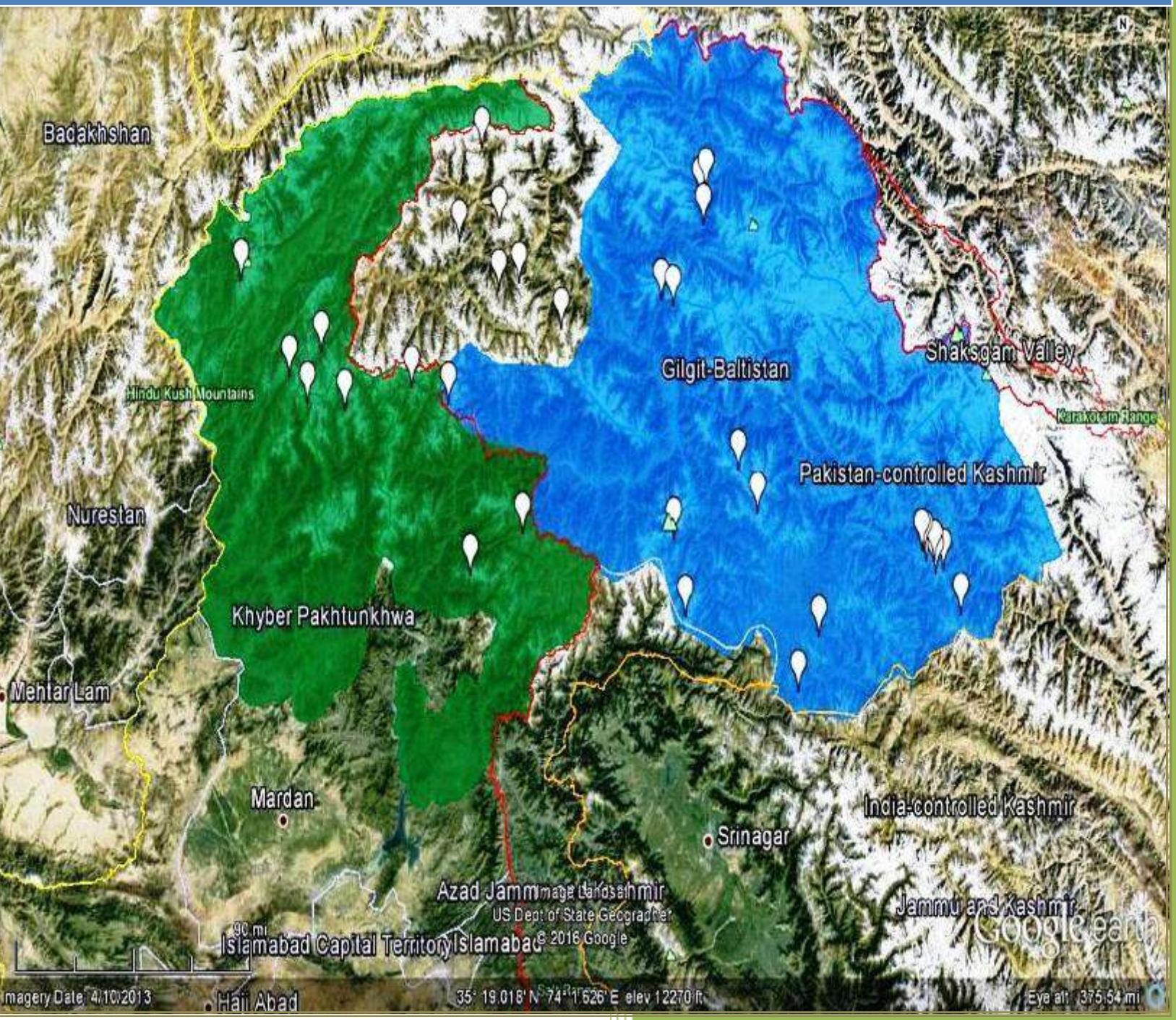
Feasibility Study

2016

Feasibility Report for scaling-up of Glacial Lak Outburst Flood (GLOF) risk reduction in Northen Pakistan



Distribution of Glacial Lakes in Northern Pakistan (Google Earth Image)

UNDP-Pakistan

15 March, 2016

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List of acronyms:

AWS:	Automatic Weather Station
ARG:	Automatic Rain Gauge
AJK:	Azad Jamu & Kashmir
m.a.s.l	Meters Above Sea Level
CBO:	Community Based Organization
CBD:	Convention on Biodiversity
CC:	Climate Change
CCD:	Climate Change Division
CFT (cft):	Cubic Feet
CO2:	Carbon Dioxide
CSOs:	Civil Society Organizations
DDMU:	District Disaster Management Unit
DNA:	Damages & Need Assessment
DERC:	District Emergency Response Cell
DME:	Discharge Measuring Equipment
DRM:	Disaster Risk Management
DRMC:	Disaster Risk Management Committee
DRR:	Disaster Risk Reduction
ERC:	Emergency Response Cell
ERRA:	Earthquake Recovery and Rehabilitation Authority
EWS:	Early Warning System
FAO:	Food and Agriculture Organization
FATA:	Federally Administrated Tribal Areas
FD:	Forest Division
GB:	Gilgit-Baltistan
GHGs:	Green House Gases
DBDMA:	Gilgit-Baltistan Disaster Management Authority
GDP:	Gross Domestic Product
GLOF:	Glacial Lake Outburst Floods
GRR:	GLOF Risk Reduction
GoP:	Government of Pakistan
GSM:	Global System for Mobile communication
ha:	Hectares
HFA:	Hyogo Framework for Action
HKH:	Himalaya Karakorum and Hindukush
HVRA:	Hazard & Vulnerability Risk Assessment
ICOR:	Incremental Capital Output Ratio
IK:	Indigenous Knowledge
IUCN:	International Union for Conservation of Nature
KG:	Kilogram
Km:	Kilometer
KP:	Khyber Pakhtunkhwa
LS:	Lump Sum
KPDMA:	Khyberpukhtunkha Disaster Management Authority

