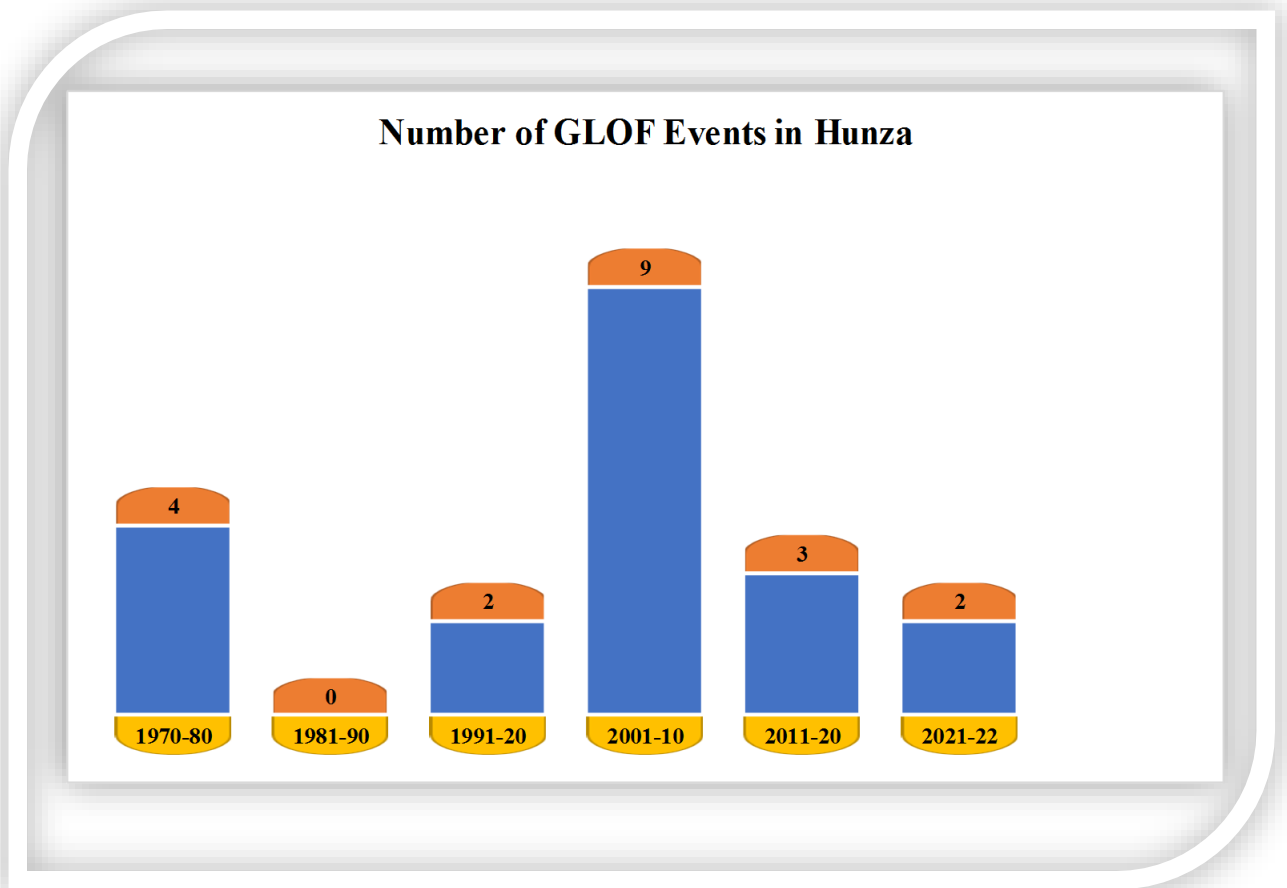


FIGURE I: NUMBER OF GLOF EVENTS IN HUNZA

Sources: (ICIMOD, 2021), (Din et al., 2014), (Ahmad et al., 2016), (A Hussain et al., 2020)

Glacier outburst floods have been recorded for centuries, particularly in Europe, America, Africa, and Asia. Glacier floods have explicitly caused at least 7 deaths in Iceland, 393 deaths in the European Alps, 5745 in South America, and 6300 deaths in Central Asia. However, only two incidents account for 88 percent of the 12,445 deaths recorded: the 1941 Huaraz, Peru, and the 2013 Kedarnath, India disasters. These two events accounts for 82% of the total damage caused globally by glacier floods because of the contribution to the damage index of these exceptionally high numbers of reported death (Carrivick & Tweed, 2016). The total number of global GLOF casualties is summed up and Figure: 2.

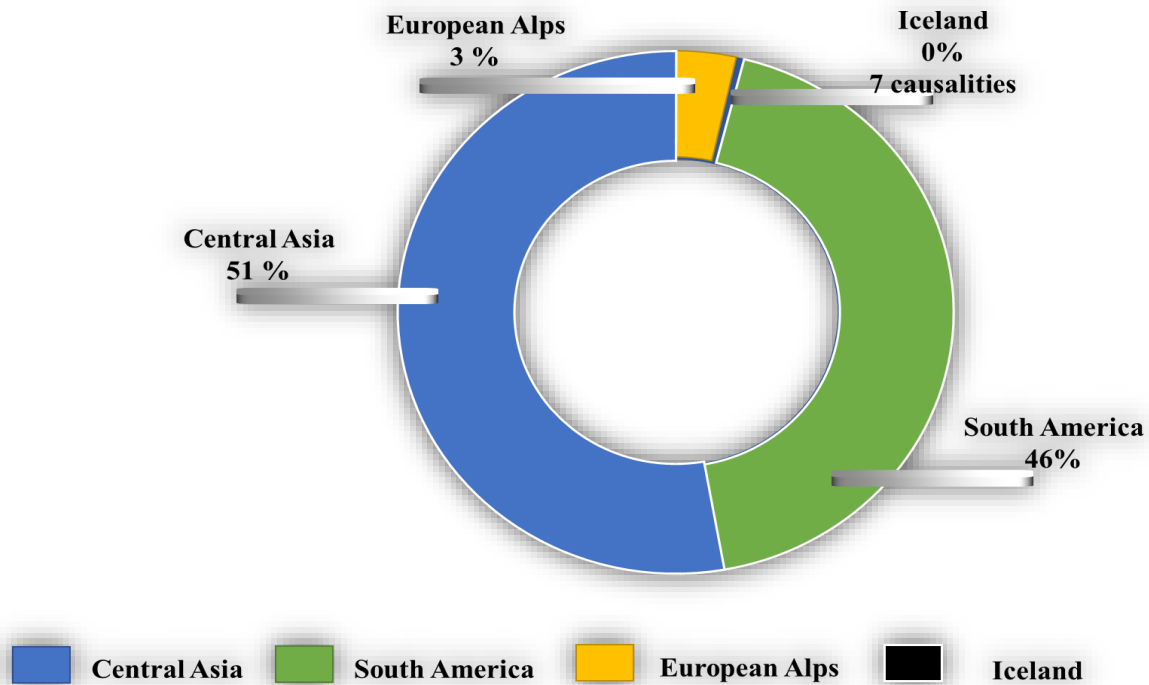


FIGURE 2: GLOBAL GLOF CAUSALITIES

SOURCE: (CARRIVICK & TWEED, 2016)

Moreover, the South Asian region has also suffered from extreme GLOF incidents. E.g. Nepal has witnessed 24 GLOF incidents, many of which have led to significant damage and loss of life, damage to road links to China, killed numerous livestock, destroyed infrastructure and hydropower houses.

It's important to remember that glaciers are vital natural features and the primary source of uninterrupted freshwater supply in the South Asian region, all of which are affected by global warming. From 2001 to 2010, the average temperature rise for Pakistan was 0.6 °C, but the actual temperature change was 0.93 °C, with the northern mountains heating up to 1.3 °C. Pakistan forms the northern intersection of the world-famous HKH mountain ranges. As these mountains are home to both the HKH glaciers, such an increase in temperature is a warning sign for glacier lake

formation, expansion, and outburst flooding. More than 5000 glaciers feed the rivers in these mountainous regions.

It is essential to understand the risk level of a population before taking any meaningful steps against climate change impacts at the community level. It would be easier to determine the resilience of a population's livelihoods if we could recognize the main aspects of risk and their magnitude for that community. The main issue is inadequate research and detailed knowledge about sensitive areas and populations. Due to a lack of understanding, there has been a lack of sufficient efforts to mitigate the effects of climate change on poor people's livelihoods and make them more sustainable.

1.3 Significance of the study

The northern areas at large and Gilgit-Baltistan, in particular, is most vulnerable to global warming and climate change. The mountains in these areas contain a massive deposit of glaciers that ensure freshwater availability in the country throughout the year. The emerging phenomena of climate change escalate incidents like GLOFs in the region. The research accounts stated that these disasters continued to cost the lives of humans and infrastructure and pose environmental damages. Very few studies have been conducted in the context of GB to uncover the impacts of GLOFs on the local populace. Therefore, the current study attempts to understand the effects of climate change, particularly GLOFs, on the lives and livelihoods of the local populations of Hassanabad valley, Hunza. This village is well-known for GLOF. In Feb 2021, the metrological department issued a GLOF alert for Hassanabad Hunza. It is expected to burst Hunza Lake owing to the surge of the Shishper glacier's melting and stoppage in the flow of water (The Express Tribune, 2021). This year, the community members will be displaced to campsites- with the current pandemic and expected GLOF, the lives and livelihood of local people will be hugely impacted. Mover, this

study intended to assess the impact on livelihood assets and stakeholders' role in mitigating the impact of GLOF in the region. This study will gauge the response from households, government, and other relevant stakeholders currently playing a vital role in mitigating such occurrences in the area.

1.4 Research Objectives

The objectives of this research are to find out:

The main goal of carrying out this endeavor is to determine and quantify the effect of GLOF in the selected spatial boundaries of Hassanabad Valley¹, Gilgit Baltistan, Pakistan; therefore, the study is divided into a sequence of objectives as under

1. Determining and quantifying the impact of glacial lake outburst floods on the natural, physical, human, and social capital of inhabitants in Hassanabad valley.
2. Exploring the approaches that are currently employed by the relevant stakeholders to mitigate the GLOF induced risks and lessons learned for the future expected events.
3. Finding out the GLOF induced risk reduction mechanisms employed by the local communities by using their experiences and indigenous knowledge.

Moving forward, the livelihoods assets that are to be assessed in this study are discussed below:

a. Natural capital

In the Sustainable Livelihoods Framework (SLF) concept, natural capital is defined as follows: Natural assets are naturally accessible resources that human being uses to sustain their livelihood. For example, land, forest, water, biodiversity, wildlife, minerals etc. This natural capital represents rural communities that are highly vulnerable to natural disasters. Climate change

¹ In this research, the main focus would be on Hassanabad Valley, where the Shishper glacial lake exist

directly influences the natural capital, and any form of variation of the naturalistic environment can restrict the livelihoods approach of an affected population.

b. Physical capital

“Physical capital comprises the basic infrastructure and producer goods needed to support livelihood” (DFID, 2014). Physical capital involves road access, affordable transportation, safe buildings, adequate water supply, and information access. It includes the physical resources that individuals possess and have access to, whether given by the government, local authority, or the private sector and if they are free or paid. This physical capital has an impact on poverty alleviation.

c. Human capital

It is agreed that the poor have limited human capital and their livelihoods are more vulnerable. At the household level, this capital determines the quality (skills and the ability to work of household members) and quantity (number of productive household members) of human resources. It represents the necessary skills, knowledge, good health and ability to labor that together facilitate people to pursue different livelihood strategies and achieve their livelihood objectives (DFID, 2014).

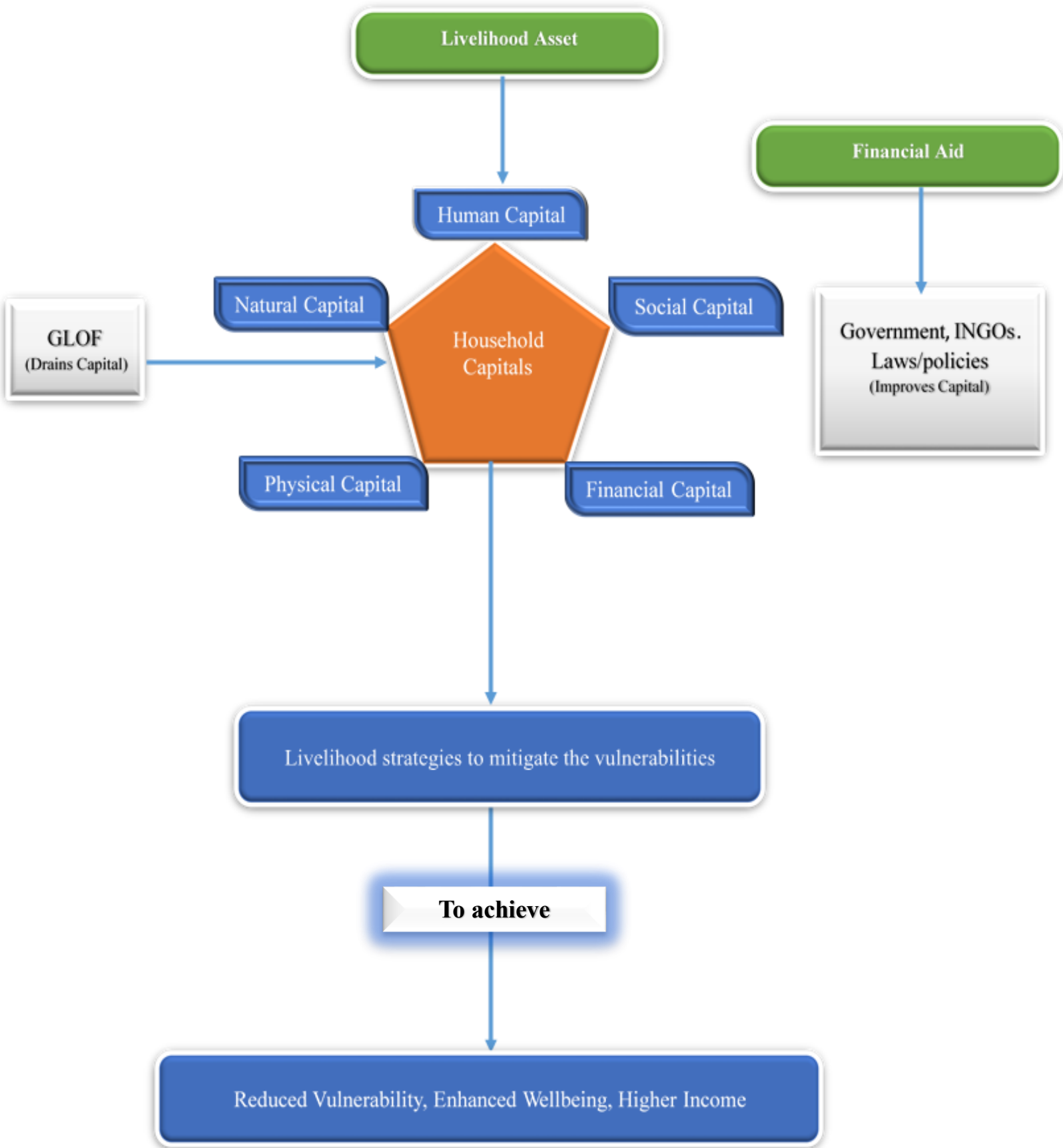
d. Social capital

Social capital is the social resources/relationships people draw in pursuit of their livelihood objectives. These relationships include networks, membership in groups, a relationship of trust and access to wider institutions of society that are vital in the functioning of a livelihood. Government institutions, cooperative groups, non-governmental organizations, and various political and non-

political groups all play an important role in developing social capital for livelihood operations. (DFID, 2014).

1.5 Conceptual Framework

The conceptual framework is based on the sustainable livelihood approach of the Department for International Development (DFID) and its asset pentagon and livelihood outcomes. The impact of glacial lake outburst floods directly impacts the livelihood assets and livelihood outcomes of the community. The role of stakeholders to provide financial aid and adopt livelihood strategies to mitigate the vulnerabilities and enhance the well-being of the community. This study will be based on primary data collected from households and stakeholders directly engaged in the situation. In the first step, GLOF impacts livelihood assets first. The stakeholders can be divided into three main strands: the community, NGOs and INGOs sector, and the government sector. The community-level responses will be collected by questionnaire and Key informant interviews from actively participating stakeholders to facilitate the community of Hunza valley.



Chapter: 2

Literature Review

2.1 Introduction

Global warming and climate change have a significant effect on mountainous communities. The accelerated melting of glaciers and snowfields causes disrupting plants and wildlife, increasing the risk of extreme rockslides, avalanches, and floods. First, we have to discuss the background and frequency of events in Gilgit-Baltistan and Chitral.

2.2 General background

Natural catastrophes have affected Pakistan at various times throughout its history, threatening the lives and livelihoods of its inhabitants. Flash floods, GLOF, earthquakes, landslides, cyclones, heat waves, and drought are examples of natural disasters (H. Khan & Khan, 2008). According to Pakistan's National Disaster Management Authority (NDMA), disaster-related losses have resulted in more than 79077 fatalities and injuries, affecting a total of 198000 people while demolishing 4.3 million dwelling units since the 2005 earthquake. At a period when Pakistan's disaster management systems were still inadequate, the 2005 earthquake alone resulted in 73,338 deaths and 128,309 injuries. The 2010 floods caused havoc on crops of over 5 million kanals, resulting in a direct loss of US\$ 10056 million. Droughts affected a population of 4.5 million people and destroyed over 500,000 animals between 1998 and 2014 (Khawar Mumtaz, 2018).

During the last several decades, the severity and frequency of climatic risks and extreme climate events appear to have grown in Gilgit-Baltistan. Around the HKH includes floods, landslides, GLOFs, and avalanches. Avalanches remain the most dangerous form of natural catastrophe in the area, followed by wind and snowstorms. Natural disasters in Gilgit-Baltistan impacted livelihood

assets from 2010 to 2015, with 306 deaths and 174 injuries, physical capital damages, which included the loss of Pakka houses, which had 15,392 fully damaged and 291 partially damaged houses, and Kacha houses, which included 2,351 fully damaged and 12, 468 partially damaged houses. There are 5,369 fully damaged and 518 partially damaged livestock sheds, a Loss of 3,207 goats and sheep, and 1855 cows and donkeys. Fruit trees numbered 111,539, while non-fruit trees numbered 239,474. Fifty-six bridges were wiped out, 580,044 RFT of water channel damage, and 87,070 RFT of protective bunds. A total of 57 water supply systems have been interrupted. A total of 111 shops were damaged (GB-EPA, 2017).

Globally there have been around 132 climate-related debacles happening in the past year. However, starting on 15 September 2020, 51.6 million individuals worldwide have been recorded as straightforwardly influenced by the cover of floods, dry spells, or storms and the COVID-19 pandemic. More than 3,000 individuals have been murdered on these occasions. The significant out-of-control fires have influenced an expected 2.3 million individuals (generally in the United States), slaughtering in any event 53 individuals. Harsh assessments show that 431.7 million individuals in weak populaces worldwide have been presented with extraordinary warmth during the COVID-19 pandemic. The European heatwave affected 75.5 million people in vulnerable regions, resulting in the overall death of over 9,000 people in July and August (Walton & Aalst, 2020).

The GLOF directly impacts downstream networks, posing a threat to living things, horticulture grounds, timberlands, foundations, and clean water facilities. The International Center for Integrated Mountain Development (ICIMOD's) five Hindu Kush-Himalayan nations of Pakistan, China, India, Nepal, and Bhutan, have an aggregate of 15,003 glacier masses covering a zone of around 33,344 sq. km and 8,790 icy lakes, of which 203 were distinguished as conceivably

hazardous. Hindukush Himalayan Region of Pakistan contains 2420 icy lakes, a zone of icy lakes covered by 126.32 sq. km, and possibly dangerous icy masses are 52. Gilgit-Baltistan has icy lakes, for example, Hunza (110), Shigar (54), Shyok (66), Shingo (238), Astore (126), and Gilgit (614) (Ives et al., 2010).

Shishper Glacier is situated in the Hassanabad area of Hunza in Gilgit-Baltistan. Shishper ice sheet is roughly 16 km, 0.8 km width, and 2500 m above ocean level in Hassanabad stream. This ice sheet began flooding in May 2018; flooding drove further into the valley and hindered the Hassanabad stream because of the arrangement of an ice-dammed lake from upstream. The complete ice-dammed length of the Hassanabad stream is 1.09 km, with a high-level region of 0.40 sq. km (Hussain, 2019). The blockage site is 8 km from the Karakoram Highway through Hassanabad town. There are seven towns with around 15,000 occupants, three extensions, two hydropower plants, five water tanks, two drinking water channels for three towns, and two water system diverts in the upstream zone; these were influenced by Shishper ice-dammed ice sheet lake upheaval flooding. Around 10 million to the US \$ 15 million, expected worth of common and man-made property inclined to conceivable peril from Shishper ice-dammed glacier lake (Baig et al., 2020).

Shimshal valley is an isolated location and a distance of 80 km from Central Hunza valley. This region is almost covered with mighty glaciers. This valley is famous for its seasonal pasture settlement at 3200 and 4600 m. According to inhabitants of Shimshal, these glacial lake outbursts and floods happened several times in 1904, 1920, 1942, 1960, 1979, 1999, and 2017 (Hussain, 2019). Six more giant glaciers are flowing toward Shimshal valley, Khurdopin glacier (47 km), Virjerab glacier (40 km), Mohmhil (35 km), Yazghil (31 km), Malangutti (23 km), and Lupghar (13 km). The distance between Virjerab, Khurdopin, and Yazghil glaciers is 10 km from the upper

Shimshal valley. Every two decades, the movement of the Khurdopin glacier is roughly 1500 times more than the average pace. The most recent surge is up to 20 meters a day in May 2017, creating a glacial lake. The surging of the Khurdopin glacier has blocked the Virjerab River various times in the past and formed a glacial lake. In August 2017, glacier-related floods eroded farmland, damaged roads, and water channels, destroyed bridges, and disconnected the valley from the rest of the country (Iturrizaga & Lasafam, 1996).

The Route of China Pakistan Economic Corridor starts from the northern areas of Pakistan, consisting of a mountainous region rich in glaciers and glacial lakes. These glaciers are water reserves and a vital natural resource by supplying fresh water to millions of people living downstream areas. The socioeconomic and environmental activities depend on these glaciers' resources. In Hunza's famous glaciers, Batura, Passu, Shishper, and Gulkin glaciers are along the CPEC route. There are six identified hazardous glacial lakes for the CPEC route in the Hunza region. In history, many GLOF events damaged bridges and the Karakoram Highway. Passu Lake was observed as a hazardous lake for Passu village. The outburst of the lake between July 2007 and April 2008 damaged the Karakoram Highway, hotels, and dwellings of the Passu village. The eruption of the Shishper glacier damaged the CPEC route and blocked it (Saifullah et al., 2021).

The inhabitants of the Hunza valley of UIB are more vulnerable to natural disasters and GLOF hazards. This GLOFs hazard is a source of loss of livestock, infrastructures, human lives, cultivable land, and pasture resources. In northern areas, glacier melting increases, and the risk factor increases exponentially. Himalayan glaciers are melting at a high pace, affecting water resources in the future, while the Karakoram glaciers are showing stability and gaining mass. Global warming and the rising temperature are the main factors for retreating glaciers in mountainous areas. In Gilgit-Baltistan, there have been approximately 35 GLOF incidents in the

previous 200 years, with the frequency of these GLOF events increasing in recent years. Glacier cover has decreased by 10 % in the last three decades and may cause GLOF events in Hunza Valley (Gilany et al., 2021).

The people of Gilgit-Baltistan's livelihood are based on the agriculture sector, livestock, and fruits. Climate change directly affects natural resources, agriculture productivity, income opportunities, and food security. In the last few decades, inhabitants of mountainous areas have been more vulnerable to land sliding, avalanches, droughts, and floods. The increase in high temperature and rainfall accompanied by melting glaciers has increased GLOF events and flash floods in the country's mountainous areas. In 2015 Chitral experienced heavy monsoon rain, and GLOF events ruined hundreds of acres of agricultural land and thousands of livestock (Hussain et al., 2015)

Researchers conducted a study in the Manas River basin, China. It is located between the south of the Junggar basin and the north of the Tianshan. They used 46 years of data, including precipitation, temperature, and glacial area. In this study, they examine the glacier melting has socioeconomic effects on the Manas River in China. In the past 50 years (1960-2010), the glaciers in the Manas river recedes approximately 82%, it alarming for the future. Manas River rainfall by 16.42 mm, and the temperature rises by 1.19 °C. According to their findings, after the 2030s, the risk of flooding will increase due to the warmer climate. The Manas River is mainly used for agriculture purposes. In the future, uncertainty and shortage of water resources arise, which will affect the environment and socioeconomic systems (Tang et al., 2012).

2.3 Literature related to the stakeholders

The term "stakeholder approach to strategy" first emerged in the mid-1980s. Freeman (1984) defines a stakeholder as an individual or group that influences or has an effect on an institution's aims and objectives (Freeman & McVea, 2001). The stakeholder approach seeks to expand

management's concept of its roles and responsibilities beyond the profit maximization function to incorporate the interests and claims of non-stockholding groups. In contrast, stakeholder theory seeks to systematically address a basic query: that set of stakeholders' merits or requires managerial attention (Mitchell & Agle, 1997).

Stakeholders have been recognized as an important driver for catastrophe mitigation and management. Stakeholder participation is critical while preparing for emergencies and catastrophes. Environmental disasters might be greatly reduced, if not eliminated if each stakeholder's right to participate is honored and their roles are clearly stated. Governments, NGOs, donors, the private sector, the media, academics, regional cooperation, community/citizens, and the immediate environment are all stakeholders in disaster management (Mohd Ahnuar et al., 2019).

Baluchistan is one of Pakistan's earthquake-prone provinces. Because earthquakes have such a negative impact on people and their economies, the participation of stakeholders in disaster preparedness, particularly at the community level, is critical in preventing future damages. At the local level, stakeholders execute initiatives and activities to empower communities in disaster preparedness and risk reduction. The cooperation between provincial and national level authorities, as well as community preparedness, must be improved in order to improve people's knowledge and defensive mechanisms in the event of an earthquake emergency (Ainuddin & Routray, 2012).

In developed countries, disasters threaten society, economic performance, the built environment, and other socio-economic and physical factors. Every year, for example, Australian communities are vulnerable to the catastrophe caused by disasters linked to climate change and sea-level rise. To examine if Australian stakeholders are taking proactive or reactive responses to catastrophes affecting transportation infrastructure. Stakeholder Disaster Response Index (SDRI) is a composite

index that permits direct comparison of stakeholder's methods and indicates the relative contributions of the socio-economic, built environment, and stakeholders' attributes to that entire response. The SDRI has the benefit of allowing direct comparisons of different stakeholders' approaches to catastrophes in society and the built environment. This can help governments, emergency response groups, and disaster management organizations as they allocate scarce resources among many stakeholders. By using more proactive methods for disaster risk management, it lays the path for stakeholders to develop a holistic strategy for a resilient built environment (S. M. H. Mojtahedi & Oo, 2014).

In Romina, local stakeholders are often involved in disaster planning and risk reduction because of their knowledge of the community, its norms, and its habits and for their capacity to assist and control people during crises. They are among the best communicator in their settlements and act as a bridge between national authorities' decisions and local people, making effective risk management plans and securing more lives and economies. Local stakeholders' essential role in reducing the vulnerability of communities and improving societal resilience (Margarint et al., 2021).

The interactions among key stakeholders (building owners, primary insurers, reinsurers, and the government), as well as between the two important risk management mechanisms of insurance and retrofit, are included in the new modeling framework used to inform the design of an improved regional natural disaster risk management in developed nations like the USA. A comprehensive regional disaster loss estimation model is linked with the decision models, and reinsurer and government responsibilities are represented as inputs (Peng et al., 2014).

There is a worldwide concern that natural disasters are becoming more frequent, deadly, and costly. The number of disasters is rising, which has an immediate impact on society and the

environment. While adaptive governance (AG) is suggested as a substitute approach for managing complex issues like disasters, disaster risk reduction (DRR) has been proposed as a systematic mechanism to reduce disaster risks by analyzing the causal factors of disasters, including the reduction of vulnerability and improved preparedness for adverse events. Multistakeholder platforms (MSPs), which are viewed as a variety of organizations working toward better coordinated and integrated DRR actions at various degrees of governance, can be used to put the AG into practice. The collaboration of several organizations is a key component of MSP duties. MSP can carry out direct risk-reduction actions due to its capacity to raise additional funds (Djalante, 2012).

As a result of the direct and indirect effects that natural disasters have on socio-economic circumstances and the built environment, not only local communities but also all residents of the region and, in some cases, the entire country are impacted in the aftermath of severe natural disasters. There are two ways to deal with natural disasters: reactive methods and proactive approaches. According to the majority of research, stakeholders frequently choose reactive techniques to deal with the problems brought on by natural catastrophes. Stakeholder theory, macroeconomic theory, disaster management theory, and decision-making theory are some of the theoretical frameworks that have been developed by stakeholders about natural disasters. Three theories can add to our understanding of how different components of stakeholders' decision-making processes work. We can help stakeholders with reactive or proactive methods before, during, and after natural catastrophes using the theory of disaster risk management. We can help stakeholders with reactive or proactive methods before, during, and after natural catastrophes using the theory of disaster risk management. In the process of managing natural disasters, macroeconomic theory is vital in helping to select suitable socioeconomic factors. To choose the

key stakeholders and control their behavior in the face of natural catastrophes, decision-making theory, and stakeholder theory work together (M. S. Mojtahedi & Oo, 2012).

A case study from Savo, Solomon Islands, which is impacted by extremely devastating volcanic eruptions. In a volcano risk management planning and awareness exercise, participatory rural appraisal (PRA) methodologies and philosophies were applied. We attempted to combine the facilitator and educator roles, and also include the input of all stakeholders (from the community to the national government) in the volcano risk management process. PRA techniques, we can generate integrated scientific/geologic, local/community, and risk assessments and also mitigation action plans from a variety of stakeholder groups (Cronin, et al., 2004).

2.4 Policies domain of Pakistan related to the environment

There are several national-level policies related to climate change and the environment to resolve all potential challenges of climate change adaptation and mitigation. Pakistan was ranked 18th out of 191 countries in the Inform Risk Index 2019 for having the highest global disaster risk levels. Pakistan averages \$1 billion in annual flood losses (World Bank Climate Change Knowledge Portal, 2020).

The National Environmental Policy of 2005 strives to safeguard, conserve, and restore Pakistan's environment to raise citizens' standards of living by sustained development. In addition, this policy offers a comprehensive framework for addressing Pakistan's environmental problems, including air pollution, water pollution in freshwater bodies and coastal waters, improper waste management, deforestation and biodiversity loss, desertification, natural disasters, and climate change. There is no pertinent policy for GLOF disaster mitigation and adaptation (EPA, 2005).

A comprehensive framework for addressing the high levels of disaster risk at the national level is provided by the National Disaster Risk Reduction Policy of 2013. The policy aims to advance both

critical steps to guarantee that upcoming development processes and programs increase resilience and priority efforts to reduce already-existing hazard vulnerability. The policy provides a framework for DRR and also appropriate development plans and initiatives, bringing attention toward priority areas. Gilgit Baltistan Disaster Management Authority actively participated in the adaptation and mitigation of the Shishper GLOF event, although there is no formal policy to mitigate GLOF incidents (NDRRP, 2013).

A framework for tackling the problems Pakistan is currently experiencing or may experience in the future as a result of climate change is provided by the National Climate Change Policy of 2012. The policy offers a thorough framework for creating action plans for national efforts at mitigation and adaptation. This policy aims to lead Pakistan toward climate-resilient development by ensuring that climate change is mainstreamed in the economically and socially vulnerable sectors of the economy. The policy measure related to disaster preparedness establishes evacuation plans for vulnerable areas in the event of Glacial Lake Outburst Floods (GLOF) by setting up suitable methods to monitor the growth of glacial lakes. The sole GLOF-related policy in the disaster preparedness section is this one (NCCP, 2012). The GLOF was incorporated as a policy in the National Climate Change Policy 2021. Create and maintain a community-based, sustainable GLOF disaster response and risk management strategy. The other policy, however, is simply a duplicate of the national climate change policy 2012 (NCCP, 2021).

2.5 Conclusion

From the above-mentioned literature, following interpretations are drawn:

- It is feasible to carry out environmental and socio-economic study of the vulnerable communities. There is authentic literature available on the frequency of events and their impacts on the livelihoods.

- The relevant literature addresses impacts of GLOF on the physical, financial, human, and natural capital, but the impact on the social capital is scarce in literature.
- The pertinent literature discusses the role of Stakeholders with reactive or proactive methods before, during, and after natural catastrophes using theory of disaster risk management.
- There are no significant national policies for addressing and mitigating GLOF.

Chapter: 3

Data and Methodology

This chapter outlines the details of the method of study, data source, and sampling technique.

3.1 Approach of the Research

This was an exploratory research study designed to investigate how people utilize their livelihood assets effectively to cope with and recover from the effects of GLOF incidents. It is based on qualitative analysis. Although primary sources provided the majority of the information, secondary sources also contributed to the development of a more comprehensive picture of the subject. Household survey questionnaires, key informant interviews with stakeholders (government, NGOs, local groups), and focus group discussions represented the primary data. Secondary data were collected through reports, research articles, journals, and case studies, both published and unpublished sources.

3.2 Sampling size and Techniques

In this study, primary data is collected from 143 households. The focus of primary data collection would be to inquire about the recent GLOFs incidents and the related environmental and socio-economic damages imposed in the area. In this study, the entire population was selected. The reason to select the entire population was the area is small and the number of households impacted varies from hamlet to hamlet. According to the data, the residents of Sherabad, Hassanabad were highly affected households, who lost their homes, and land. Moderately affected were those who lost their trees, and land, while, low affected were those who were affected due to the damage to the RCC bridge and blockage of KKH. Moreover, the potential threats of GLOFs, the measures

and responses adopted to avoid and respond to any emergency, and efforts made to raise voices for policy actions on a greater scale to advocate for curbing climate change.

Key Informant Interviews from stakeholders include government, NGO, and local organizations. Six people were interviewed as key Informants (Appendix: 5 Key Informant Survey Profile. Stakeholders provide their services in different areas related to their organizational expertise. Two representatives were from NGOs, three officials were from the government sector, and one representative was from a local organization. These stakeholders were interviewed regarding their key interventions to safeguard the lives and livelihood assets of the community.

The Focus Group Discussion comprises six participants; *Ala Nambardar*, *Nambardar*, and community representatives who are fully aware of GLOF incidents and engage in the preparation and mitigation. The participants belong to Aliabad and Dorkhun valley (Appendix: 3 list of Participants Focus Group Discussion). The representatives of the community identified the key issues and collaboratively work with the government and NGOs to resolve those problems faced by the community.

Chapter: 4

Profile of Study Area

4.1 Geographic and Climatic Conditions of the Region

The Government of Pakistan has renamed its Northern Areas Gilgit Baltistan, and last year, in 2021, it granted Gilgit Baltistan interim provincial status. Hunza is located in Gilgit-Baltistan, in the north of Pakistan. Gilgit Baltistan is situated between the longitudes of 720.54 and 780 East and the latitudes of 340.54 and 370 North. High mountain ranges such as the Himalayas, Hindu Kush, and Karakorum may be found in the northeastern and northwest parts of the country (Khan et al., 2020). Between latitude 35055 and 37006 N and longitude 74003 and 75049 E, the Hunza River Basin (HRB) is located. The drainage area of the Hunza river basin is 13,567 km², with glaciers covering 30 to 38 percent of the total area. There are 1384 glaciers, with three large glaciers, Khurdopin, Batura, and Hisper, covering roughly 1/3 of the glaciated area (Ali et al., 2021). Hunza shares its border with Xinjiang province China in the northeast, in the northwest by the Wakhan district of Afghanistan's Badakhshan province, and Ghizer district, in the west. There are three geographic subdivisions of Hunza valley. Upper Hunza consists of the Gojal tehsil of Hunza, while Central and Lower Hunza are part of the Aliabad tehsil. The streams that unite to make up the Hunza River are sourced in the passes of Kalik, Mintaka, Parpik, Shimshal, and Khunjerab, near the Pakistan-China border. The upper course of the Hunza River took care of by meltwaters from a few icy masses, including the Batura, Passu, Ghulkin, and Gulmit glacial masses in its upper. Its centre compasses, from outlet glacial masses of the Rakaposhi, including the Minapin, Pisan, and Ghulmet, just as from the Hassanabad-Shishper-Mutschual glacier framework on its northern banks (Derbyshire & Fort, 2006).

Rainfall and high temperatures are the primary causes of catastrophic floods in Pakistan, and these occurrences have a devastating impact on people's lives and livelihood assets. Monsoon rains in 2010 caused over 1500 deaths and hundreds of thousands of people to lose their livelihood assets. Villages were flooded, bridges were swept away, highways were wrecked, millions of hectares of crops were destroyed, and health concerns arose across the country. Hunza-Nagar has an average maximum temperature of 35.9 degrees Celsius and a minimum temperature of 16 degrees Celsius, with an annual rainfall of 136.2 mm in April and 28.3 mm in November. The severe temperature event affects the glaciers and the ecosystem of mountainous places (Afsar et al., 2013).