Man-D (MD):	----------Man Days
MDGs:	----------Millennium Development Goals
mm:	----------millimeter
NAMC:	----------National Agro Met Center
NEAP:	----------National Environment Action Plan
NDMA:	----------National Disaster Management Authority
NDMC:	----------National Disaster Management Commission
NFR:	----------Net Farm Revenue
NASSD:	----------Northern Areas Strategy for Sustainable Development
PARC:	----------Pakistan Agriculture Research Council
PMD:	----------Pakistan Meteorological Department
PDMA:	----------Provincial Disaster Management Authority
Qty:	----------Quantity
RAMC :	----------Regional Agro Met Center
RCC:	----------Reinforced Concrete
Sft:	---------- Square Feet
SUPARCO:	----------Pakistan Space and Upper Atmosphere Research Commission
TMA:	----------Tehsil Municipal Administration
TFCC:	----------Task Force on Climate Change
UC:	----------Union Council
USD:	----------US Dollar
WAPDA:	----------Water and Power Development Authority
WWF:	----------World Wide Fund for Nature Pakistan

Executive Summary:

Climate change has emerged as the greatest threat which impacts every aspect of our lives and work. It has a significant economic and environmental impact on communities. These climatic impacts have massive potential for seriously undermining development gains. According to the recent studies, global climate change has had a significant impact on the high mountain environment of the South Asia in the past few decades that has resulted in rapid melting of snow and glaciers, creation of new lakes and outburst of old ones posing high risk of glacial lakes outburst flood (GLOF) hazard for the downstream communities. With the onset of twenty first century both the intensity and frequency of climate induced hazards like flash floods and GLOFs have increased many folds in the Hindukush, Karakoram, Himalaya (HKH) region.

Pakistan was amongst top 10 among developing countries in terms of its vulnerability and Global Climate Change Risk Index 2014 (Briefing Paper: Global Climate Risk Index 2014 Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2012 and 1993 to 2012, Sönke Kreft & David Eckstein)

A number of factors lay behind socio-economic vulnerabilities of Pakistani society to climate-related hazards. It includes lack of awareness of GLOF risks, inadequate management to address them, increasing poverty rates, poor construction practices, unsustainable livestock and agricultural management, fragile natural environment in mountainous regions, weak early warning systems, and almost non-existent resilience tools for communities. Poor communication infrastructure and lack of critical facilities aggravate vulnerabilities of communities. In mountainous regions of Pakistan, non-availability of safer land for construction, scattered settlement patterns and harsh climatic conditions further intensify the vulnerabilities. The size and growth of human and animal population, environmental degradation resulting from poorly managed urban and industrial development processes, and climate change and variability are major dynamic pressures that increase vulnerabilities of Pakistani rural communities. It is anticipated based on the IPCC reports that in the coming decades, frequency, severity and impact of certain hazards may increase which might lead to greater social, economic and environmental losses.

Pakistan has been hit by widespread flood disasters in recent years. Such prevailing situation demanded a thorough research of the current status of the glacial lakes in the northern HKH ranges of Pakistan. The first phase of the project on “Reducing Risk and Vulnerability from Glacial Lakes Outburst Floods (GLOF) in Northern Pakistan”- a Joint Project of Ministry of Climate Change (MoCC) and United Nations Development Program (UNDP), funded by the Adaptation Fund has yielded positive results in reducing risks due to climate change. Total in-cash budget of the project was $4.1 Million (USD), focusing on the following two main objectives of the project:

- To develop the human and technical capacity of public institutions to understand and address immediate GLOF risks for vulnerable communities in Northern Pakistan.
- To enable vulnerable local communities in Northern Pakistan to better understand and respond to GLOF risks and thereby adapt to growing climate change pressures.

During the project implementation period, a number of surveys and assessments were undertaken, which identified over 7000 glaciers spread over 15,041 square kilometers in Pakistan’s northern area. The melting of these glaciers because of global warming and carbon soot deposits from trans-boundary pollution poses a serious threat to the lives of vulnerable mountain communities, as well as the sustainability of the Indus River System (IRS) flows and of agriculture, which is mainstay of the country’s economy. The country’s Hindu Kush, Karakoram and Himalayan glaciers are receding at an alarming rate

of almost 40 to 60 meters a decade as a result of the rapidly changing climatic conditions, according to Pakistan Meteorological Department. Overall annual flows of the IRS risk a potential decrease of about 15% and a considerable change in the monthly flow pattern, with more water coming in the spring and early summer, and less water in the later part of the summer, due to the projected recession of glaciers.

The provinces of Gilgit-Baltistan (G-B) and Khyber Pakhtunkhwa (KP) being home to huge glacial deposits are particularly vulnerable to climate change in the coming years as rising temperatures affect weather cycles and the quantity of glaciers/snow melt, and thereby the water flows originating from the three mountain ranges. Further to this, due to rising temperatures, around 2,420 glacial lakes have formed, 36 of which are potentially hazardous and extremely vulnerable to sudden outbursts/ breaches called glacial lake outburst floods (GLOF) as identified by Pakistan Meteorological Department (PMD) in Collaboration of National Agricultural Research Council (NARC). Such outbursts can lead to a release of millions of cubic metres of water and debris in a few hours with the peak flows as high as 15,000 cubic metres a second. The GLOFs events have resulted in loss of lives as well as the destruction of property and infrastructure, and severe damage to livelihoods in some of the most remote and inaccessible areas of northern Pakistan. Due to these potentially hazardous glacial lakes, there are 5,300,000 people at risk at present in GB and KP provinces due to climate change induced disasters, particularly floods caused by glacial lake outbursts and increased melting of glaciers.

Based on the previous project experience, phase II of the project proposal has been submitted to GCF secretariat to upscale the project activities and interventions to other adjoining vulnerable mountain communities in order to reduce vulnerability and climate change-induced natural disaster risks as a result of GLOFs. To ensure an appropriate response to climate change induced natural disasters in glaciated areas of Pakistan, the following barriers have been identified and addressed in feasibility study:

1. Weak management and legislative structures, regional level strategies, policies, partnerships, coordination mechanisms and capacities for adopting landscape-wide adaptation practices and approaches.

2. Poor planning and decision-making capacity at the provincial level for sustainable mountain land use and development practices due to inadequate tools and insufficient data and information.

3. Scattered on-the-ground implementation of successful adaptation models to reduce land degradation and enhance ecosystem services and support livelihoods.

4. Mismanagement of soil and water conservation and disaster preventive measures to increase production of food and fodder crops.

5. Non-existent extension delivery mechanisms in remote areas.

6. Relief, restoration and rehabilitation measures are disjointed in nature and not linked with national, provincial and district level DRM initiatives.