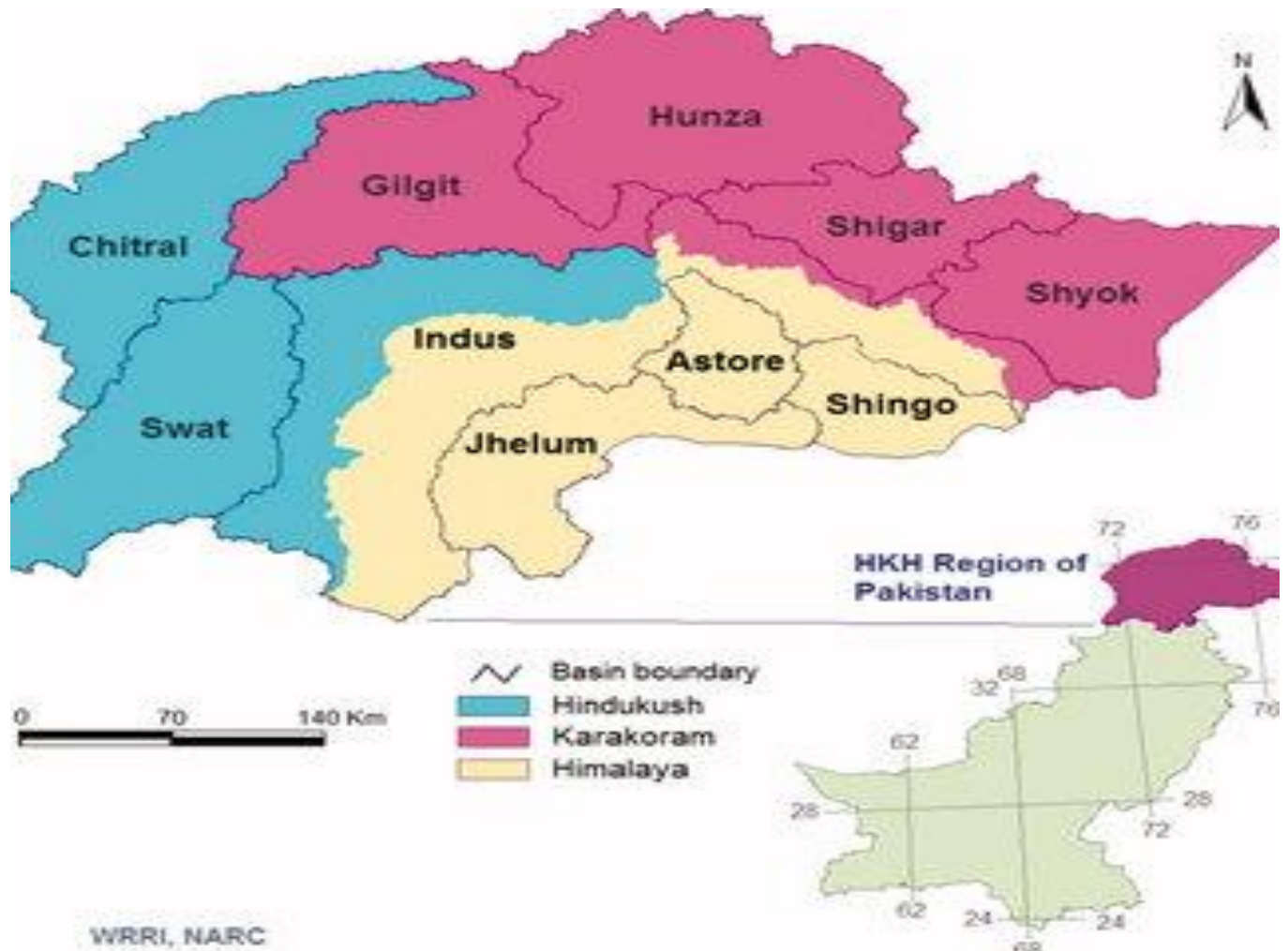


FIGURE 3: MAP OF THE HINDUKUSH, KARAKORAM, AND HIMALAYA REGION OF PAKISTAN
SOURCE: (ROOHI, 2012)

4.2 Profile of Hassanabad Valley

Hassanabad is a small village between Aliabad and Murtazabad Hunza, Pakistan. China Pakistan Economic Corridor is passed through this village.

Sherabad contains 23 houses, two flour mills, a hydropower generation plant, a generator for power supply, and a community. In the previous four years, ten houses were partially damaged, one under construction hydropower unit was wiped out, another hydropower unit was partially damaged, and the community centre has also damaged as a result of Shishper GLOF. Because of its proximity to a valley, this hamlet has been designated as a red zone.

4.3 Description and surge history of Shishper glacier

Shishper Glacier is 12 km long and covers an area of nearly 24.9 km². This glacier probably comes from six tributary glaciers. Shishper is located east of the Batura Wall, the highest point in Pakistan's Batura Muztagh. Shishper glacier is named after Shishper Mountain, which measures 7611 m (24,970 feet) and is located near Hassanabad valley in central Hunza. The Shishper glacier's snout is around 4 km away from the Karakoram Highway (PMD, 2021).

Shishper Glacier is a surging type glacier nourished mainly through snow avalanches. The melting of glacial lakes occurs mainly during the summer months due to rising temperatures. Surges of the Shishper glacier were observed in 1892-1893, and then again in 1974. The advance and retreat cycle of the Shishper glacier is 45 years, according to local knowledge of the local community (Karim et al., 2020). Since 2016, the Shishper glacier has been aggressively surging. In May and June 2018, it surged at a rate of up to 43.3 meters per day. In November 2018, the end of the Shishper glacier collided with the opposite face of the Hachindar Mountain, blocking the flow of meltwater from the Muchuhur glacier, and resulting in the development of a glacier-dammed lake. Four GLOF events have been occurred on (23 June 2019, 29 May 2020, 18 May

2021, and 7 May 2022) with a peak discharge from Shishper glacier-dammed lake of 5500 and 5000 cusecs. It damaged the area's physical and natural capital (PMD, 2021).



Re-Formation of Ice-dammed Lake due to Shishper Glacier surge

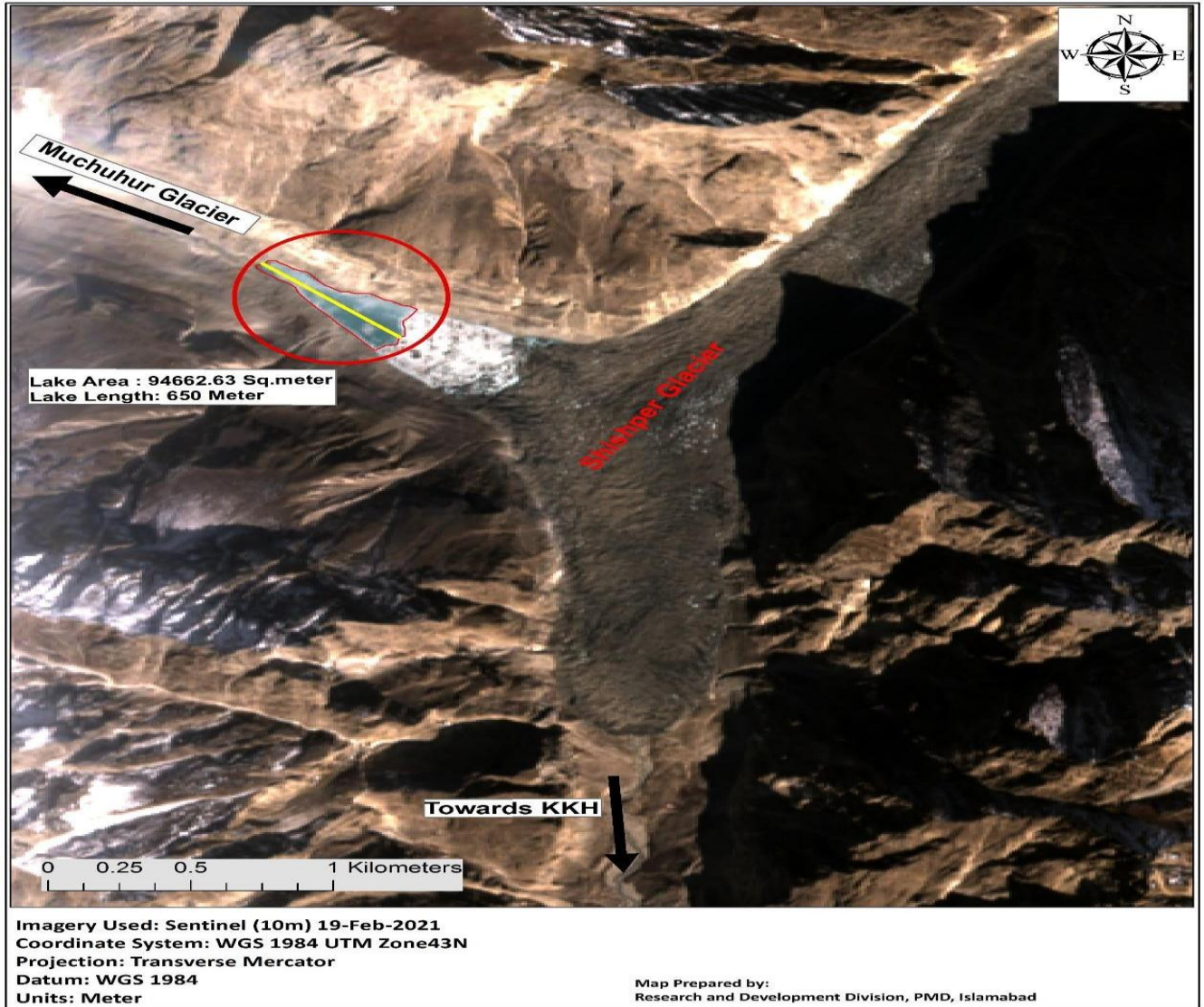
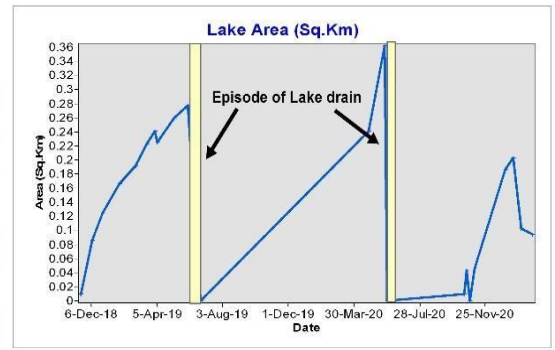
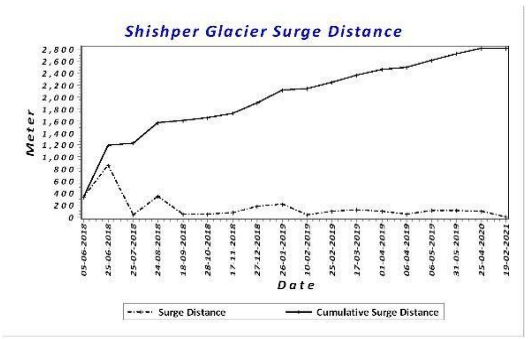
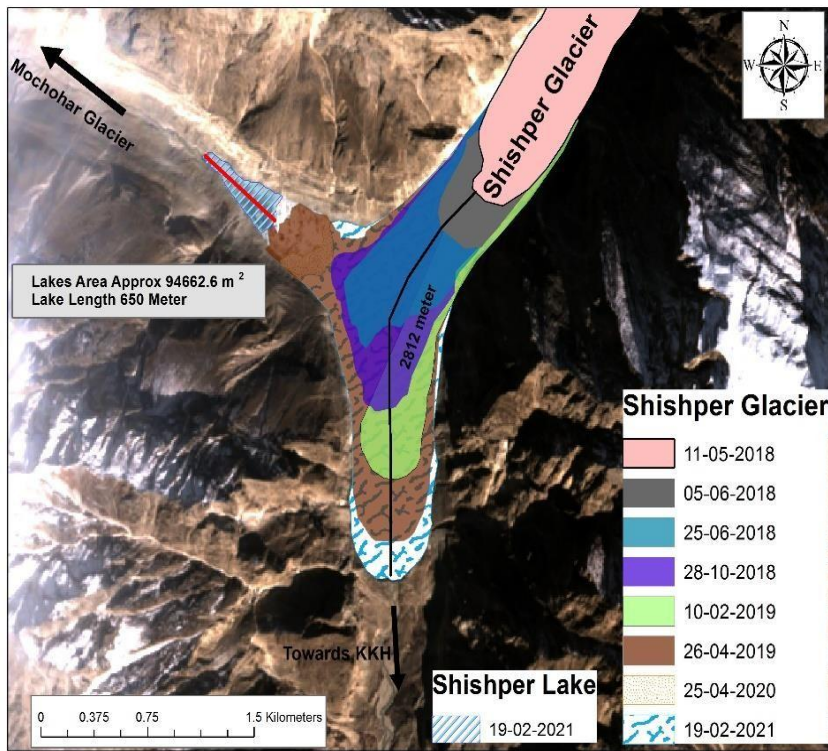


FIGURE 4: FORMATION OF GLACIAL DAMMED LAKE INITIATED BY THE BLOCKAGE OF GLACIER MELT WATER FROM MUCHUHUR GLACIER BY SHISHPER GLACIER IN NOVEMBER 2018.

SOURCE: (PMD, 2021)



Spatio-Temporal Analysis of Surge in Shishper Glacier, Hunza



Imagery Used: Sentinel (10m)
 Image Date: 19-Feb-2021
 Coordinate System: WGS 1984 UTM Zone43N
 Projection: Transverse Mercator
 Datum: WGS 1984
 Units: Meter

Map Prepared by:
 Research and Development Division, PMD, Islamabad

FIGURE 5: THE ANALYSIS OF SHISHPER GLACIAL DAMMED LAKE
 SOURCE: (PMD, 2021)

Chapter: 5

Results and Discussions

5.1 Responses of Households

5.1.1 Profile of Respondents

The study aims to understand better the changes in livelihood assets of Hassanabad valley households affected by Shishper GLOF disasters. Male and female individuals over the age of 20 were the desired respondents for this study, and the home was used as the unit of analysis. The respondents answered the questions in coordination with the other household members present during the interview. Due to economic activity outside the home, male members of households are typically not present at home throughout the day. Collect an equal number of responses from men and women to avoid gender bias. This gender and age gap allows for the inclusion of persons of various ages and shared experiences related to GLOF incidence. The majority of the responders in the house were household members, although 45.5 percent were household heads and 54.5 were other members. The age distribution is shown in Figure 6. Approximately 50 % of the Head of HH's age is above 50 years, and the average age of the head of a household was 53.50 years.

TABLE 1: FREQUENCY DISTRIBUTION OF GENDER COMPOSITION AND AGE OF RESPONDENTS

Attribute of Respondents	Group	Frequency	%
Age distribution of Head HH	30 – 40	25	17.5
	41 – 50	48	33.6
	51 – 60	26	18.2
	61 and above	44	30.8
	Total	143	100
Gender Composition	Male	76	53.1
	Female	67	46.9
	Total	143	100
Status in their Households	Household Head	65	45.5
	Household Member	78	54.5
	Total	143	100

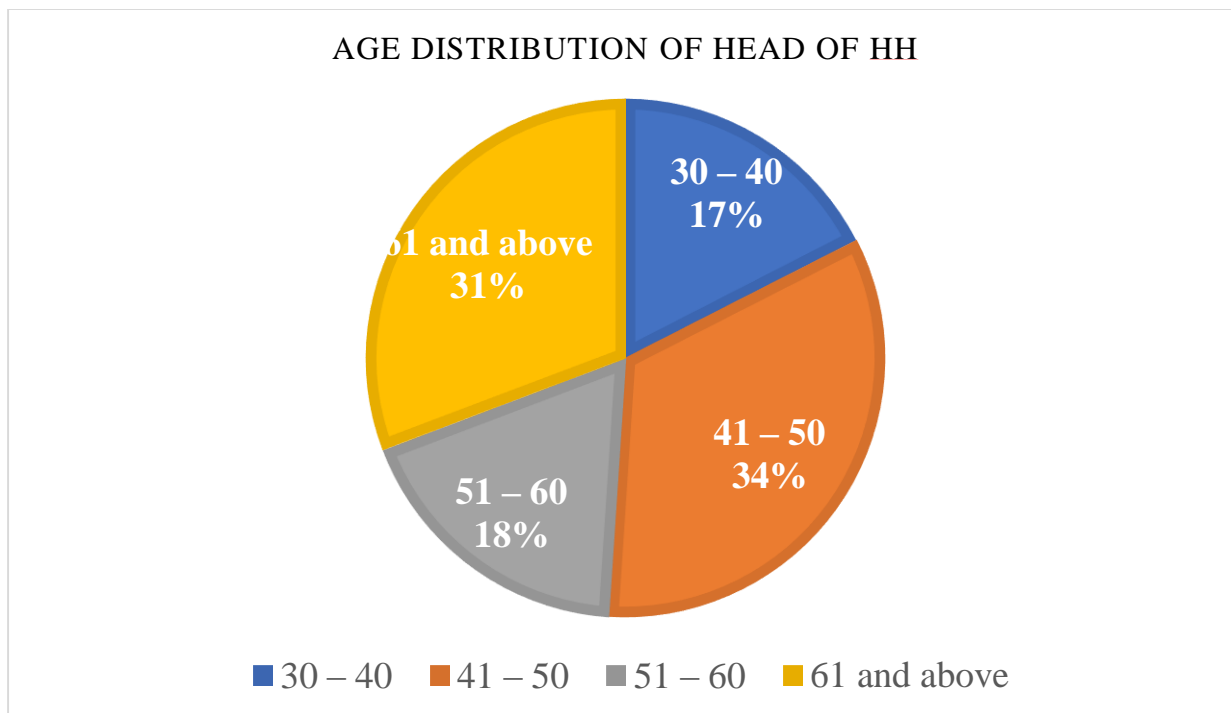


FIGURE 6: AGE DISTRIBUTION OF HEAD OF HOUSEHOLD

5.1.2 Changes in Natural Capital

Natural Capital is closely linked with vulnerability because GLOF events destroy natural capital like agriculture, orchard, barren land, and forest, erode on both sides of the Nullah, disrupt irrigation and drinking water facilities, and wipe out water channels. Climate change affects seasonal and long-term fluctuations in agricultural production. GB occupies roughly 2% of the cultivable land area in a total area of 72,971 km². In the GB, the agricultural sector employs 80 percent of the workforce, providing vegetables, fruits, cereal crops, and hay for livestock (GB-EPA, 2017). Potato is a significant cash crop in GB, with 8422 ha of agricultural area under cultivation and a yield of more than 131,275 tons, which is supplied to the domestic market (Wu et al., 2014).

Natural capitals are significant to the rural and mountainous areas whose livelihood is associated with agriculture and livestock. Agricultural land had been the primary livelihood source for most

households in the village. The community of Hassanabad village grew potatoes, cherries, and other fruits being cash crops that enabled these people to educate their children and fulfil their basic needs.

According to 74.1 percent of respondents, they lost their land was affected somehow or the other as a result of GLOF events, with 64.3 percent losing 2 Kanal or less of land and 9.1 percent losing more than 2 Kanal of land. Households seek compensation for land losses, yet stakeholders have no policy available to compensate for land losses. They assist homes by building protective walls to safeguard habitat lands.

Figure 8 illustrates the majority of land damage, 77.6% for cultivated land and 14% for non-cultivable land.

TABLE 2: FREQUENCY DISTRIBUTION OF AGRICULTURE LAND

Responses	Groups	Frequency	%
Agriculture Land	Yes	140	97.9
	No	3	2.1
		Total	143
If Yes, Agriculture land in Kanals	0.1 – 4 Kanal	115	80.4
	5 – 9 Kanal	19	13.3
	10 and above	6	4.2
		Total	140
Land affected by GLOF in the past five years	Yes	106	74.1
	No	37	25.9
		Total	143
If yes, how many Kanal of land affected	0.1 – 2 Kanal	93	65
	2.1 – 4 Kanal	9	6.3
	above 4 Kanal	4	2.8
		Total	106
Land damages	Agriculture	19	13.3
	Orchard	92	64.3
	Barren	20	14
Type of Damage	Wiped-out	91	63.6

Erosion	60	42
Loss of fertility	15	10.5

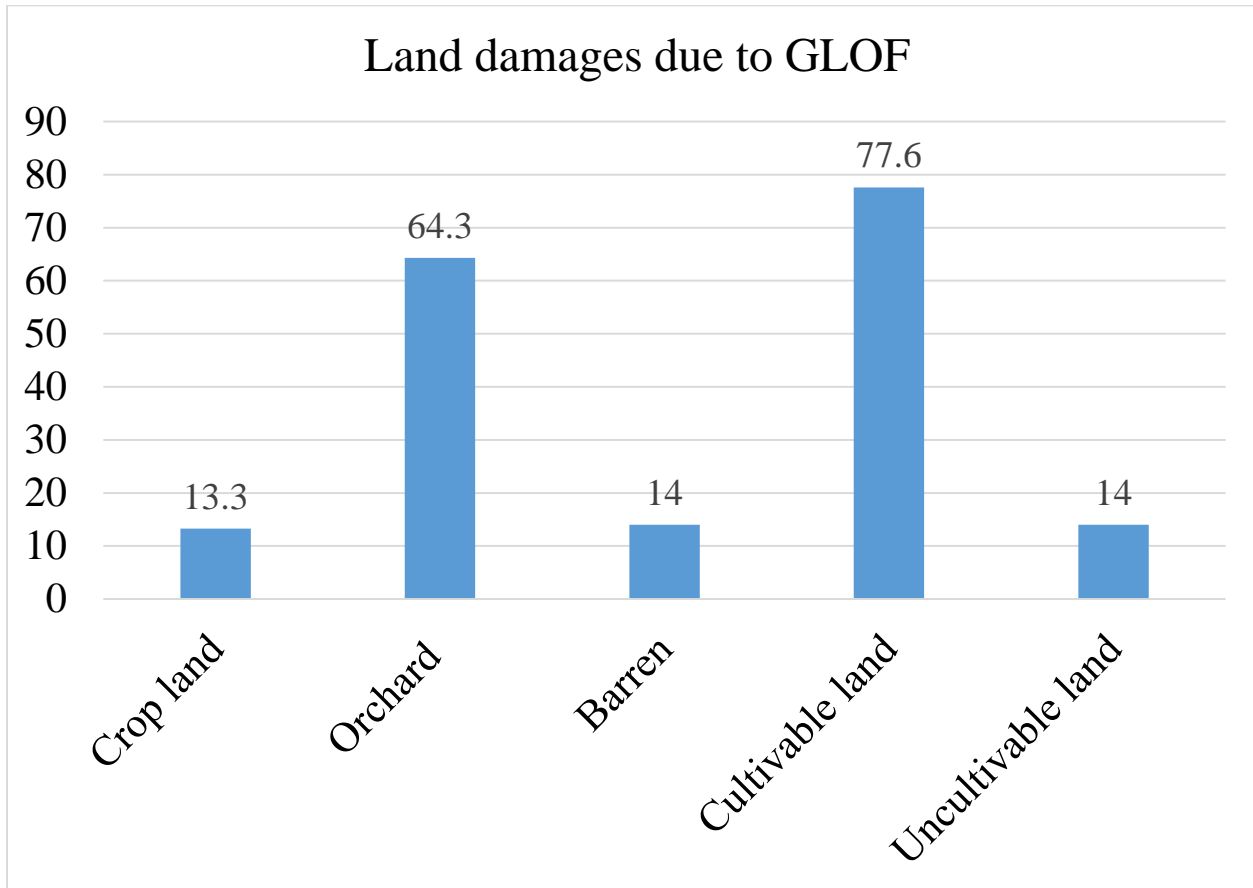


FIGURE 7: LAND DAMAGED DUE TO GLOF EVENTS

Major fruit trees in Hassanabad include apricot, apple, mulberry, pear, peach, walnut, cherry, almond, pomegranate, and grapes. Non-fruit trees include keekar, sea buckthorn, poplar, and lunthus. Almost more than 2500 fruits and wild trees were destroyed, resulting in a loss of 5 million rupees in economic value. These fruit and wild tree damages and the associated financial losses are illustrated in table 3. Figure 9 depicts the loss of 1 to 40 trees (fruit and wild trees) by 73 percent of the community. It is a massive loss for the poor community whose income is based on these natural resources.

TABLE 3: FREQUENCY DISTRIBUTION OF FRUIT AND NON-FRUIT TREES

Responses	Groups	Frequency	%
GLOF destroyed fruit and wild trees	Yes	83	58
	No	60	42
		Total	143
Total Nos of fruit and wild trees	1 – 20 trees	56	39
	21 – 40 trees	12	8
	41 – 60 trees	5	3
	61 and above	10	7
	Total	83	58
Total value of trees in PKR	Under 30000 PKR	21	15
	30001 – 60000 PKR	32	22
	60001 – 90000 PKR	10	7
	90001 and above	20	14
		Total	83

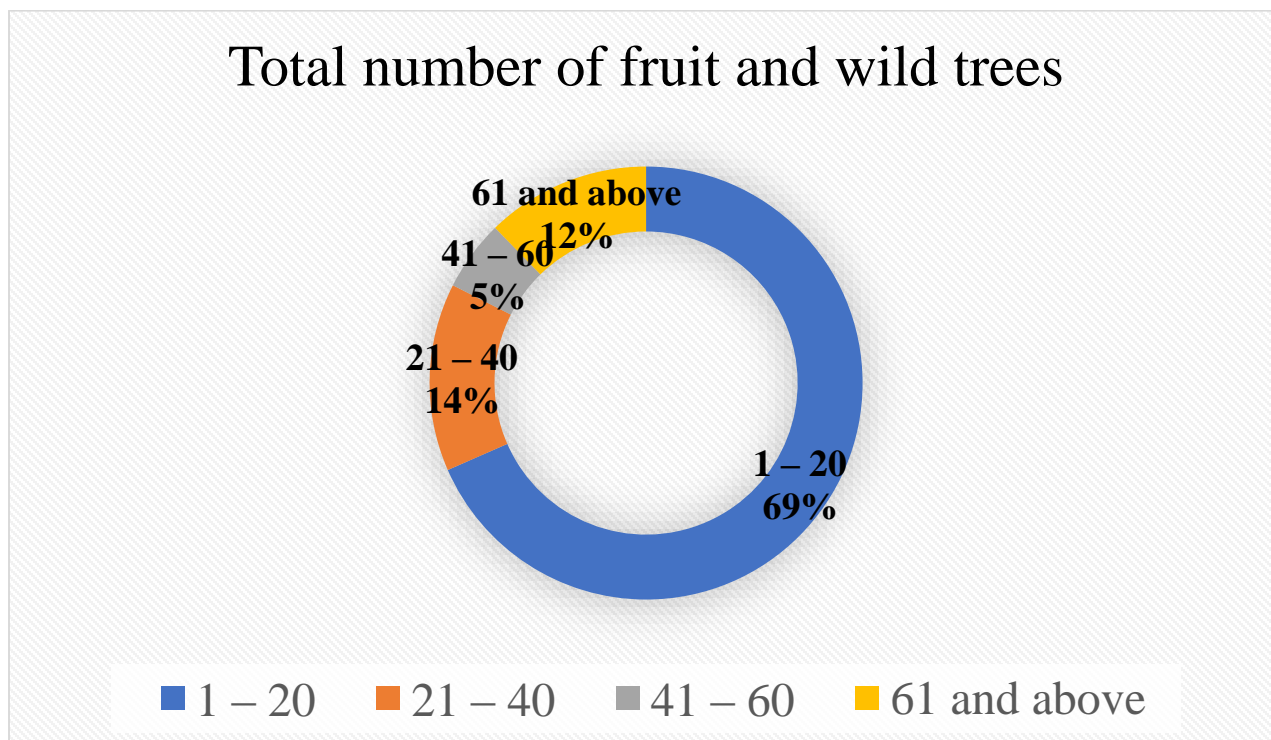


FIGURE 8: TOTAL NUMBER OF FRUIT AND WILD TREES WIPE OUT IN GLOF EVENTS

Households with more agricultural land, orchards, and human resources managed more livestock than those with fewer facilities. On average, Hunza residents keep at least a few cows and goats to meet their domestic demands. Those who have extra milk can sell it to earn small cash. Households can also make a small cash income by selling butter and eggs.

The GLOF incident has had no significant impact on livestock; 76.6 percent of households have livestock. Most of the habitat in Hassanabad belongs to the Ganishkuch tribe, and the Ganishkuch pasture is accessible for grazing animals; however, three pastures' accessibility is limited due to glacial movement Broung Pasture, Dirmiting Pasture, and Khurokuch Pasture. Shepherds have not taken animals for grazing in these pastures in the last three years. In 2019 Dirmiting pasture (Shishper valley) alone, 142 Yaks died as heavy snowfall resulted in starvation. In usual conditions, owners used to bring yaks to the lower altitude where they could find food during winters. Poor livestock owners have suffered a significant economic loss because they have received no assistance from the Agriculture, Livestock, and Fisheries Department GB.

Table 4: Frequency distribution of livestock and pastures

Responses	Groups	Frequency	%
Livestock	Yes	111	76.6
	No	32	22.4
		Total	143
Affected due to GLOF	Yes	0	0
	No	111	76.6
		Total	111
Access to Pastures	Yes	143	100
	No	0	0
		Total	143

Every family in Hassanabad village has access to clean drinking water, including tap water, pond water, spring water, stream water, and river water. Figure 10 depicts every household has multiple sources of water supply. Every household in the village has access to adequately regulated tap water for drinking, cooking, and other needs. In the case of an emergency or a disaster, residents have access to additional resources like ponds, natural springs, streams, and rivers for drinking and cooking. These facilities are utilized for drinking and irrigation in Hassanabad and the surrounding areas. The government is primarily responsible for managing and supplying drinking water to the residents. During the GLOF, the government provided a water tanker to Mohalla Sherabad Hassanabad. Although about 50.3 percent of households obtain their drinking water from outside sources, the pipeline of drinking water facilities is not repaired. The Hassanabad valley is essential for supplying water to the Aliabad-Hyderabad irrigation channel, the only water source for a 6 sq. km agricultural area on the upper side of Aliabad, Dorkhun, and Hyderabad. However, less than five water channels were destroyed, and water supplies were affected, including a critical irrigation channel that served as a lifeline for Hassanabad and adjacent villages. Most agricultural and orchard land has dried up mainly due to the lack of timely water supplies. Due to GLOF, the main water channel to the powerhouse has also been disrupted, and the families were without electricity for a week. More than half of families are unsatisfied with the role of government in protecting their natural capital.

TABLE 5: FREQUENCY DISTRIBUTION OF SOURCES OF WATER, EATER CHANNELS, AND ENERGY SHORTAGE

Responses	Groups	Frequency	%
Sources of Water prior to GLOF	Tape Water	143	100
	Pond	24	16.8
	Natural Spring	56	39.2
	River and streams	83	58
GLOF damaged the Water supply line	Yes	143	100

	No	0	0
	Total	143	100
Water requirements after GLOF	Same as before	71	49.7
	Fetch from outside	72	50.3
	Total	143	100
Water Channel Affected	Yes	143	100
	No	0	0
	Total	143	100
How many water channels Kanal of land affected due to the cut of water supply	1 – 5 water channels	143	100
	1 – 8 Kanal	105	73
	8 – 16 Kanal	31	22
	16 and above	7	5
	Total	143	100
Power shortage due to disruption of water channel	One week	134	93.7
	Two weeks	9	6.3
	Total	143	100
Role of govt to protect natural capital	Positive response	46	32.2
	Negative response	97	67.8
	Total	143	100

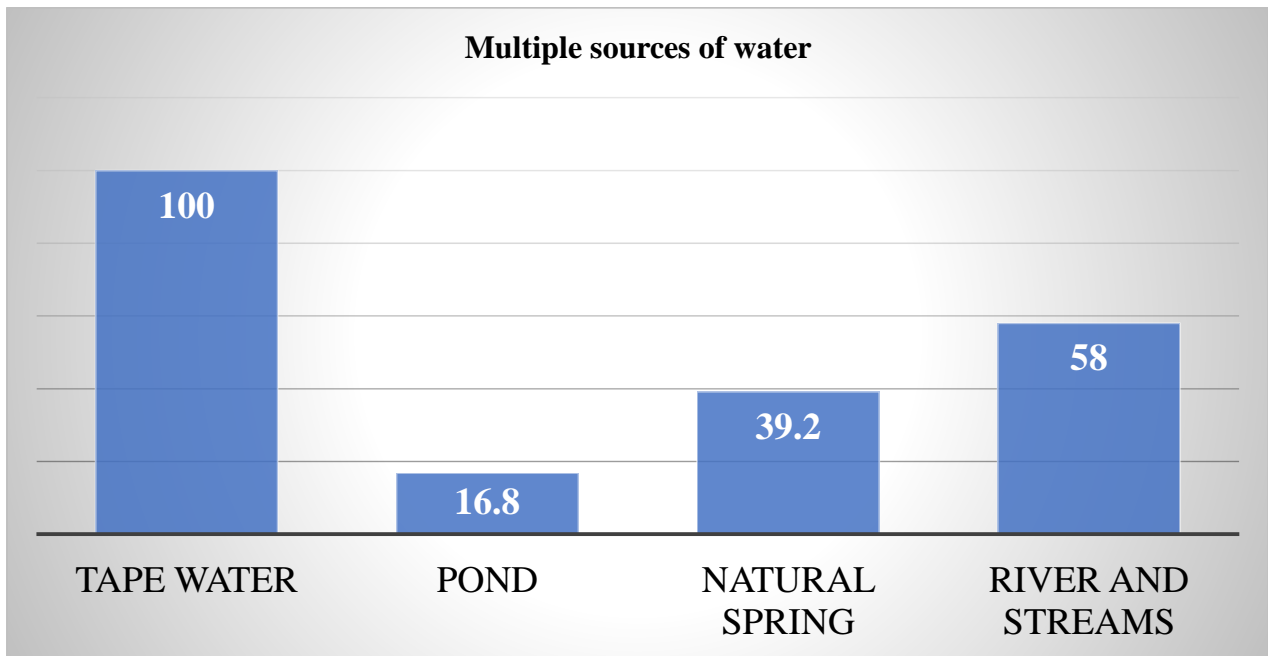


FIGURE 9: MULTIPLE SOURCES OF WATER

5.1.3 Changes in Social Capital

In the context of the framework for sustainable livelihoods, it refers to the social resources that individuals rely on to survive. Social resources are the networks and connections that strengthen people's trust and capacity to collaborate and access larger organizations such as the government, INGOs, and NGOs. Individuals and communities may use social capital as a valuable asset in developing and responding to emergencies (Willis, 2011).

According to Table 6, 55.9 percent of respondents are involved with volunteer groups in various capacities, and these organizations aim to improve the lives of Hassanabad valley residents. The organization assigned a role to each member (Ladies, gent Volunteers, boys Scouts and Girl Guides). Boys' scouts and gents' volunteers assisted the community in evacuation and dismantling houses in the red zone, distributing rations, providing volunteer services to relocate movable assets to safe locations, and collaborating with stakeholders during the lake's outburst. Figure 11 represented 45.5 percent of Hassanabad valley households and family members who attended training sessions led by stakeholders. Locals who have been trained respond more effectively and protect themselves and others. Ladies' volunteers and girls' guides attend risk management awareness sessions and training to prepare themselves for emergencies better. The collaboration within the community is tremendous; locals outside the village or country have started a Facebook campaign to assist a low-income family in reconstructing a house that the GLOF has damaged; a million-rupee fund has been sent to the head of household. They formed committees to address and represent the community's issues. The committee's role is to identify community issues and concerns and provide perfect information to stakeholders to resolve the problems. As seen in the table, 83.2 percent of the community was involved in improving social capital, recovery services,

and reconstruction. Almost half of the community is satisfied with the mechanisms formulated and implemented to streamline social capital.

Government and non-governmental organizations (NGOs) are collaborating to develop policies and assist communities in mitigating the impact and minimizing the loss of lives and livelihood assets. During the GLOF, stakeholders worked together to provide technical support and disaster recovery assistance to lessen the impact of the GLOF and assist affected populations. The government, other non-governmental organizations, and local groups assigned relief management and distribution responsibilities to various non-governmental organizations. Under the supervision of the Community Based Disaster Risk Management Committee (CBDRMC), fair distribution of relief and rations to affected or deserving people in a community. Social capital may be understood through the assistance that individuals have received from various organizations in relief and cash.