The **purpose** of the socio-economic feasibility study is to provide an in-depth analysis of the project activities to be implemented keeping in view so far, after four years of implementation, providing a moment of stock-taking and retrospection. The feasibility study aims to describe the following aspects in the detail:

- Analysis of climate change risks, impacts, and vulnerability

- Institutional and beneficiaries' situation analysis and economic benefits of the intervention
- Past and current projects and programs interventions
- Logic of the intervention
- Technical specifications of equipment and interventions
- Technical Studies conducted
- Costing and Sustainability

PART-A:

1. *Analysis of climate change risks, impacts, and vulnerability*

1.1 Overview of the situation:

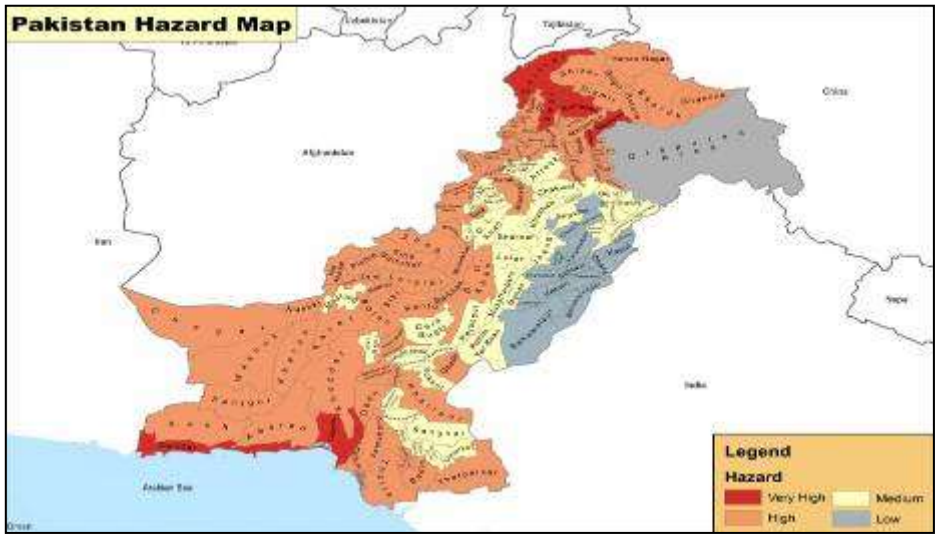


Figure 1: Hazard Map of Pakistan (NDMA)

Climate change resulting from an increasing concentration of Greenhouse Gases (GHGs) in the atmosphere due to the use of fossil fuels and other human activities has become a major worldwide concern. It is particularly so for Pakistan because climate change is posing a direct threat to its water security, food security and energy security. The country's vulnerability to such adverse impacts is likely to increase considerably in the coming decades as the average global temperature, which increased by 0.6 °C over the past century, is projected to increase further by 1.1 to 6.4 °C by the end of the current century.

A Task Force on Climate Change (TFCC) was set up by the Planning Commission of Pakistan in October 2008 with the view to take stock of country's situation in relation to climate change; to contribute to the formulation of a climate change policy that would assist the government in achieving sustained economic growth by appropriately addressing climate change threats so as to ensure water security, food security and energy security of the country; and to recommend policy measures for promoting large scale Adaptation and Mitigation efforts, raising awareness of various stakeholders; and enhancing the capacities of relevant national institutions.

Due to scarcity of social, technological and financial resources developing countries like Pakistan are the highly vulnerable to climate change induced disaster and their impacts. Climate change is anticipated to have far reaching effects on the sustainable development of developing countries including their ability to attain the United Nations Millennium Development Goals by 2015 (UN 2007). Many developing countries' governments have given adaptation action a high, even urgent, priority.

Climate Change risks and vulnerabilities in Pakistan are multidimensional.

PMD with collaboration of NARC, has developed a list of 36 Hazardous lakes in northern parts of the country. Map showing location of these lakes and vulnerable areas is given below:

On the basis of findings and detail report of PMD on glacial lakes in Pakistan a rapid assessment was carried out in the vulnerable communities (districts). According to the studies conducted by PMD (Glacial Lake Assessment) districts/provinces are highly vulnerable to Glacial Lake outburst Floods in northern Pakistan:

The proposed target areas are located in the northern parts of Pakistan, consisting of the GB Province and 5 district of Khyberpukhtunkhwa Province. Brief profile of the proposed target areas is given below:

Table 1: Basic information about target areas

Name of area	Population	Total area	Population density	Percentage area under snow/glaciers	Location
District Swat, KP	2,000,000	5,337 sq km	236/sq km	19.2%	35°23'N 72°11'E
District Chitral, KP	450,000	14,850 sq Km	28/ sq Km	19.5%	35° 50.785'N, 71° 47.053'E
District Upper Dir, KP	890,000	3,699 sq km	192/ sq Km	12%	35° 9.931'N, 72° 2.809'E
District Mansehra, KP	1,75,0000	4,580 sq Km	272/sq Km	11%	34° 20.033'N, 73° 12.064'E
District Kohistan, KP	65,000	7,492 sq km	72/sq km	22.5%	35°15'N 73°30'E
Gilgit-Baltistan, Province	1,560,000	72,971 sq km	22/sq km	20.5%	35.35°N 75.9°E

According to Pakistan Meteorological Department (PMD), the northern areas of the country including GB province and northern parts of KP Province are home to over 7000 glaciers and 3000+ glacial lakes. Of the total, PMD has notified 36 lakes and potentially hazardous to trigger Glacial Lake Outburst Floods. The potentially dangerous lakes are scattered in northern parts of the country.

Details of individual target valley and vulnerability to GLOF are given in table-2 below.