TABLE 6: FREQUENCY DISTRIBUTION OF SOCIAL CAPITAL

Responses	Groups	Frequency	%
Volunteer Member	Yes	80	55.9
	No	63	44.1
Total		143	100
Name of Organization	Boys Scout Association	6	4.2
	CBDRMC	2	1.4
	CERT	11	7.7
	FOCUS	1	.7
	Gents Volunteer Corps	18	12.6
	Girls Guide Association	6	4.2
	Ladies Volunteer Corps	36	25.2
Total		80	55.9
Training from NGO, INGO, and Government related to disaster management	Yes	65	45.5
	No	78	54.5
Total		143	100
Community Involvement in social capital improvement	Yes	119	83.2
	No	24	16.8

		Total	143	100
Streamline social capital in post GLOF activities	Satisfied		71	49.7
	Not Satisfied		72	50.3
		Total	143	100

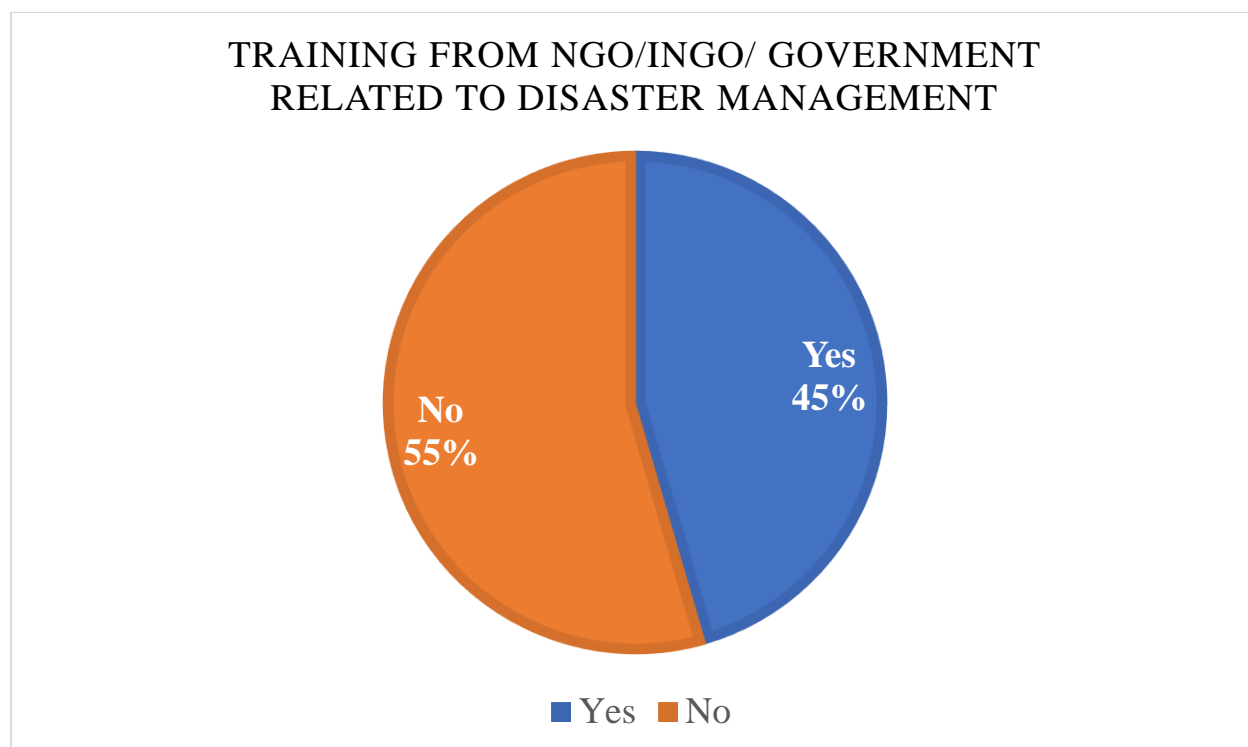


FIGURE 10: TRAINING FROM NGO/INGO/GOVERNMENT, RELATED TO DISASTER MANAGEMENT

5.1.4 Changes in Human Capital

Our primary focus is on two human capital indicators: health and education. There are around 150 houses in this village; however, there is no basic health facility. People get treatment at Aliabad Hunza or Gilgit city.

Although there have been no significant physical injuries or deaths due to GLOF, families demand a basic health unit with an expert staff and emergency medications. Peoples usually become weak and ill in catastrophe situations due to a lack of food products; however, this problem did not

impact the people of Hassanabad, where stakeholders have been delivering rations to deserving families. Locals also cultivate crops and vegetables and consume dairy products.

TABLE 7: FREQUENCY DISTRIBUTION OF HEALTH UNIT, AND INJURIES OF GLOF

Responses	Groups	Frequency	%
Health Unit	Yes	0	0
	No	143	100
Total		143	100
Injuries due to GLOF	Yes	0	0
	No	143	100
Total		143	100

Table 8 and graphical Figure 12 show the educational status of the head of the household as follows: 25.9 percent were illiterate, while the remaining 74.1 percent were literate. Moreover, shown in the table, the highest level of education among the households was 60.8 percent of members having a bachelor's degree or higher. It demonstrates that the literacy rate is higher than the head of the family.

TABLE 8: FREQUENCY DISTRIBUTION OF EDUCATION STATUS OF RESPONDENTS

Attribute of Respondents	Group	Frequency	%
Education Status	Education level of Head HH		
	Illiterate	37	25.9
	Primary	38	26.6
	Middle	23	16.1
	Matric	19	13.3
	Intermediate	12	8.4
	Bachelor	12	8.4
	Masters	2	1.4
Total		143	100
Highest Level of Education HH Member	Primary	2	1.4
	Middle	9	6.3
	Matric	24	16.8
	Intermediate	21	14.7
	Bachelor	28	19.6
	Masters	55	38.5

M.Phil.	4	2.8
Total	143	100.0

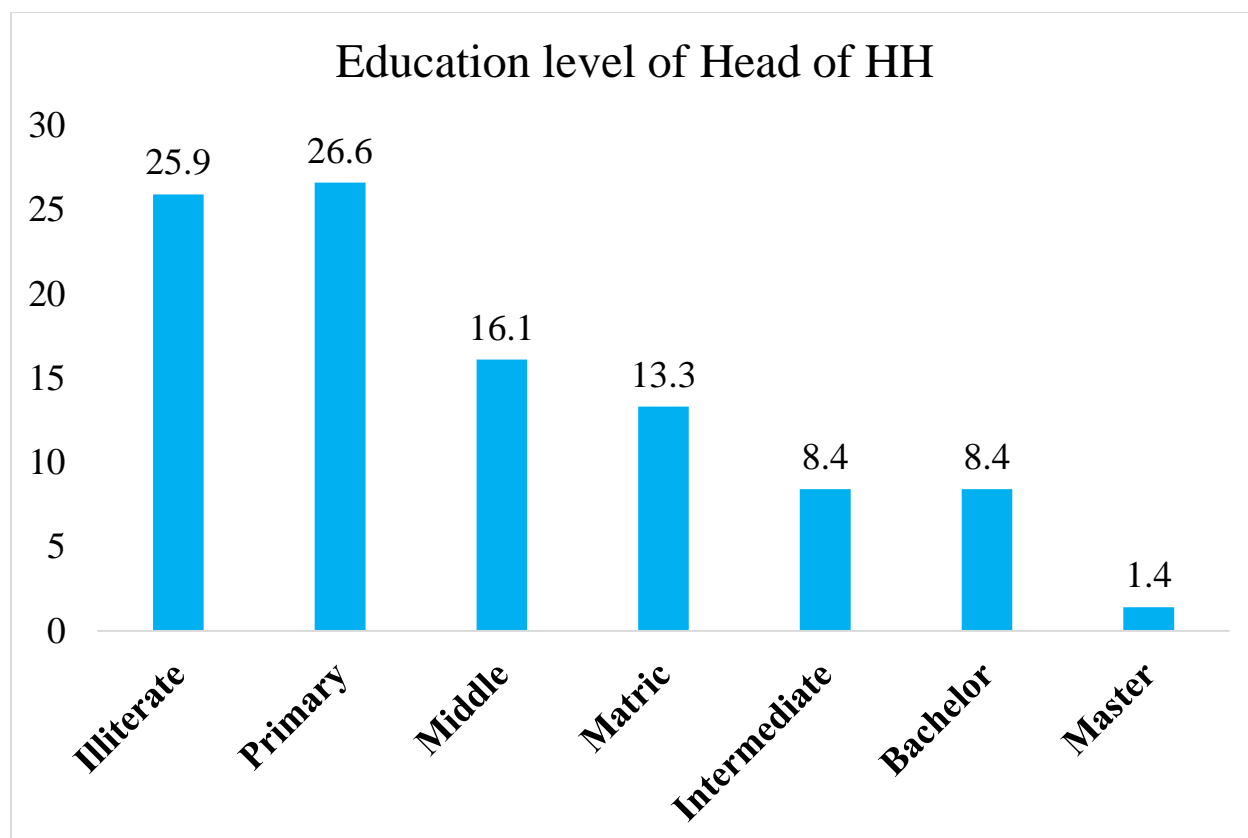


FIGURE 11: EDUCATION LEVEL OF HEAD OF HOUSEHOLD

one private school, ECD centre for students in Hassanabad valley; many students from this village are pursuing Master's, MPhil, and PhD degrees at various national and international universities, while school and college students are studying in Aliabad, Murtazabad, and Gilgit. Most kids attend a community-based English medium school because their parents believe that the quality of education is higher in these schools. As a result, even though teachers at government schools were more professional and competent than those in community schools, the strength of students at government schools was low. The literacy rate among young students is high, and the total literacy rate in this district is more than 90%. There was no direct impact of GLOF on academic

institutions. Students suffered from road and RCC bridge damage; most Sherabad, Roshanabad, and Gawokin students missed classes, whereas Centre and Haraum students had no inconvenience missing school. Only 36.4 percent of students not attended a week of classes. Due to Covid-19, the majority of schools were closed. In this village, 96.5 percent of households do not have access to the internet, and just 3.5 percent have access to the internet at home. The majority of university students from rural regions study in Pakistan's major cities. Due to the Covid-19 epidemic, all educational institutions worldwide have been suspended, and online classes have started. Most students return to their homes, and the lack of internet access in rural regions has become a severe challenge for students. It is tough for students from Hassanabad village to go daily to FG Boys High School Aliabad Hunza to access internet amenities. Another difficulty that students encountered was the schedule of online classes; while some classes were held in the evening, the internet facilities centre was open from 9 a.m. to 4 p.m. The majority of students miss their evening classes, which has a negative impact on their academic performance. The internet has a beneficial and significant role in formation human capital, supporting human capital's absorptive ability. Freelancing opportunities are growing in Gilgit Baltistan, and training sessions are being held for students to help them develop their freelancing skills. The major challenge for freelancers is a poor internet connection and a lack of energy.

This valley has no government or private sector technical or vocational centers. One vocational facility for females in Centre Hassanabad is managed by a local woman, where women study cutting and sewing ladies' clothes and making handicrafts. The vocational center's owner pays the workers on a work-by-work basis. Most of these women are uneducated; by working in this vocational facility centre, they can support their families. This vocational training Centre is not impacted by GLOF because the location is safe and far from Hassanabad Nullah.

TABLE 9: FREQUENCY DISTRIBUTION OF EDUCATIONAL, INTERNET FACILITIES, AND TECHNICAL CENTRE

Attribute of Respondents	Group	Frequency	%
Educational facilities affected due to GLOF	Yes	52	36.4
	No	91	63.6
	Total	143	100
Missed school or college due to GLOF	1 – 3 days	9	6
	4 – 6 days	20	14
	A week	23	16
	Total	52	36
Internet facilities	Yes	5	3.5
	No	138	96.5
	Total	143	100
Technical and vocational centre	Yes	40	28
	No	103	72
	Total	143	100

5.1.5 Changes in Physical Capital

Changes in the physical structure of local dwellings, as well as changes in access to essential amenities for these households, as a result of the GLOF incident. Physical capital is a vast concept in and of itself; the two most important indicators defining the idea are the quality of the house and the physical availability of fundamental services. This term is especially relevant in the context of hazards like GLOF, which only becomes a disaster if it threatens lives and assets.

A traditional house in Hassanabad village has a central area of around 5.5 meters square and is separated into six sections. The cooking stove, or *Bukhari*, is located in the centre part. A square opening in the roof just over the *Bukhari* or fireplace enables smoke to escape and "fresh air" to enter the dwelling. The remaining space is used for seating, sleeping, and storage. Indigenous masons build these traditional dwellings under the climatic requirements of the study area. The primary building resources for such houses are mud, stones, and wood. After completing the KKH, people started to travel to cities in search of education and work possibilities. They get exposure

to urban dwellings and lifestyles, which has resulted in adaptations and upgrades to their own houses. Currently, most individuals use cement, sand, and stone in their walls, while others use cement bricks because they are less expensive. Traditionally, just a few houses had separate rooms and baths for each household member. People are more aware of health and hygiene concerns these days; therefore, they prefer to have separate rooms, washrooms, and kitchens.

5.1.5.1 Characteristics of housing in Hunza

TABLE 10: FREQUENCY DISTRIBUTION OF PHYSICAL CAPITAL

Responses	Groups	Frequency	%
House	Kaccha	1	.7
	Pakka	142	99.3
Total		143	100
Damaged House due to GLOF	Yes	10	7
	No	133	93
Total		143	100
Financial cost of house	800,000	1	.7
	1800000	1	.7
Total		2	1.4
Source of Energy	Electricity	143	100
Impact Power plant	Yes	143	100
Road damage	Yes	143	100
Road reconstructed	Yes	0	0
	No	143	100
Total		143	100
Distance: Home to Concrete road	Within 500 meters	105	73.4
	Within 1 km	32	22.4
	With 2 km	4	2.8
	More than 2 km	2	1.4
Total		143	100
Distance: Access to Market from house	Within 500 meters	5	3.5
	Within 1 km	6	4.2
	With 2 km	40	28
	More than 2 km	92	64.3
Total		143	100
Distance: Nearest hospital from house	Within 1 km	4	2.8

	With 2 km	38	26.6
	More than 2 km	101	70.6
	Total	143	100
Distance: School and college from home	Within 500 meters	7	4.9
	Within 1 km	5	3.5
	With 2 km	39	27.3
	More than 2 km	92	64.3
	Total	143	100
Mode of Transportation	Van	81	56.5
	Bus	41	28.7
	Suzuki	60	42.2
	Flight	6	4.2
	Own Vehicle	32	22.4
	Bike	6	4.2

5.1.5.2 Access to basic facilities

In Hassanabad Hunza, 99 percent of the home buildings are *pakka*. *Pakka* houses are built of cement, sand, bricks, stone, wood, and steel, whereas *kaccha* houses are made of raw materials, including stone, mud, and wood. In this area, there has been no significant impact of GLOF on housing; although one house has been dismantled, and a few houses are in the red zone. The strength of the flood in the ravine after the outburst of Shishper GLOF causes cracks in surrounding dwellings. GLOF has a direct impact on just 7% of houses. According to one respondent, the financial cost related to home damage is around 1.8 million rupees, while another respondent claims a loss of approximately 8 lac rupees. The government (NGOs) and the community give that affected financial support and volunteer services. Locals are demanding that the government take our lands and houses and provide us with a secure area where we can build new homes because living in such a location is impossible due to extreme weather events. The primary light source is electricity, and the Shishper glacier outburst destroyed a water channel to a hydropower station and a 2 MW hydropower facility under construction. The Hassanabad river ceased to flow downstream for months during the winters of 2019-22, forcing the 1.2-megawatt power plant to

discontinue power generation and rely on a thermal generator for power supplies. According to 93.7 percent of responders, one-week electricity shortfall in Hassanabad and neighboring villages. Aside from energy, water supply channels and pipelines have been destroyed, resulting in a lack of access to water for everyday consumption and the irrigation system. The KKH was damaged due to the GLOF outburst, and the local administration closed the KKH for all transportation, causing a traffic jam for 24 hours, but the road was restored by using land from two local habitats. The local administration had an agreement with the owner of the land to pay rent every month until the road was restored. According to one respondent, the local authorities did not pay the rent for two years.

A large number of villagers have easy access to KKH, with 95.8 percent having within 1 km or less. Still, other services like the market, school, and hospital are far distant from their homes, so they go to nearby villages to use facilities. 92.3 percent travelled 2 km or more to get to the main bazaar to buy basic commodities, 97.2 percent travelled 2 km or more to get to a hospital, and 91.6 percent of students travelled 2 km or more to get to schools and colleges. The majority of these services are available in Aliabad or Gilgit.

Locals use a variety of means of transportation to get around their districts and major cities. People utilize public and private transportation to commute long and short distances. 56.6% of households use a van as a form of transport to travel within a district. 28.7% use a bus to travel to cities, just 4.2 percent use air services to cities, 42 percent use Suzuki to move from one village to another, and only 22.4 percent own a car to serve as a means of transport.

5.1.6 Changes in Financial Capital

TABLE 11: FREQUENCY DISTRIBUTION OF INCOME STATUS PER ANNUM

Responses	Groups	Frequency	%
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Income Status Per Annum	100000 – 500000	59	41.3
	500001 – 1000000	58	40.6
	1000001 – 1500000	23	16.1
	1500001 and above	3	2.1
	Total	143	100.0

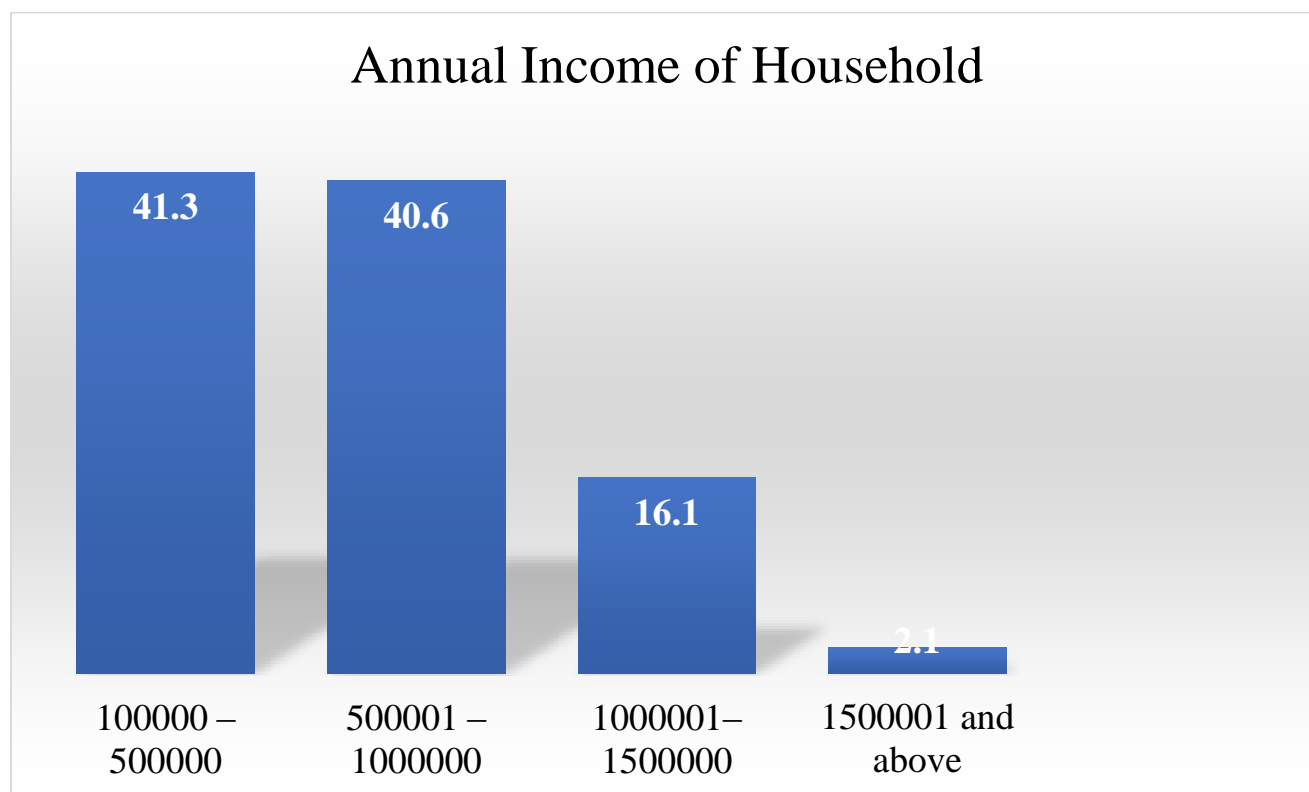


FIGURE 12: ANNUAL INCOME OF HOUSEHOLDS

Figure 12 illustrates that 81.9 % of households have an annual income between 1 lac to 10 lac rupees.

5.1.6.1 Sources of Income (Per Annum)

The local people have different sources of income, such as agriculture, livestock, businesses, services, skilled and unskilled labour. All of their sources of revenue were used to achieve the goal of their livelihoods. People can also access various credit institutions, which can help them

improve their financial situation. As a result, financial capital is monitored from crucial sources of income and access to different credit markets.

Households' annual income is determined by all of the above factors, including agriculture, livestock, pensions, remittances, business, and work in the private and public sectors. Natural capital (agriculture) is the economic basis for the households; they make at least 20,000 to one lac rupees per year from potato growing, which is a key source of a cash crop. The principal cash crops are cherries, apples, and dried fruits grown in large quantities. In Hassanabad, most households sell cherries and apples, and 37.8 percent make between 30 and 60 thousand rupees each year. The portion of agricultural land has been impacted due to the GLOF disaster. According to families, the output of cash crops has been affected by the timely unavailability of water to crops during the previous two years. 7.7 percent of households run a livestock business.

Thirty-one percent of household members work in the private sector and earn between 1 lac and 9 lac rupees per year, while 36 percent work in the government sector and earn between 1 lac and 13 lac rupees per year. Most male family members work in the Northern Areas Public Work Department (NAPWD). Locals have a lower ratio of business and shop-keeping; the ratio for shop-keeping is 14 percent, and the percentage for business is 9 percent; they receive between 1 lac and 9 lacs from shop-keeping and 1 to 12 lacs from business yearly. The overall skilled and unskilled labour is 32.9 percent, with earnings ranging from 1 lakh to 8 lakh rupees.

90.9 percent of participants save through banks and microcredit institutions. People also used it to secure loans for education and other household purposes. People had deposited a portion of their annual cash crop earnings in banks. Following GLOF events, villagers utilized their savings to satisfy educational, health, and other domestic needs. There was no financial aid from stakeholders who had lost land or trees, but financial assistance was provided to those who had lost their homes.

TABLE 12: FREQUENCY DISTRIBUTION OF SOURCES OF INCOME

Responses	Groups	Frequency	%
Economically active members	1	93	65
	2	38	26
	3	9	6.3
	4	3	2.1
Total		143	100
Crop farming	100 – 20000 rupees	8	6
	20000 – 40000 rupees	4	3
	40000 – 60000 rupees	5	3
	60000 – 1 lac	3	2
Total		20	14
Fruit farming	100 – 30000 rupees	38	26.6
	30000 – 60000 rupees	16	11.2
	60000 – 90000 rupees	7	4.9
	90000 and above	3	2.1
Total		64	44.8
Livestock	100 – 30000 rupees	4	3
	30000 – 60000 rupees	5	3
	60000 – 90000 rupees	2	1
Total		11	7.7
Private Sector	1 lac – 3 lacs	16	11
	3 lacs – 6 lacs	21	15
	6 lacs – 9 lacs	8	6
Total		45	31
Remittances	1 lac – 4 lacs	5	3
	4 lac – 8 lacs	3	2
Total		8	5
Pension	1 lac – 3 lacs	12	8
	3 lacs – 6 lacs	4	3
	6 lacs – 9 lacs	3	2
Total		19	12
Government Job	1 lac – 4 lacs	19	13
	4 lacs – 8 lacs	27	19
	8 lacs – 13 lacs	6	4
Total		52	36
Shop-keeping	1 lac – 3 lacs	5	3
	3 lacs – 6 lacs	14	10
	6 lacs – 9 lacs	1	1
Total		20	14
Businesses other than Shop-keeping	1 lac – 4 lacs	2	1
	4 lacs – 8 lacs	7	5

	8 lacs – 12 lacs	5	3
		Total	14
Unskilled labor	3 lacs – 6 lacs	7	4.9
Skilled labor	1 lac – 2 lacs	1	1
	2 lacs – 4 lacs	25	17
	4 lacs – 6 lacs	11	8
	6 lacs – 8 lacs	3	2
		Total	40
Mode of Saving	Banks	126	88.1
	Microcredit banks	4	2.8
		Total	130
Financial help by stakeholders	Yes	5	3.5
	No	138	96.5
		Total	143
			100

5.2 Indigenous Knowledge of Community

5.2.1 Religious and traditional beliefs toward mitigation

There is no single knowledge form that can be a solution for disaster risk reduction, but indigenous knowledge has the potential to contribute far more than is typically permitted (Kelman et al., 2020). The local community in Hassanabad is becoming more aware of the GLOF. This information, however, is not very old, as the GLOF episodes were observed by residents in 1974.

The local communities take preventive measures to the GLOF incidents. Which observed them as religious and traditional practices including, an annual gathering of local community men in the leadership of representatives of 4 tribes, community leaders i.e., *Nambardar* and religious men to offer prayers and distribute *Brumhanik* (It is a local word of Brushuski, it mean white food, consist of bread and butter). *Brumhanik*, local food shows a positive sign to undertaking the task. Before this gathering, all the tribe members spend a few days cleaning the water canals. Water canals are extended to many kilometers, and several occurrences of land sliding and rock falling occur. The gathering happens in March when the water channel must be operational for the Navroz (Persian

New Year). During the yearly meeting, religious men read Quranic verses, and the entire community prays for their safety from natural calamities. They have strong beliefs in this practice.

GLOF and flash flood directly impact water resources, i.e., water channels often break due to glacial floods. Every year, one out of four main tribes in Hunza becomes in charge of water supply and maintaining water to distribute water to farmers adequately.

5.2.2 Coping mechanism adopted by a community

“Coping mechanism is a manner in which people acted within the existing resources and ranges of expectations of a situation to achieve various ends” (Wisner et al., 2003). Community coping strategies are a method of addressing one's vulnerabilities within the constraints of available resources. The indigenous knowledge of the local people comprises people's techniques for dealing with such disasters. A coping mechanism aims to safeguard and recover from losses or damages caused by the flood event. (Wisner et al., 2003).

The community's feasible coping strategies to guard and cope with the consequences of the GLOF were classified into physical, social, and economic. Economic coping mechanisms are more dependent on economic linkages. Saving money, irrigation of cash crops, and selling fruits to enhance family income are examples of financial systems. Physical coping measures include the construction of walls and channelization of Hassanabad Nullah to protect community lives and assets, the reconstruction of KKH, and the maintenance of water channels and pipelines. This reconstruction work should be done by stakeholders and is not in the capacity of the community due to scarcity of resources and a lack of financial support. The social coping responses include assistance from relatives, neighbors, friends, organizations, and the government. For example, the local community raises cash for affected families, neighbors share commodities with relatives and neighbors, non-governmental organizations (NGOs) give relief and training to homes, and the

government provides rations, shelters, and financial support. Finally, the community has various coping techniques based on previous experiences and the availability of resources. The significant assets in coping with the disaster are social structure and income.

5.2.3 Role of religious institutions in the preparation and planning process

Religious institutions may be pivotal in the aftermath of disasters. The Attabad land sliding incident in 2010 impacted the communities of central Hunza and upper Hunza due to the blockage of KKH and the isolation of upper Hunza from the rest of the country. With the collaboration of the Ismaili Local Council, Hunza and Gojal play a leading role in monitoring catastrophe and relief management, as well as the general activities of the community. Similarly, in the case of the Shishper glacier outburst flood, the Local Council Hunza provides services during the response and recovery phases of the disaster. The Ismaili Council and community centres play a pivotal role in gathering donations from individuals and organizations for the affectees. In doing so, they recruit male and female volunteers to play an active role in disaster preparedness and mitigation efforts during the disaster period. Local religious institutions serve as a link between communities and stakeholders.

5.3 Role of Stakeholders to mitigate the impact of GLOF

Stakeholder engagement is essential in planning for emergencies and disasters. Stakeholders have a critical role in raising awareness among individuals, communities, and organizations involved in early warning and implementing early warning systems at the local/community level. Stakeholders are actively participating in mitigating the impact of GLOF and helping the affected communities to recover their livelihood assets. They also ensure proper mitigation, preparedness, response, relief, and prevention activities at Hassanabad Valley since the Shishper GLOF events.

Government and NGOs are responsible for policies and facilitate early warning. They are also responsible for the technical system and effective hazard warnings for their respective locals.

Six stakeholders actively participated in mitigating the impact of the GLOF event in Hassanabad, including government institutions, private organizations, and non-government organizations. Stakeholders provide their services in different areas related to their organizational expertise.

Government Organizations

1. Gilgit Baltistan Disaster Management Authority
2. Water and power department Hunza
3. District Commissioner (Climate Change Cell)

INGOs, NGOs & Private organizations

1. GLOF-II UNDP
2. Aga Khan Agency for Habitat
3. Civic Management Society

5.3.1 Key Interventions of Government Organizations

The critical interventions of government organizations are strengthening water and hydropower heads, building protective walls and rehabilitation, enhancing energy capacity, repairing the RCC bridge, and installing CCTV cameras for monitoring. They have provided these services for the last three years in the region.

5.3.2 Key Interventions of NGOs and INGOs

Non-governmental organizations and private institutes have also provided services for over three years. The UNDP “GLOF-II” project aims to establish sustainable livelihood options, increase women's engagement in food security and livelihoods, improve community preparedness and disaster response, and educate communities to identify and manage risks related to GLOF events.

This project is only functional in two regions of Pakistan: KPK and Gilgit-Baltistan. GLOF-II project involvements are community mobilization, protective structure, repair of irrigation channels, slope stabilization, and capacity building through training and evacuation drills. Installation of Flood automatic weather station (FAWS) under UNDP GLOF-II. Aga Khan Agency for Habitat (AKAH) interventions are glacier monitoring, report and scenarios developed, identification of safe heavens, building protective walls, installation of early warning system (through CCTV camera), give training and evacuation drills to the community. They have served the region for the past two decades in different capacities.

Stakeholders have taken a few measures to protect water, land, livelihood, and infrastructure. A community-based active monitoring team (Community emergency response team) was formed and trained in glacier monitoring, providing the necessary equipment for weekly, bimonthly, and monthly visits to the site. They are evacuating the vulnerable houses in a disaster, shifting them to a safe heaven, and providing shelter and rations. An early warning system's installation gives us information about risk knowledge, monitoring, response capability, and warning communication to protect land and infrastructure, build protective and gabions walls.

5.3.3 Measures are taken to protect Natural Capital

There are three primary drinking water sources in Hassanabad and nearby villages (glaciers, springs, and stream water), and glacier water is used for agriculture. In contrast, springs and stream water are used for drinking purposes. Hassanabad provides clean drinking water to around 2800 Aliabad households and businesses. Hassanabad to adjacent villages has three water channels for irrigation. These villages face acute water shortages as most settlements depend on the glacial melt stream (Hassanabad Nallah) as their primary water source. The 2019-2021 glacial lake outburst floods have severely impacted these villages' water supply, water channels, and other community

infrastructure. The Government, NGOs, and community are actively participating in the maintenance and management of the water facilities in the region. They provide financial and technical aid to restore drinking water and irrigation systems. The community's participation in water facility maintenance is also crucial, including administration, monitoring, volunteer activities, and collecting yearly fees for the repair and maintenance of water channels and pipelines.

To better respond to natural disasters (floods, GLOF events), the Gilgit-Baltistan administration has signed a collaboration agreement with Aga Khan Agency for Habitat (AKAH) Pakistan to conduct a study on the supply of drinking water to central Hunza, where inhabitants have been severely impacted recent floods in Ultar Nullah and GLOF events in Hassanabad Nullah. Deputy Commissioner Hunza intended that the collaboration with AKAH would allow the district administration to give long-term access to safe drinking water to 5,500 families, business organizations, health and education institutions from eight villages in central Hunza.

The lake outbursts in the previous three years have caused devastation and erosion of agricultural and non-agricultural land. Most of the damage has been documented on fruit and non-fruit trees, agricultural land, barren land, and water sources along the main Nullah. The stakeholders have no compensation policy for communities that have lost their agricultural or barren lands. Still, stakeholders have taken measurable steps to prevent significant losses of land and infrastructure, such as building protective walls, channelizing Nullah, and installing an early warning system to ensure 24-hour monitoring.

5.3.4 Role of Stakeholders to Protect Physical Capital

The Shishper glacier outburst has already had catastrophic effects on infrastructure, including the destruction of a 2 MW under construction hydropower plant, the disruption of five irrigation water

supply channels, the damage of four houses, the damage of a water supply pipeline, and the eroding of approximately 800 RFT of the Karakorum highway in two locations. Furthermore, stakeholders faced challenges due to a lack of resources for shelter installation and mitigation efforts. Stakeholders take action for infrastructure restoration, providing four shelters, pre-fabricated shelters to inhabitants whose houses are listed as red, and the District Disaster Management Authority Hunza issues Rs. 80.000 million for 500 Rft protective works, as well as funding for KKH rebuilding. DDMA equipment was deployed to redirect water in areas where post-flooding is predicted to harm people and infrastructure.

Hassanabad Nullah is vital to Central Hunza because it provides drinking water, agricultural water facilities, and water for energy production. Besides, most construction materials, including stones, clay, sand, and aggregates, are supplied from Hassanabad valley to the other areas for construction purposes. Due to the outburst of the Shishper glacier-dammed lake, this Nullah is constantly disturbed, causing the necessities mentioned above to be disrupted; hence, a long-term solution for the protection of Nullah is essential. On 7 May 2022, the outburst of the Shishper glacier damaged the RCC Bridge. The Karakoram Highway, the main route connecting China and Hunza to the rest of Pakistan, was blocked for thirteen days due mainly to the Shishper Glacial Lake Outburst, highlighting the possible consequences of the GLOF phenomenon on the China-Pakistan Economic Corridor (CPEC). On 9 May 2022, FWO constructed a temporary bridge to link upper Hunza to the rest of the country.

Infrastructure damage has implications all over society, including a lack of energy for households and businesses, a disruption in water supply for irrigation and drinking, the dismantling of low-income families' homes and relocation to shelters, and damage to the Karakoram Highway, which causes 24-hour traffic jams.

The stakeholders' suggestions to resolve these issues are to strengthen the water channels in Hassanabad. Channelization has been proven to be a beneficial approach for causing fewer damages during the outburst of a glacier lake since the volume of water may flow more efficiently and allow more water and erosion controls, as well as river restoration. Another effective water supply method is the Siphon, which flows from Chosh Nala to Aliabad and Hassanabad.

Government organizations give financial assistance to impoverished families in Hassanabad. The head of household receives a one-time payment under the Gilgit-Baltistan Ministry's authorized policy. INGOs and NGOs do not provide financial support, but they do provide rations and shelter to impacted families.

5.3.5 Main Challenges faced by Stakeholders

To deal with disasters, there should be adequate people, funding, advanced machinery, and a well-equipped organization to deal with any natural disaster. Stakeholders have learned that there should be strong cooperation across all government entities, NGOs, and INGOs in times of peace and emergency. It is also critical to have a long-term system in place to limit the danger of GLOF (drain of water from the lake through the construction of a tunnel). The major challenges experienced by stakeholders are the timely lack of funds for shelter building and mitigation efforts due to repeated outbursts, a lack of resources, and panic in the community. Physical capital damages included the disruption of a water supply, the damage of KKH, the damage to an under-construction hydropower plant, and the dismantling of a house, all of which made it impossible to deliver timely services to the community. Furthermore, scientific research must be conducted, and scientific monitoring may result in fewer damages, as in the case of a Shishper glacier outburst.

5.3.6 Future actions respond to such events

Government, non-governmental organizations (NGOs), local authorities, communities, and the private sector collaborate to ensure a shared awareness of future threats to people and their livelihood assets. We work together to solve them. Relocating high-risk households to safer locations and enforcing building codes (construction in safer areas). Furthermore, we consider habitat protection and restoration to mitigate the effects of GLOF incidents. The construction of protective walls safeguards the community's physical capital downstream. Reforestation of sea buckthorn and wild trees along the stream reduces soil erosion and slope stabilization. Due to the outburst of floods it disrupts the water system, irrigation canals, and freshwater supply, the government has announced two schemes for pipeline and major water channel restoration. The first scheme is for the Roshanabad and Sherabad main open and pipeline channel phase I, with a total estimated cost of Rs. 721955, a government contribution of Rs. 577564, and a farmer contribution of about Rs. 144391, while the second plan is Hassanabad main channel phase I, with a total estimated cost of Rs. 1641765, a government contribution of Rs. 1313412, and a farmer contribution of Rs. 328353. As of November 2021, both schemes are in development. Our Identification of risks and vulnerable areas and the installation of an early warning system to offer appropriate information for early response. These relevant instruments and measures should be developed to reduce the threats of GLOF.

5.3.7 Strategies to mitigate the impact of GLOF

There are numerous options for mitigating the severity of Glacial Lake Outburst Flood surges, including installing an early warning system and automatic weather stations. The most basic risk-mitigation method is to lower the volume of water by digging a tunnel through the moraine barrier. The optimum strategy is to provide awareness and training to the community mobilization. The

government should prepare early as possible and integrate GLOF into the provincial climate action plan. Another aspect that might help mitigate the impact of GLOF is improved planning and prompt involvement by stakeholders.

5.5 Focus Group Discussion

5.5.1 Introduction of locale

This focus group discussion aims to investigate the influences of GLOF in adjacent villages like Aliabad and Dorkhun Hunza. Participants in this FDG comprise *Ala Nambardar*, *Nambardar*, seniors, and community representatives who are fully aware of GLOF incidents and engage in the preparation and mitigation. Aliabad is the district headquarters, schools, colleges, government/private hospitals, and the central commercial hub of Hunza. Locals from upper and lower Hunza commute to Aliabad for education, health care, and business. They are tenants in Aliabad and Dorkhun. In Aliabad, there are around 1750 households, including renters, and 145 in Dorkhun.

Most households and commercial entities in these areas rely on the glacier melt stream Hassanabad Nallah and Ultar Nallah as their primary water supply. Both drinking and irrigation water is supplied to both regions by Hassanabad Nallah, but Ultar Nallah glacier water is exclusively utilized to irrigate the whole central Hunza. Ultar Nallah originates from Ultar Sar and is located approximately 10 kilometers northeast of Karimabad Hunza. From this Ultar Nallah, seven water channels flow west, and five water channels flow east. The water problem was worsened further by floods and mudflow in Ultar watershed during the peak summer season. Water supply into villages like Altit, Ganish, Karimabad, Hyderabad, and Aliabad was disrupted as the irrigation channel network from Ultar Nallah washed away frequently. Two full-time watchmen (*yatkuin* or *dargah*) are appointed to supervise the flow through the other regulatory gates and patrol the entire

length of the water channel. In August 2019, a flash flood occurred in the Ultar Nallah, causing a stopping flood to enter the water channel; one *yatkuin* died, his body was buried in the flood, and another was injured. In the almost 200 years that central Hunza has been inhabited, no such water deficiency situation has ever been observed or reported.