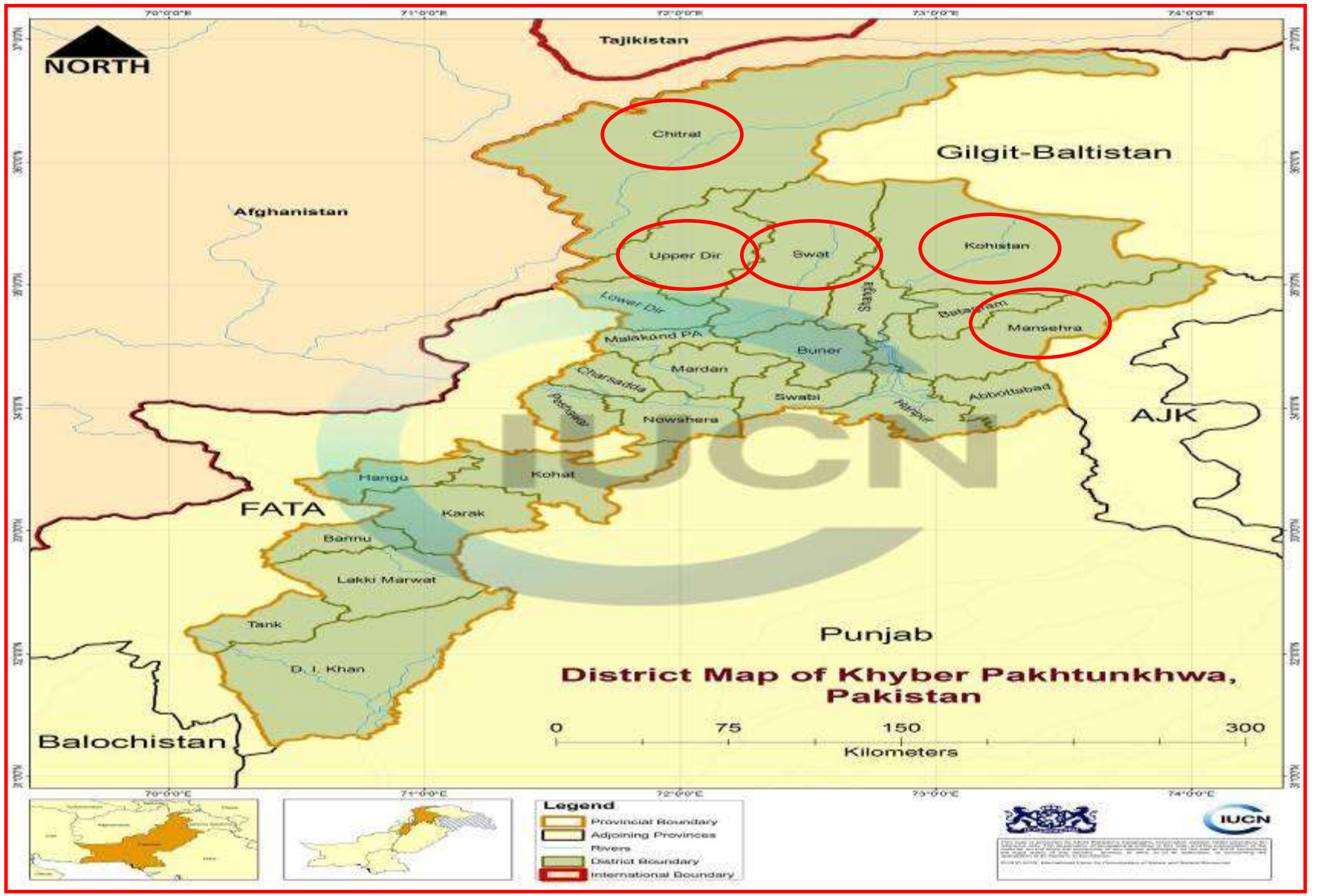


Figure 2: District Map of KP Province (Target areas encircled red)

Figure 4: Map of GB Province

Table 2: Details of Proposed target areas

Province	District	Valley	HHs	Male Beneficiaries	Female Beneficiaries	Total Beneficiaries	Percentage Community Near River Banks	Vulnerable Population
Gilgit Baltistan	Ghizer	Sengul	486.00	1,829.00	2,060.00	3,888.00	4.30	
Gilgit Baltistan	Ghizer	Damas	630.00	2,470.00	2,570.00	5,040.00	1.20	
Gilgit Baltistan	Ghizer	Roushan Hakis	300.00	1,150.00	1,350.00	2,500.00	6.70	
Gilgit Baltistan	Ghizer	Dahimal	240.00	618.00	617.00	1,235.00	9.80	
Gilgit Baltistan	Ghizer	Darkut	3,185.00	1,625.00	1,560.00	3,185.00	18.00	
Gilgit Baltistan	Ghizer	Sandhi	6,090.00	3,166.00	2,924.00	6,090.00	42.00	2,557.00
Gilgit Baltistan	Gilgit	Hinarchi Bagrote	370.00	1,539.00	1,421.00	2,960.00	70.00	2,072.00
Gilgit Baltistan	Gilgit	Gargo Bagrote	390.00	1,622.00	1,498.00	3,120.00	90.00	2,808.00
Gilgit Baltistan	Hunza Nagar	Attaabad Hunza	1,363.00	5,670.00	5,234.00	10,904.00	45.00	4,906.00
Gilgit Baltistan	Hunza Nagar	Gulkin Hussaini	228.00	948.00	876.00	1,824.00	70.00	1,276.00
Gilgit Baltistan	Hunza Nagar	Passu	680.00	2,829.00	2,611.00	5,440.00	40.00	2,176.00
Gilgit Baltistan	Ghancha	Hassnabad	270.00	1,123.00	1,037.00	2,160.00	50.00	1,080.00
Gilgit Baltistan	Ghancha	Lunkha	32.00	133.00	123.00	256.00	70.00	200
Gilgit Baltistan	Ghancha	Khaplu Town	2,500.00	10,400.00	9,600.00	20,000.00	56.00	11,200.00
Gilgit Baltistan	Ghancha	Barah	932.00	3,877.00	3,579.00	7,456.00	45.00	3,355.00
Gilgit Baltistan	Skardu	Kharmang Valley	5,658.00	23,537.00	21,727.00	45,264.00	80.00	36,211.00
Gilgit Baltistan	Astore District	Parishing Valley	1,750.00	7,280.00	6,720.00	14,000.00	50.00	7,000.00
Gilgit Baltistan	Astore District	Rattu Valley	2,250.00	9,360.00	8,640.00	18,000.00	50.00	9,000.00
Gilgit Baltistan	Astore District	Rupal Valley	2,500.00	10,400.00	9,600.00	20,000.00	50.00	10,000.00
Gilgit Baltistan	Astore District	Shingo River Basin	3,500.00	14,560.00	13,440.00	28,000.00	50.00	14,000.00