5.5.2 Responses of Discussants

According to one respondent, a water channel from Hassanabad Nallah to Aliabad, Dorkhun, and Hyderabad was built in 1986 with the Aga Khan Rural Support Program (AKRSP) and the community. Seven laborers died due to a mountain sliding until this water channel was completed. It is an important water channel for irrigation of Aliabad, Dorkhun, and Hyderabad orchards that were destroyed due to the Shishper GLOF disaster. Due to the GLOF occurrence, only the mentioned region could be irrigated once over the whole irrigation period (April - October); the land requires irrigation six to eight times before the GLOF event to ensure smooth growth and yield. Due to a lack of water in the area during the previous two to three years, hundreds and thousands of trees (mainly apricot and other fruit trees) have dried or are in danger of being lost. Drought affects an average area of seven kilometers in length and one kilometer in width. The Shishper GLOF has directly impacted the society's poor and marginalized farmers, who comprise a significant population and depends on horticulture and stockbreeding for a livelihood.

Another participant emphasizes the challenges with clean drinking water facilities during the last three years. There are two primary water pipelines from Hassanabad Nallah: one for Aliabad and Dorkhun, and another for Aliabad that is a collaborative between the Civic Management Society (CMS) and the community. The government pipeline is 8 inches wide for 600 families; although the population has tripled, water facilities have not been improved in response to the population ratio. The tape water is only available for three to four hours per day, three days a week. Currently,

almost 1800 homes and commercial consumers in Aliabad rely on these resources, while roughly 160 domestic and commercial users in Dorkhun are affected by the lack of clean water facilities. Water is suspended for one month in July 2019, when demand for home and commercial use is at its peak. The glacier hit a suspension bridge constructed over a river to carry spring water into Aliabad, causing drinkable water shortages. The implications for water supply included an absence of a filter tank at the entry point, flood water into the pipeline, which damaged and choked the supply of water, poor engineering, mismanagement, and corruption in using poor-quality materials. The pipeline was damaged or broke, usually due to land sliding or water pressure. It is difficult for the community to maintain and operate the water pipeline. Dorkhun village takes the "Ghumat water pipeline" initiative to resolve the water issue after experiencing a severe water shortage. The community raises donations and funds for this initiative, and every family and commercial customer helps finance this project. This initiative receives no financial or technical assistance from the government or other stakeholders. Nambardars are the government's helping hands in resolving water issues in central Hunza; we provide various options to the government to overcome the region's water crisis for both irrigation water and drinking water facilities, but the governmental department produces a feasible report. Still, it has shown no progress on the ground. According to a respondent from the Hotel Association Hunza, more than 15 lac tourists visit Hunza throughout the year, with the majority of tourists coming during the summer, and we cannot provide better services to them. During peak flow of tourists, water is scarce; thus, most hotels acquire water tankers to meet their drinking, cooking, and washroom needs. Another big concern is electricity, which is in short supply throughout the summer. The power division only provides us with 4 to 6 hours of electricity each day, and the voltage is also low. Generators, solar panels, and UPS were used as backup sources of electricity in the case of a power outage. In Hunza, there

are no toilet facilities for tourists. Aliabad has over shops and 105 hotels, with 35 hotels offering stay and dining services and the remaining 60 offering basic hotels and restaurants. Hunza has had severe energy shortages due to the Shishper GLOF business community's major difficulties in fulfilling electricity and water demand. However, other districts in GB are in a better condition than Hunza. Our areas are rich in natural resources; the government and other key stakeholders use these resources to assist communities and business entities overcome water and energy difficulties.

A government representative said we had taken the initiative of afforestation campaign on 27 December 2019 with the collaboration of the local council and community volunteers. In this campaign, male and female volunteers planted 870 trees near *Taltaq Daas* Aliabad. The initiative's objective was to green Hunza by restoring the barren land. Planting trees has numerous benefits, one of which is that it helps avoid flooding and soil erosion. We will initiate a plantation campaign in a college with the support of the principal of FG Boys Degree College Aliabad. In this effort, we provide them with the plants; every college student should plant a tree in the college area, and he is responsible for caring for the tree during his study period time in college.

Chapter: 7

Discussion, Conclusion and Recommendations

7.1 Discussion

The objective of the study was to understand the effects of GLOF incidence on the environment and livelihood assets of the community, as well as the intervention of stakeholders to mitigate the GLOF induced risks and lessons learned for the future expected events. Data for this study were collected from 143 households, 6 stakeholders, and one focus group discussion with inhabitants who had encountered the disaster caused by the Shishper GLOF.

The results indicate that the GLOF disaster damaged physical infrastructure (KKH, RCC bridge, Power house, land, and houses), which had a detrimental effect on local livelihoods. GLOF incidents have caused KKH to be disrupted over the last three years. This route has been an important contributor to the development of the affected village. It had linked the village to the rest of the country as well as China. It had opened access for the local cash crops to large markets. The GLOF tragedy has had an impact on both locals and tourists owing to the blockage of the KKH, the lake's outburst destroyed both public and private infrastructure. Major damages from the 2022 outburst include the RRC Bridge, the KKH, and the destruction of crops, orchards, and barren land. The most affected families received compensation from the government. CM Khalid Khurshid distributed around 2.5 million rupees among 15 affected families, each household receive 150,000 rupees. Natural capital is also adversely impacted by GLOF occurrences, which destroy natural capital such as agriculture, orchards, barren land, and forests, erode on both sides of the Nullah, disrupt irrigation and drinking water facilities, and wipe out water channels.

In terms of social capital, this village already linkages with different institutions and organizations. The Shishper GLOF disaster has further increased affiliations with different institutions, NGO's, and International Non-governmental Organizations. The local community has their own centralized institutions that mobilize the community according to need of the hour. This village's inhabitants and the Community Based Risk Management Committee (CBRMC) have been actively involved in the recovery process alongside stakeholders. Many NGOs and Government Organization have play key role to support the affected people to recover during the disaster.

In Human Capital our focus on two indicators; health and education. In this village no basic health facility for the local during emergency situation. Although there have been no significant physical injuries or deaths due to GLOF. In this village has no government or private sector college, technical or vocational centers. The majority of university students from Hassanabad village study in Pakistan's main cities, while college students attend classes in nearby villages or Gilgit. School going students suffered due the blockage of road and damage of bridge. Financial capital has deteriorated since community loss their lands, and houses. Those households whose income was based on natural capital. After earning income from the cash crop households were purchasing stock of food and non-food for the whole year and the rest of money had been saving in banks.

In the literature, we studied that natural catastrophes have affected Pakistan at various times throughout its history, threatening lives and livelihoods of its inhabitants. GLOF, flash floods, earthquakes, landslides, cyclones, heat waves, and drought are common disaster occurred in the country. During the last several decades, the severity and frequency of climatic risks and extreme climate events appear to have grown in Gilgit-Baltistan. The relevant literature addresses impacts of GLOF on the physical, financial, human, and natural capital. The pertinent literature discusses the role of Stakeholders with reactive or proactive methods before, during, and after natural

catastrophes using theory of disaster risk management. There are no significant national policies for addressing and mitigating GLOF.

7.2 Conclusion

According to the study's findings, the area's residents still live in highly vulnerable conditions after three years. 74.1 percent of respondents lost their land (fruit and non-fruit trees) due to GLOF events, with 64.3 percent losing 2 Kanal or less land and 9.1 percent losing more than 2 Kanal of land. Drinking water facilities and irrigation channels are disrupted, which causes 50.3 percent of households to fetch water from the outside (water tanker, wells, and spring water). Furthermore, due to water scarcity in agriculture and orchard land in the last three years, hundreds and thousands of trees (fruits and non-fruit trees) have dried, which diminishes agriculture yield. Most rural people rely on natural capital and the environment for their livelihood. When these communities are hit by a GLOF event that changes their environment, their natural capital may lose instant value, as it has occurred in our study area. It seems that natural capital will re-dominate upon restoring supporting physical infrastructure, i.e. restoration of water pipeline and water channels, reconstruction of KKH, and RCC Bridge.

The local community has continued their livelihoods by changing their dependence from natural to social and human capital. Within social capital, the interaction of people with institutions is more critical in coping, rehabilitation activities, and addressing the intangible impacts of GLOF events. According to the data, 55.9 percent of respondents are involved with volunteer groups in various capacities, while 45.5 percent of HHs attend stakeholder training sessions. 83.2 percent of the community was involved in improving social capital, recovery services, and reconstruction. The bonding of local people with supporting institutions plays a crucial role in local recovery in our study area.

Human capital is the essential capital in the natural disaster recovery process. The incidence causes no physical injuries or death. In Hassanabad no primary health unit centre during an emergency. This village has no government school, college, or technical centre; most students travel to other towns to pursue education. In the last four years, 36.4 percent of students have not attended more than one week of classes due to bridge damage and emergencies. A high literacy rate can increase understanding related to disaster preparedness and awareness while attending disaster management sessions by students and family members, which help reduce the risk of disaster that will cause lives and livelihood assets of locals. 96.5 percent of households have no access to internet facilities, while the internet has a beneficial and significant role in the formation of human capital.

The indigenous knowledge of the community related to natural incidents by performing religious rituals, offering collective prayers, and reciting the holy Quran for the protection of the community's lives and livelihood assets.

Stakeholder involvement is crucial in emergency and disaster preparation. Stakeholders have a critical role in raising awareness among individuals, communities, and organizations involved in early warning and implementing early warning systems at the local level. Hassanabad Valley's stakeholders have been actively engaged in pre-and post-disaster operations. It is not in the community's capacity to respond to natural disasters without the assistance of stakeholders. They provided technical and financial assistance to save the community's lives and livelihoods.

7.3 Recommendations

The following recommendations are drawn from the analysis made in this study as well as are based on the recommendations made during the FGDs. These are presented for informed policies and restoration of the livelihoods of the GLOF-prone community of Hassanabad Hunza.

1. The government and key stakeholders should focus on building engineered protection barriers beneath residential and agricultural land. The structure should be durable and resistant to the tidal energy of water. The government must start to conduct pilots of such projects and must cooperate with its international counterparts. Besides, the private sector can also get engaged with such projects and explore the potential of public-private partnerships in remote local communities.
2. The government should allocate space for housing and some agricultural land so that locals will agree to relocate to a new site. The households of Sherabad and Harum in the most vulnerable areas are hardly 20-30 dwellings. This scattered mode of the settlement also makes these communities more susceptible to such events; the settlement model can also be altered for community resilience.
3. Human Capital plays a critical role in community disaster preparedness. Investment in the construction of schools, universities, and education indicates that a diverse Human Capital will be available to deal with any unanticipated circumstance.
4. The GLOFs are seasonal and periodic and can be reduced or limited by the effective and efficient actions of the third tier of government (Local government). Further resilience and awareness can be built by the central government.

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Appendixes

Appendix 1: Questionnaire for Household

Pakistan Institute of Development Economics Islamabad

Questionnaire

This survey aims to write a thesis required for my MPhil degree in Environmental Economics from the Pakistan Institute of Development Economics, Islamabad. The title of my thesis is ***“Glacial Lake Outburst Floods: Impact on the Environment and Socioeconomic Conditions of Hunza”***. In this questionnaire survey, I want to focus on the direct impact of Shishper glacial lake outburst floods events that happened in the last five years and its impact on the livelihood assets of the community in this region. The research aim is to understand what policies and financial aid are provided by stakeholders to mitigate the impact of GLOF and helped the affected community to recover their livelihood assets. It is ensured that the information and identity of the respondents will be kept highly confidential. Your cooperation in this respect would be highly appreciated.

Questionnaire No.

Date:

Enumerator:

Demographics

1. Name of Respondent _____	2. M / F _____
3. Are you the Head of the family? Yes / No _____	4. Age of the HH Head _____
5. Education of HHH _____	6. Household Size _____
7. Total number of males _____	8. Total number of females _____
9. Number of Children (6-15 years) _____	10. Number of Kids (0-5) _____
11. Number of Elders (60+) _____	12. Household Income Rs. _____ _____ /annum
13. Number of economically active members _____	14. Highest education among HH _____

1. Natural Capital

S.No	Questions	Responses
1.	Do you have agricultural land? If Yes	----- Kanal/ ----- sq. meter
2.	Has your land been affected by the outburst of Shishper lake in the past five years?	Yes (how much _____ Kanal/sq m) No

3.	If yes, what type of land has been damaged? Explain what type of damage/loss has been done to the land by GLOF.	Agricultural, Orchard Barren, Type of damage to the land Wiped-out Erosion Loss of fertility Any other (Plz specify)
4.	Due to the glacial floods, does the wild trees/fruit trees being destroyed in your farmland?	No. of trees Value _____Rs.
5.	Do you have livestock?	Yes No (>>8)
5.a	Is it affected due to GLOF in recent years	Yes (How_____/Loss_____) No
6.	Is the access to communal pastures still open after GLOF?	Yes No
7.	If No, what is the impact on livestock and the livelihood of the community?	_____
8.	What is the source of water in your area?	Tape water Pond Natural Spring Water from rivers & streams
8.1	Did GLOF damage the water supply lines?	Yes No
8.2	How do you fulfill the water requirements after the GLOF?	Same as before Fetch from outside now
9.	Have the water resources depleted/non-usable during floods?	Yes No
10.	Is there any impact of GLOF on the water channels?	Yes No
11.	If Yes, How many water channels disrupted due to the GLOF?	---- More than 5
12.	How much Kanal of land has been affected due to the cut of the water channel?	----- Kanals
13.	Due to the disruption of the water channel/supply to the hydropower generation, how many days did you face electricity shortages?	_____ days
14.	What is the role of government and NGOs to protect the natural capital in the affected areas?	Positive Negative (please elaborate)

2. Social Capital

1.	Are you a member of any local volunteer organization?	Yes No
1.1	If yes, Name of the Organization and in what capacity?	
2.	Does this local organization provide any assistance to the GLOF-affected community?	Yes No
2.2	If yes, what type of assistance does the local organization provide to the community?	
3.	Do you have any engagement with NGOs?	Yes No
3.3	If yes, the Name of the organization and in what capacity?	
4.	Do you have any involvement with INGOs and the Government?	Yes No
4.4	If yes, Name the INGOs, and Government. And in what capacity?	INGOs _____ Government _____
5.	Have got any training concerning disaster management from NGO/INGO/Government?	Yes No
6.	Name the organizations/institutions that provided relief and recovery inputs	1. 2. 3. 4.
7.	Insert the name of institutions/organizations from question 6 and mentioned what type of support provided by these institutions/organizations?	Name of Institute/organization _____ Support _____
8.	Has the community involvement/social capital improved the recovery services and reconstruction	
9.	How much you are satisfied with the mechanisms adopted to streamline social capital in post-GLOF activities?	
10.	Could these efforts be improved further in the special context of Hunza? If yes How.	

3. Human Capital

1.	Is there any health center in your village?	Yes No
2.	Have the medical services affected due to any incidence related to GLOF	Health center's Building Doctor's availability Paramedics availability Any other (plz. Specify)

3.	Has anyone in your family been injured due to GLOF in the past 5 years?	Yes No
4.	Has anyone in your family died due to GLOF in the past 5 years?	Yes (Age_____Gender__) No
5.	Do you have an internet facility in your home?	Yes No
5.1	If yes, Is there any source of income from online earning?	Yes No
6.	Are there any Technical and vocational centers available in your area?	Yes No
6.1	Are there any Technical and vocational centers destroyed due to GLOF?	Yes (if yes, are these restored since _____) No
7.	Have the educational facilities affected due to any incidence related to GLOF	School's Building Teacher's availability Staff availability Any other (plz. Specify)
8.	Did your kids miss school due to any incidence related to GLOF	Yes (how many days) _____ No
9.	Is there anyone in your family who has completed any form of training w.r.t. disaster management?	Yes No_____

4. Physical Capital

1.	House ownership?	Own Rented
2.	House material?	Kacha Kacha/Pakka Pakka
3.	Has the GLOF damaged your house?	Yes No
3.1	If yes, what was the financial cost of damage imposed?	Rs. _____
3.2	What reconstruction/restoration costs did you bear?	Rs. _____
4.	What is the artificial light source in your home?	Candle Lamp Gas cylinder Electricity
4.1	Did the GLOF impact the Hydropower generation Plant that provides electricity to your area?	Yes No
5.	Is road damage due to the GLOF?	Yes No
5.1	For how many days road have been blocked for public transportation?	_____ days
5.2	Has the road been reconstructed/restored?	Yes

		No
6.	Is there any other infrastructure that has been damaged due to GLOF?	Details.....
4.	What is the distance between your house and the nearest concrete road?	within 500 meters within 1 km within 2 km more than 2 km
5.	How far away is the nearest market from your house?	within 500 meters within 1 km within 2 km more than 2 km
6.	Distance of the nearest hospital from home:	within 500 meters within 1 km within 2 km more than 2 km
7.	Number of Schools/Colleges within the Hassanabad	Numbers of Schools <hr/> Numbers of College
8.	How far away are a school and college from your home?	within 500 meters within 1 km within 2 km more than 2 km
9.	What is the most common mode of long-distance travel?	Van Bus Suzuki Flight Own vehicle Other

5. Financial Capital

1.	How much land does your family have?	_____ kanals
2.	What are the major income sources of your family?	

Sources of Income	Approximately yearly income (PKR)
Crop farming	
Fruit farming	
Livestock	
Private job	
Remittances	
Pension	
Government Job	
Shopkeeping	

Businesses other than shopkeeping	
Handicrafts (in house activities)	
Unskilled labor	
Skilled labor	
Other	

3.	Do you save money?	Yes No
4.	What is the mode of saving?	Bank NGO Microcredit Bank Local committee Relatives Other
5.	Is there any major impact on the financial capital due to the GLOF?	Yes No
6.	Are the stakeholders helping financially the affectees of GLOF?	Yes No
8.	If Yes, are you satisfied with the financial aid provided by stakeholders?	Yes No

6. Indigenous knowledge of community

1.	What are the religious and traditional beliefs towards mitigation of the adverse impacts of GLOF?	
2.	What are the coping mechanisms adopted by communities?	
3.	From past experience, what challenges did you face as a consequence of GLOF events?	
4.	Based on your previous experience with GLOF, how did you prepare for or react to these events?	
5.	Are cultural or religious institutions participating in the preparation and planning process at the community level?	
6.	Is there any awareness campaign for the community by stakeholders? What types of awareness campaigns?	

Comments and Suggestions

Appendix: 2 Questionnaire from Stakeholders

Pakistan Institute of Development Economics Islamabad

**Qualitative Survey on
Impact of glacial lake outburst floods on the livelihood Assets**

Questionnaire

The purpose of this survey is to write a thesis required for my MPhil degree in Environmental Economics from the Pakistan Institute of Development Economics, Islamabad. The title of my thesis is *“Glacial Lake Outburst Floods: Impact on the Environment and Socioeconomic Conditions of Hunza”*. In this questionnaire survey, we will focus on the direct impact of Shishper glacial lake outburst floods events that happened in the last five years and impact on the livelihood assets of the community in this region. The research aim is to understand what policies and financial aid are provided by stakeholders to mitigate the impact of GLOF and helped the affected community to recover their livelihood assets. It is ensured that the information and identity of the respondents will be kept highly confidential. Your cooperation is highly appreciated in this regard.