Province	District	Valley	HHs	Male Beneficiaries	Female Beneficiaries	Total Beneficiaries	Percentage Community Near River Banks	Vulnerable Population
Khyber-Pakhtunkhwa	Chitral	Laspoor valley, Chitral	5,700.00	26,000.00	25,200.00	51,200.00	50.00	25,000.00
Khyber-Pakhtunkhwa	Chitral	Boni valley, Tehsil Mastuj, Dist Chitral	3,000.00	13,000.00	12,200.00	25,200.00	60.00	13,000.00
Khyber-Pakhtunkhwa	Chitral	Madaklasht valley, Dist Chitral	1,800.00	5,100.00	5,000.00	11,900.00	80.00	8,000.00
Khyber-Pakhtunkhwa	Chitral	Arkari Valley, Dist Chitral	430.00	1,500.00	1,750.00	3,250.00	60.00	1,800.00
Khyber-Pakhtunkhwa	Chitral	Rumboor Kalasha valley, Chitral	500.00	3,000.00	2,100.00	5,100.00	100	5,100.00
Khyber-Pakhtunkhwa	Chitral	Terich Valley, Dist Chitral	1,500.00	7,800.00	7,100.00	14,900.00	80.00	10,000.00
Khyber-Pakhtunkhwa	Chitral	Ovir Valley, Dist Chitral	2,300.00	10,000.00	9,300.00	19,300.00	70.00	12,000.00
Khyber-Pakhtunkhwa	Chitral	Broghil Valley, Dist Chitral	450.00	2,100.00	1,900.00	4,000.00		3000
Khyber-Pakhtunkhwa	Dir	Shiringal	5,463.00	.	.	40,000.00	55.00	22,000.00
Khyber-Pakhtunkhwa	Dir	Ushuraj	722.00	.	.	5,772.00	55.00	3,174.60
Khyber-Pakhtunkhwa	Swat	Matiltan Valley	641.00	.	.	5,448.00	60.00	3,268.80
Khyber-	Swat	Utror Valley	1,976.00	.	.	16,800.00	60.00	10,080.00

Province	District	Valley	HHs	Male Beneficiaries	Female Beneficiaries	Total Beneficiaries	Percentage Community Near River Banks	Vulnerable Population
Pakhtunkhwa								
Khyber-Pakhtunkhwa	Kohistan	Dubair Valley	.	.	.	25,000.00	45.00	11,250.00
Khyber-Pakhtunkhwa	Kohistan	Palas Valley	.	.	.	90,000.00	45.00	40,500.00
Khyber-Pakhtunkhwa	Kohistan	Khandia Valley	.	.	.	51,000.00	45.00	22,950.00
Khyber-Pakhtunkhwa	Mansehra	Kaghan Valley	.	.	.	90,000.00	80.00	72,000.00
Khyber-Pakhtunkhwa	Mansehra	Naran Valley	.	.	.	71,000.00	80.00	56,800.00
						811,192.00		**515,835.89**

1.2 Some of the major risks associated with rapid climate change:

A. Changing climatic conditions and its impact:

The result of high resolution gridded projections of temperature and precipitation for Pakistan shows 3°C–5°C temperature rise in mean temperature under RCP 4.5 emission scenario. RCP 4.5 (Representative Concentration Pathways) is a stabilization scenario which is consistent with the recently developed policies and frameworks to reduce greenhouse gas emissions through efficient energy use, land-use and population control. Rainfall is highly variable in both spatial and temporal domains. Area averaged rainfall over Pakistan shows a large interannual variability. Sharp rising peaks give some indication of extreme precipitation events while negative peaks indicate droughts.

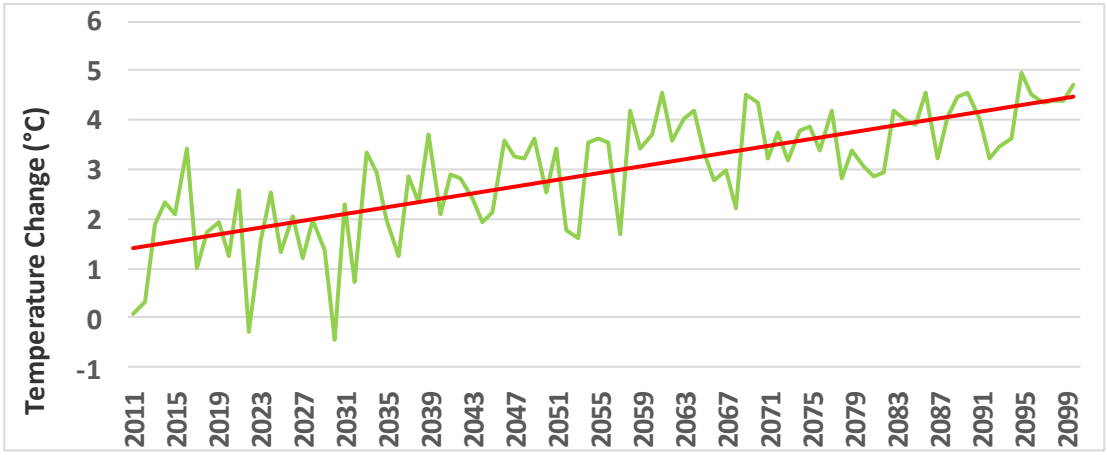


Figure 5: Pakistan's mean annual temperature deviation projections during 21st century.

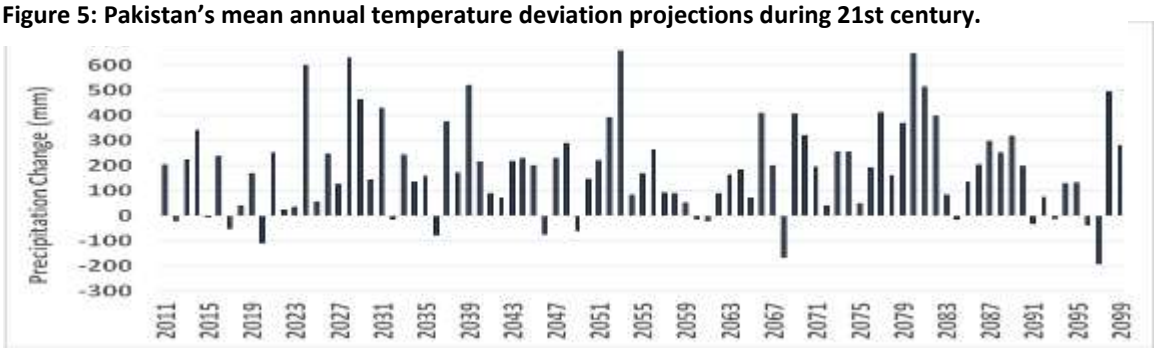


Figure 6: Pakistan annual mean precipitation deviation projection during 21st century.