Section I:

1. Name: _____
2. Gender: Male Female
3. Age: _____
4. Qualification: _____
5. Expertise/Designation: _____
6. Name of Organization: _____
7. Address: _____
8. Cell #: _____ 9. Email: _____

Section: II

1. What types of intervention your organizations have taken in Hassanabad and nearby areas to respond and protect the Shishper GLOF?

2. How long have you been providing services in this area?

3. What measures your organization has taken to protect the water/land/livelihood/environment/infrastructure during the GLOF?

If the organization has focused on one of the following areas, then ask questions on that specific topic

Water

Potential stakeholders for the interview (CMS, NAPWD)

a) What type of water resources are available in Hassanabad valley and how many inhabitants are utilizing these resources including nearby villages?

b) How many water connections originated or connected from Hassanabad village? (drinking water, irrigation water, or others)

c) Due to GLOF, how many water resources are destroyed in the last five years? Who is responsible to repair them? (local community, government support, or others)

d) How long does it take to repair these water channels?

e) What type of support have you been provided to repair the water channels (probe: financial support, redesign the water channel, technical other, etc.)?

f) What are the main challenges faced by your organizations or other stakeholders to provide timely services?

g) What lessons your organization has learned to better respond to GLOF in the future?

Land

a) What type of land eroded in Hassanabad due to GLOF? (agricultural land, barren land, trees)

b) What type of support your organization has provided to compensate for the loss?

c) What type of measures were taken to protect and prevent land erosion issues in the future? (engineers were inducted to study the area and install fences etc., an early warning system introduced, community awareness on the early warning systems)

d) Do you know if the local community demands any compensation scheme? Was it implemented on time? Were there any compensation schemes introduced to the local community?

e) What are the future actions to respond to such events?

Infrastructure (*public and private infrastructure-roads, bridges, buildings, houses, community centers, schools, etc.*)

a) What type of infrastructure was destroyed as a result of GLOF in the last five years? (Schools, houses, FWO camp, hydroelectric power station, bridge, roads, etc.)

b) What interventions your organization has taken to repair the destruction?

c) What are the challenges faced by your and peer organization to respond to such events?

d) What is the lesson you learned?

e) Who was impacted the most due to the destruction of the infrastructures? (Students, local transportation, power cuts, etc.)

f) What are the areas which are not been addressed yet? What are the reasons?

g) What are your recommendations to address such areas?

Livelihoods

a) Have you provided any financial assistance to the families affected by the GLOF? If yes, how many families have you covered? Total how many families were directly and indirectly affected by the GLOF?

b) What were the criteria to provide financial aid? Was it one-time assistance? Or have you continued supporting for a specific period? (Mention the number of years.)

c) Was this assistance provided to the head of household? Were you contacted by the child-headed or female-headed households? Have your organization self-identified this type of HH head? Have you provided any special assistance to widows, Pregnant women, elderly, and disabled people?

d) Have you provided any support to school-going children? Were there any specific opportunities provided to the young people in terms of skills, training, or supporting them to get the employment opportunities? Was there any scholarship introduced to the students of this area?

e) Have you taken measures to provide sustainable livelihood opportunities to families?

General questions: Government/department/org (note: *these questions to ask from all stakeholders*)

1. What kind of strategies did your organization adopt to mitigate the impact of GLOF in the region?

2. What kind of policies do you make to protect the natural capital and enhance the livelihood of the community?

3. What are your learnings so far from the GLOF events? Can you share the key learning that can be taken forward for the following year?

Comments and Suggestions

Appendix: 3 list of Participants Focus Group Discussion

S.No	Name	Profession
1.	Shamshad Baig	Ala Nambardar for Aliabad Hunza
2.	Fida Karim	Nambardar for Dorkhun Hunza
3.	Aslam Khan	Nambardar for Aliabad Hunza
4.	Sherbaz Khan	Lecturer at FG Boys Degree College, Aliabad Hunza
5.	Shah Nawaz	Finance member, Hotel Association Hunza
6.	Sohukat Ali	Teacher at FG Boys Degree College Karimabad

Appendix:4 Responses of Stakeholders

Common responses of Stakeholders

TABLE 13: COMMON RESPONSES OF STAKEHOLDERS

	Aga Khan Agency for Habitat	UNDP (GLOF II)	GBDMA
Key Interventions	<ol style="list-style-type: none"> 1. Glacier monitoring 2. Report & scenarios developed 3. Identification of safe heavens 4. Community training and evacuation drills 5. Installation of Early Warning System (through CCTV camera) 6. Mitigation work 	<ol style="list-style-type: none"> 1. Community Mobilization 2. Protective structure 3. Repair of Irrigation channel 4. Slope stabilization 5. Capacity building 6. EWS 7. Provision of equipment (Safe heaven) 8. Building training 	<ol style="list-style-type: none"> 1. Protective bunds & rehabilitation 2. Strengthening of water & hydropower heads
Time periods	<ol style="list-style-type: none"> 1. Two decades 	2 years	2 years
Measures are taken to protect water, land, livelihood, environment, infrastructure	<ol style="list-style-type: none"> 1. Install EWS 2. Evacuate the vulnerable houses in time of disaster 3. Mitigation work done 4. Construction of shelters for affected households 	<ol style="list-style-type: none"> 1. Repair of irrigation channel 2. Protective work of infrastructure 3. Through protective structures 	<ol style="list-style-type: none"> 1. Provision of headworks
Lesson learn to better respond to GLOF	Water supply passes through safe routes to reduce the damages	Channelization work is mandatory to reduce its impact on future	Displacement of highly vulnerable HHs. Proper excavation on an annual basis. Construction of resilient protective structures community awareness & EWS
Land Eroded in Hassanabad Valley	<ol style="list-style-type: none"> 1. Agricultural 2. Orchards 3. Barren 	Mostly agriculture land	<ol style="list-style-type: none"> 1. Agricultural 2. Orchards
Compensation for Loss	No Compensation policy	No Compensation	House compensation paid as per policy to affected HHs
Measures are taken to protect against land erosion	<ol style="list-style-type: none"> 1. Mitigation work to protect against erosion 2. EWS installed to ensure 24 hours monitoring 3. Awareness sessions for community 	<ol style="list-style-type: none"> 1. Slope stabilization activities 2. EWS 3. Construction of a protective structure 	These measures are under the UNDP GLOF-II project
Compensation for the local community	No compensation schemes	No compensation schemes under the GLOF-II project	The only compensation was paid to 4x damaged houses; however, no amount paid against losses of their livelihood
Future actions respond to such events	<ol style="list-style-type: none"> 1. Identification of hazards & risks 2. DDR Intervention (awareness, mitigation, EWS) 3. Re-location of high risky HH to safer areas 4. Implementation of building codes 	<ol style="list-style-type: none"> 1. Construction of protective walls 2. Repair of irrigation channel 3. Slope stabilization activities plantation 	DMAs have been established & equipped with heavy machinery. Sufficient funds are provided to cope with such incidents. The project is in the pipeline to enhance resiliency in at-risk community

	(Construction in safer areas)		
Infrastructure destroyed	<ol style="list-style-type: none"> Hydropower building KKH at two locations 4 houses 	<ol style="list-style-type: none"> Irrigation channel Hydropower house Road Bridge FWO office 	<p>Portion of KKH Hydropower house under constructed building The suspension bridge, 4 houses</p>
Intervention to repair the destruction	<ol style="list-style-type: none"> Safe shelters are constructed for the affected houses 	<ol style="list-style-type: none"> Irrigation channel Hydropower house Road Bridge FWO office 	<p>After the declaration of emergency by DDMA Hunza, Rehab activities are in progress</p>
Challenges faced by your organization	Unavailability of budget for shelters construction & undertake mitigation work	Frequent burst, lack of resources, panic among community members	Lack of resources and HR
Impacted most due to destruction of Infrastructure	Community of Hassanabad & Aliabad, Energy shortages & disruption of water supply	As GLOF damaged the water channel resulted in a shortage of water both for irrigation & drinking	Local community Commuters and powerhouse
Areas not addressed yet? Reason	Water supply to Aliabad, Hyderabad. It is engulfed by glacier	Compensation of the affected community is necessary, and most organisations do not cover it.	There is a lack of integration of DRR into development planning
Recommendations to address such areas	Water can be uplifted from Hassanabad Nala, Chosh Nala through the Siphon technique	Channelization is proven successful. It should be done in the future too	<p>Identification & frequency of all hazards CBDRM Resilient housing/ land use management Restrictions on Encroachment</p>
Strategies to mitigate the impact of GLOF	<ol style="list-style-type: none"> Identification of GLOF hazard & its monitoring Community preparedness Mitigation EWS 	Preparation and integration of GLOF in the provincial climate action plan	Formulation of GBDM & District Disaster management plans are in the pipeline to mitigate the impact across GB
Policies to protect natural capital & enhance the livelihood of the community	Supply of clean drinking water to the community	Integration of GLOF in all government line departmental interventions	The mandate of this authority is to save lives & reduce sufferings
Learnings so far from GLOF events	<ol style="list-style-type: none"> Well-coordinated efforts involving all stakeholders Actively monitoring GLOF Timely mitigation measures Placement of EWS Preparedness & Evacuation drills for community Involvement of local community in different projects 	<ol style="list-style-type: none"> GLOF needs to be regularly monitored and prepare the community for emergency response Protective structures Hazard watch group: give training to community members to monitor by themselves 	<p>Round-the-clock monitoring of Highly vulnerable valleys. In time assessment and protective measures</p>

	Deputy Commissioner (Climate Change Cell)	Civic Management Society (CMS) Aliabad	Water and Power Department Hunza
Key Interventions	Protective walls Repaired RCC Bridge CCTV cameras were installed	CMS doesn't have the mandate to respond but created awareness & mobilized the community	The capacity of 1.9 MW of electricity at Hassanabad Nullah
Time periods	3 years	9 years	2 years
Measures are taken to protect water, land, livelihood, environment, infrastructure	The 24/7 active monitoring team at the site diverted traffic on KKH to the alternate route	In sensitized communities during the issue, water sources are damaged with the help of community members & institutions. We did our best to protect water resources	Installed Gabions, and penstock pipe route of Phase III
Who is responsible for repairing them	Government and NGOs are responsible for repairing them	The local community, government, and other stakeholders are responsible to repair them	Government and community
Support provided to repair water channel	Technical support	Community mobilization	Both technical and financial support
Main challenges faced by your organization	Unpredictable GLOF events need collaboration from other organizations as well	Due to damage of the main water source, we were unable to provide services to the community	Restoration of intake works especially during flood season
Lesson learn to better respond to GLOF	EWS should be installed Volunteerism should encourage awareness to the community	We learned that institutions working on GLOF should predict early so that they would be able to respond timely	Close coordination with district admin proved a success in responding to GLOF timely.
Land Eroded in Hassanabad Valley	Agricultural and orchard	Agricultural, barren, orchard	Agricultural, barren, orchard
Compensation for Loss	Provide Ration	It is not our mandate	District administrations job
Measures are taken to protect against land erosion	Protective walls and EWS	Government institution special DDMA is working	Channelization of main nullah & plum concreting will remain useful.
Compensation for the local community	If there is any scheme, then the government is responsible for the compensation	It is not in my knowledge	The district admin is compensating the local community
Future actions respond to such events	Encourage community participation, administrative level, awareness to the community, EWS installed	There should be an early warning system installed to respond to early	Intake if existing hydropower plant and under construction of 2 MW HHP
Infrastructure destroyed	RCC bridge KKH Two houses	Hydropower station, road, bridge, & pipeline	Intake works were restored promptly construction of 2 MW HPP frozen in 2018
Intervention to repair the destruction	Provide technical and financial support	PWD repaired the road but the hydropower house was wiped-out permanently	Non-timely release of funds for restoration works.

Additional responses of Aga Khan Agency for Habitat

TABLE 14: ADDITIONAL RESPONSES OF AGA KHAN AGENCY FOR HABITAT

Aga Khan Agency for Habitat	
Water Resources	1. Springwater

	<ol style="list-style-type: none"> 2. Glacier Water 3. Stream water
Water connections	<ol style="list-style-type: none"> 1. Drinking water (Hassanabad, Aliabad, Murtazabad) 2. Irrigation water (Hassanabad, Aliabad, Hyderabad Murtazabad) 3. Siphon Water supply from Chosh Nala to Aliabad Irrigation
Water resources destroyed	<ol style="list-style-type: none"> 1. Springwater supply 2. Irrigation water channel (Aliabad, Hyderabad)
Who responsible for repairing them	Drinking water pipeline repaired by government, Irrigation water channel couldn't repair due to glacier surge
Duration to repair	3 months
Support provided to repair water channel	No, the technical or financial support provided by our organization

Additional responses of UNDP (GLOF II)

TABLE 15: ADDITIONAL RESPONSES OF UNDP (GLOF II)

	UNDP (GLOF II)
Water resources destroyed	Water management
Who responsible to repair them	GLOF II
Duration to repair	Through the project time
Support provided to repair water channel	Repair, through redesign and construction of identified irrigation channel
Main challenges faced by your organization	The outburst of the Shispher glacier, timely availability of funds
Lesson you learned	Community mobilization is the best practice, EWS system is mandatory

Additional responses of GBDMA

TABLE 16: ADDITIONAL RESPONSES OF GBDMA

	GBDMA
Financial Assistance to the affected HHs	Some 22 families were affected
Criteria to provide financial assistance	As per approved policy by GB Ministry, one-time compensation paid to damaged houses
Assistance provided to whom	Head of Household
Have you provided any support to school going children	Awareness sessions and training provided through AKAH, GBRSP

Additional responses of Deputy Commissioner (Climate Change Cell)

TABLE 17: ADDITIONAL RESPONSES OF DC (CLIMATE CHANGE CELL)

	Deputy Commissioner (Climate Change Cell)
Water Resources	Springwater & glacier water, Almost the entire valley is utilizing these resources
Water resources destroyed	The main Hassanabad Nallah was damaged last year
Duration to repair	10 to 15 days
Challenges faced by your organization	Traffic on KKH & water flow in Nallah
Lesson you learned	Government, NGOs, & community should prepare mentally & physically
Impacted most due to destruction of Infrastructure	Local community & travelers
Financial Assistance to the affected HHs	During the GLOF event of 2021, two families were affected directly and provided them shelter & ration
Criteria to provide financial assistance	Financial aid is for the affectees
Assistance provided to whom	The list provided by the head of the community
Have you provided any support to school going children	Different first Aid sessions were conducted for youth and adults

Strategies to mitigate the impact of GLOF	Installed EWS & automatic weather station
Learnings so far from GLOF events	Pre-disaster actions are more important & can lessen the damage

Additional responses of Civic Management Society (CMS) Aliabad

TABLE 18: ADDITIONAL RESPONSES OF CMS ALIABAD

	Civic Management Society (CMS) Aliabad
Water Resources	Both drinking and irrigation water sources are available used by Aliabad, Hassanabad, and Murtazabad. 1800 domestic & commercial consumers are benefiting from the water supply
Water connections	Three water connections 1800 consumers
Water resources destroyed	All water resources were damaged
Duration to repair	It depends upon the situation and volume of damage
Challenges faced by your organization	Financial resources
Lesson you learned	To be vigilant & planned
Impacted most due to destruction of Infrastructure	Every segment of society
Areas not addressed yet? Reason	Water sources are not addressed yet, lack of interest by PWD
Recommendations to address such areas	Government should take such measures to avoid damage again
Strategies to mitigate the impact of GLOF	Better planning and timely interventions
Learnings so far from GLOF events	Planted more trees to mitigate challenges in future

Additional responses of Water and Power Department Hunza

TABLE 19: ADDITIONAL RESPONSES OF WATER AND POWER DEPARTMENT HUNZA

	Water and Power Department Hunza
Water connections	One for Hydropower house, and multiple connections for drinking and irrigation purposes

Appendix: 5 Key Informant Survey Profile

S.No	Name	Organization	Profession
1.	Deedar Karim	AKAH	Program Coordinator
2.	Nazakat Jabeen	GLOF II, UNDP	Monitoring and Evaluation officer
3.	Javed Ali	CMS Aliabad	Manager
4.	Sherbaz Khan	Water & Power	Engineer
5.	Ehsam Karim	GBDMA	Assistant Director
6.	Asiya Aman	District office	District officer climate change cell

Appendix: 6 Study Area Pictures



FIGURE 13: DISRUPTION OF KARAKORAM HIGHWAY

Figure 13 depicts two photographs of the same location, one taken in 2019 and the other in 2022, the year of KKH's massive disruption. The damage to the Karakoram Highway during the Shishper GLOF incident of 2019, however it was restored within 24 hours by using local community land. According to land owners, they had not received rent for the past two years. They request that the concerned government department pay the land rent on timely. KKH was restored in February 2022, however on May 7, 2022, the GLOF catastrophe wipes away the road once again.



FIGURE 14: CHANNELIZATION INFRONT OF FWO CAMP (13 AUGUST 2021)

The channelization approach to protect the FWO CAMP Hassanabad was depicted in Figure 14. According to the opinion of Ex Candidate GBLA-6, was channelization in front of the FWO camp, which diverted the intensity of flood to the opposite deck of the bridge, forcing the bridge to collapse.



FIGURE 15: DAMAGE OF HASSANABAD BRIDGE (7 MAY 2022)

In the Figure 15 represented the incidence of the outburst of Shishper glacial lake and collopsed the Hassanabad Bridge.



FIGURE 16: MAP OF ALTERNATIVE ROUTE

Source: (Chatta, 2022)

In Figure 16: the alternative route was opened for the light traffic through Nagar valley to Hunza, locals and tourist used alternative route to travel for the down areas (Chatta, 2022)



FIGURE 17: RESTORATION OF STEEL BRIDGE (20 MAY 2022)

Figure 17 displays FWO opening the temporary steel bridge for light traffic in Hassanabad on May 20, 2022.



FIGURE 18: WATER SCARCITY AFTER GLOF EVENT (7 MAY 2022)

Figure 18 depicts water shortage in Aliabad and surrounding regions following the eruption of Shishper glacier lake in 2022. The government provides water tankers to the Muhallah's, who collect buckets of water for daily consumption.



FIGURE 19: COMMUNITY VOLUNTEERS ACTIVELY PARTICIPATED IN RESTORING DRINKING WATER FACILITIES

Figure 19 depicts the volunteerism services by community to restore drinking water facilities to Aliabad and Dorkhun village. From 2019 to 2022 every year water resources are disrupted due to GLOF events.



FIGURE 20: AFFORESTATION DRILL IN ALIABAD

Figure 20 illustrate that afforestation campaign on 27 December 2019 with the collaboration of the local council and community volunteers. In this campaign, male and female volunteers planted 870 trees near *Taltaq Daas* Aliabad. The initiative's objective was to green Hunza by restoring the barren land. Planting trees has numerous benefits, one of which is that it helps avoid flooding and soil erosion. Due to the shortage of water facilities caused by the GLOF occurrences, all of the trees have dried up.



Shot on OnePlus × Hasselblad
By saaz hunzai



FIGURE 21: WATER CHANNEL CLEANING BY VOLUNTEERS

Figure 21 depicted three images of volunteer members cleaning a water channel. Representatives from the community and members of each tribe participate in the maintenance of the water channel.