The mean annual temperatures of Northern part of the country shows increasing trends in the last century especially very significant increase in last decade as shown in the above figure. Keeping this in view, future temperature trends also shows increasing trends in the coming century. This warming is more in Northern Parts of the country than the warming over the country and is an alarming situation since it will increase the climate related disasters in magnitude and frequency in this area. The northern parts of HKH region of Pakistan are heavily glaciated and are home to over 7000 glaciers and 3000+ glacial lake of which 36 are potentially dangerous. This increasing trend in temperature and precipitation increases the possibilities of GLOFs risk in the area along with rapid depletion of water resources. Glaciers and snow melt water contributes to 60% to total fresh water resources of the country and rapid melting resources will result acute fresh water supply in winters in short terms and chronic shortage of fresh water in the longer terms.

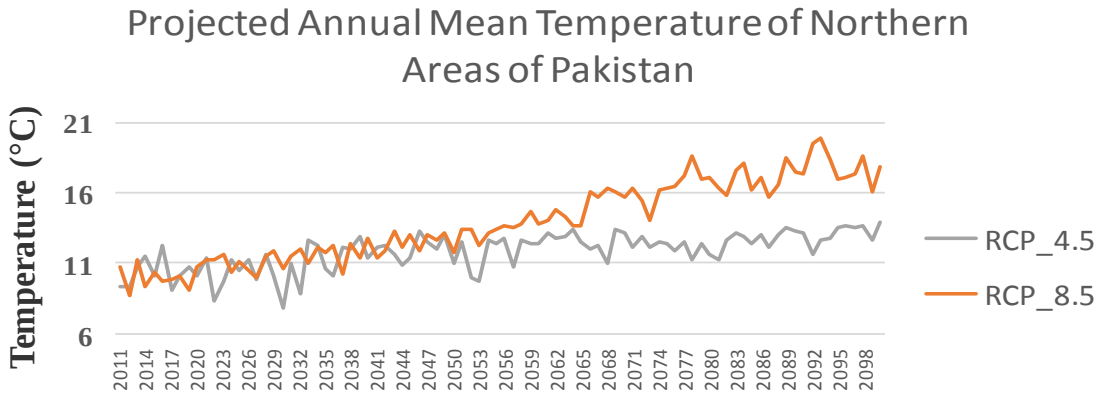


Figure 7: Projected mean temperature of Northern Areas of Pakistan

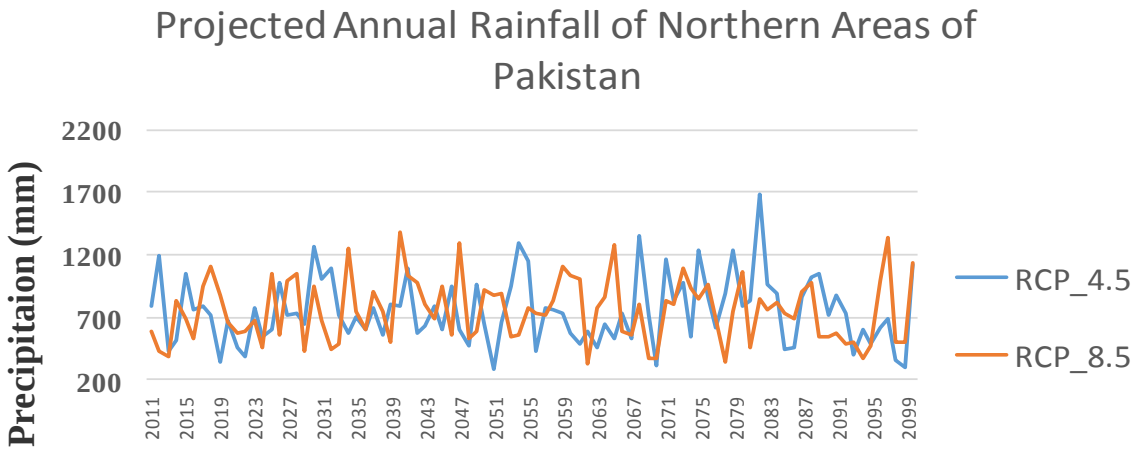


Figure 8: Projected Annual Rainfall of NAs of Pakistan

However, precipitation patterns are stable but with variability increases showing erratic behavior in precipitation patterns. Snow covered areas of Pakistan in the north are likely to observe more increase in mean temperature (5°C to 6°C) as compared to central and southern regions. Mid–century summer rainfall peaks are expected to shift towards August while those of winter season have been shown to shift towards March. The shift in these rainfall peaks continue to dwell even up to the end of the century. The seasonal cycle shows that the winters are warming more than summers with an increase in temperature of up to 6°C to 8°C in the 21st century with respect to baseline (1975-2005).

Whereas, the Monsoon belt of the country show an overall increase of 3 to 4 mm/day. Future scenarios show that the monsoon region is likely to be more confined over the northeastern Parts of Punjab and adjoining Kashmir. Sharper increase in mean temperature of northern areas as compared to southern areas of Pakistan is going to have adverse impacts on the water resources present in those

areas. This situation will directly affect livelihood of the communities in northern areas of Pakistan as indicated below:

1. Rapid melting of stored (frozen) reserves of water resulting in supply fluctuation and increased events of GLOFs and other disasters (will be discussed in subsequent sections of the report).
2. Reduced water availability, which is altering the crop rotation and cropping patterns
3. Drastic reduction in cereal production, e.g wheat and rice, as well as in cotton and sugarcane
4. In southern Pakistan yields of major cereals predicted to decline by 15-20% by Regional Climate Change Models
5. In the northern area minor improvements in yield due to increased duration of growing period
6. Livestock production predicted to decline by 20-30%, creating crises in milk, meat and poultry supplies and pushing prices beyond reach of the average Pakistani
7. Rangelands will be over-stressed from prolonged droughts and shifting human and livestock populations around riverine areas and in mountainous regions. This will reduce tree and shrub cover. Pakistan is already amongst the most forest/tree resource-poor countries in the world with a meager 5.2% forest cover, and even that sparsely stocked. l Inland fisheries predicted to be reduced due to decreased water availability and changing river flows
8. High frequency and intensity of extreme weather events
9. Plant diseases, weeds and insect attacks will increase considerably, resulting in major crop losses
10. Fruits, vegetables and horticultural products are high-value exports for Pakistan. A predicted reduction in these will severely impact our balance of payments.
11. The livelihood of farm communities will be affected, and marginalized groups like women, children and the elderly will be negatively impacted through widespread malnutrition.

Pakistan earns 70% of its foreign exchange from agriculture alone. Unless it maintains stable growth rates, its economy will suffer immensely. The International Food Policy Research Institute states in its 2009 report, "South Asia will be the most severely impacted by climate change. By 2050 it could lose 50% of its wheat productivity". Recent ranking by Maplecroft of the UK places Pakistan at 28th amongst those that will be most severely affected. But since 22 of those countries are in Africa, Pakistan is ranked amongst the top ten outside Africa. By virtue of sharing a highly porous border with Afghanistan (ranked No. 4) and being a neighbor to the emerging economies of China and India, Pakistan is being squeezed from all sides. Pakistan is an agriculture supplier that feeds vast populations of its own and of neighboring countries like Afghanistan, as well as the Middle East and several Central Asian Republics (Report on Climate Change Vulnerabilities in Agriculture in Pakistan, IUCN-Pakistan).

The loss of life and property and the challenges that were faced in the aftermath of 2010 floods affecting Northern Pakistan mostly exhibited the need for establishing appropriate policy and institutional arrangements to reduce losses from disasters in future.

Despite being extremely prone to both natural and human-induced hazards, no proper system existed in Pakistan to identify, treat and manage risks and disasters until the aftermath of the 2005 Pakistan earthquake. Following this massive disaster, the National Disaster Management Ordinance (NDMO) was introduced as a legal instrument for disaster management in Pakistan. The Ordinance was converted to the National Disaster Management Act in 2010. The Ordinance, and the subsequent Act,

was developed in alignment with the global Hyogo Framework for Action (HFA, 2005-2015) to incorporate the benefits of international disaster management practice and experience.

After 2010 floods, identification and profiling of potential hazard is the most important component in the risk analysis exercise. The understanding and awareness about the hazards induced by climate change is low in northern Pakistan. The vulnerability and exposure to the natural hazards and impacts thereof has not remained in the frontline to deal with the risks and disaster. Rather there is strong importance in achieving the goals of mitigation strategies. Thus increasing resilience to hazards and disasters in the target area needs to be addressed effectively.

Glaciers are the water source for the 10 major river systems in the region (Figure-1) – the Amu Darya, Indus, Ganges, Brahmaputra (Yarlungtsanpo), Irrawaddy, Salween (Nu), Mekong (Lancang), Yangtse (Jinsha), Yellow River (Huanghe), and Tarim (Dayan) – providing water and ecosystem services, and forming the basis of the livelihoods for 1.3 billion people, a fifth of the world's population. The melting of Himalayan glaciers seriously affects half a billion people in the HKH region and a quarter of a billion people in China who depend directly on these frozen waters for their water supply (Stern 2006).

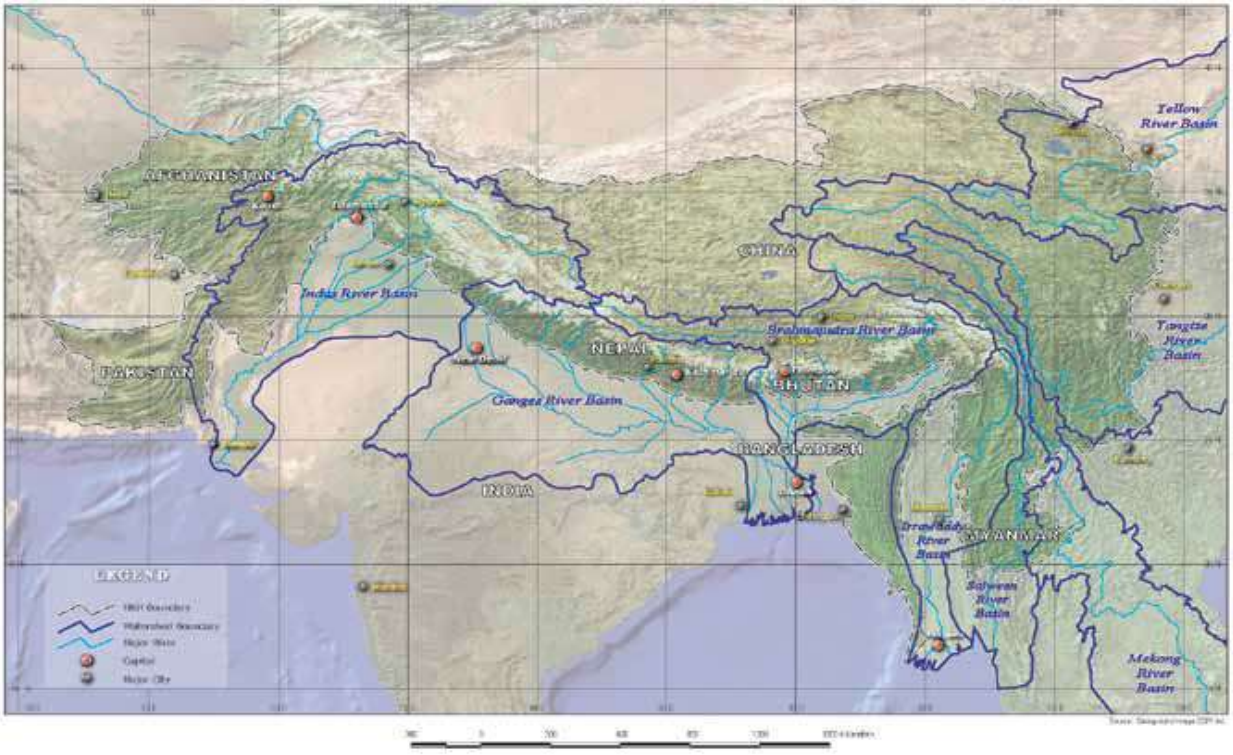


Figure 9: Map of HKH River System (Courtesy to ICIMOD)

C
onsequences for downstream agriculture, which relies on these waters for irrigation, are potentially staggering. Already there has been a noted decline in the yields of cereal crops such as rice, maize, wheat, and millet in the region, on which the world depends for 25 per cent of its supply of cereal food. This decline could further drop by as much as 30 percent by 2050 (IPCC 2007).

Glaciers also play an important role in determining slope stability, ecology, erosion processes, and surface water. The rapid thawing of permafrost and decrease in the depth of frozen soil has threatened many human settlements downstream, causing frequent landslides and the degeneration

of some forest ecosystems (IPCC 2007). In fact, the region is noted for its vulnerability to hazards and disasters, which is likely to be exacerbated by climate change.

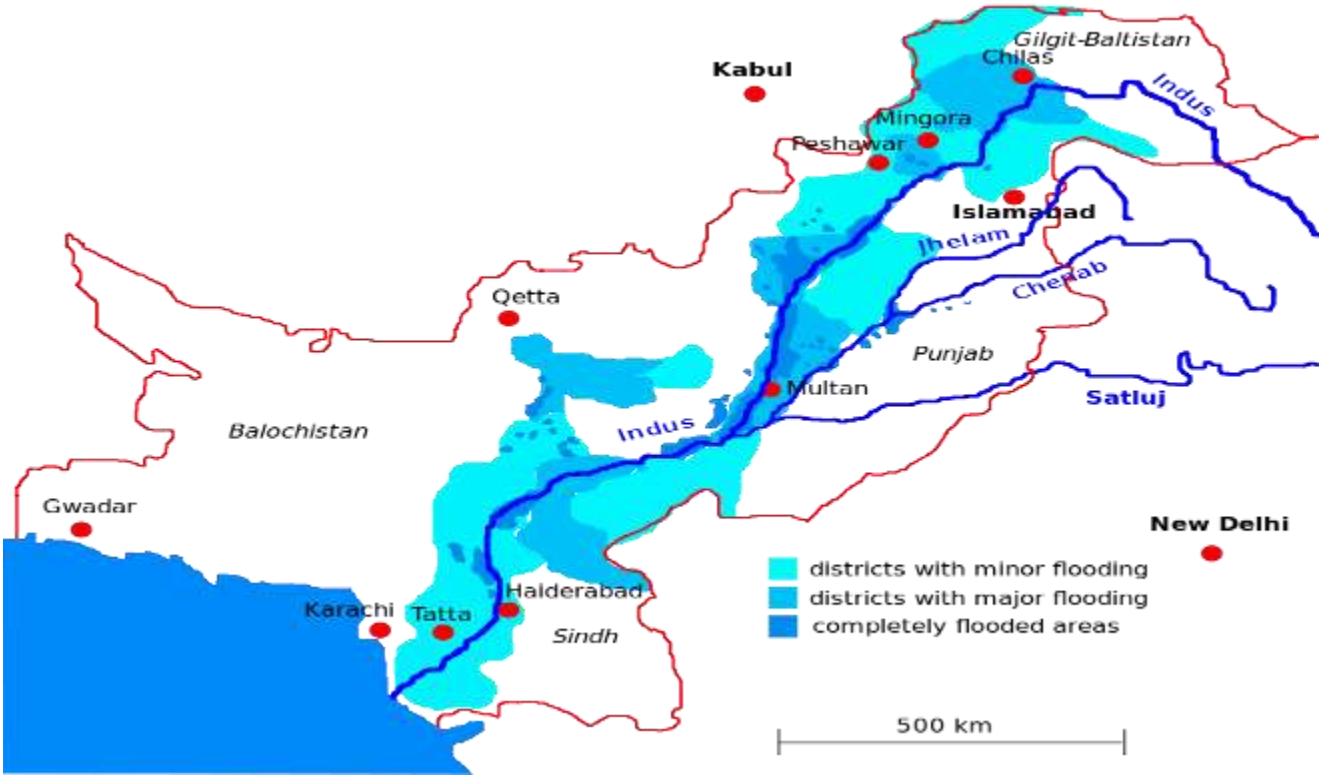
1.3 Risks According to Region/Area:

The Northern area is exposed to variety of hazards due to geo-climatic characteristics and surface atmosphere interactions. The frequency and intensity of these natural hazards induced due to changing climate have increased sharply in recent years. The common hazards include landslides, GLOFs, flash floods, heat waves, land degradations, in these mountainous areas. Flooding is most common disaster in the northern area. Then the earth quakes resulting in landslides and avalanches in the target area are also a major concern. The landslides and debris flow also occurs as a result of flood/ GLOF events. Among disasters of flooding, landslides, droughts, earthquakes and cyclones, flood contributes to 51% in Pakistan according to a study conducted by World Bank Group. South Asian Disaster Risk Management and Climate Change Unit. Sustainable Development Network. The frequency and intensity of the natural disasters has increased.

Climate change is considered a critical factor behind changing rainfall patterns and the visible increase in precipitation during monsoon seasons in parts of the country. Research work based on long-term climate change data points towards a scenario of future occurrence of heavy rainfall events during monsoon seasons over north-west Pakistan instead of north-east. As a result, areas along the western rivers of the country (Indus and Kabul) will be more vulnerable to flood episodes similar to the one experienced during the current season.

The 2010 flooding (Figure-2) the most worst in the last eighty years effects 20 million significantly with a 1800 death toll according to the NDMA situation report October 19, 2010. Similarly flash floods and GLOF events during the flooding of July August 2015 resulted in disasters.

Figure 10: Map of flood affected areas in Pakistan (NDMA)



Occasionally higher spells of precipitation increases the frequency of floods in the areas. Moreover the increasing temperatures results in increased runoff generated by melting of glaciers causing the flash floods and GLOFs more frequent along with debris flow. Thus the changes in glacier regimes due to retreat/ surging may have long term implications on the lives of the communities of the target areas. These communities have only developed indigenous knowledge to cope with the situation of the disaster which may not remain effective with the changing scenarios of weather pattern. Therefore, an up to mark state of the art mechanism of EWS is required for these vulnerable communities to cope with the situation during disasters and its preparedness. Additionally they are living in remote locations of mountainous terrain which may get cut off from the rest of the world so they are relying on themselves in coping with the local situation arising as a result of disaster.

1.4 Climate Scenario:

During the last century, average annual temperature over Pakistan increased by 0.6 °C, in agreement with the global trend, with the temperature increase over northern Pakistan being higher than over southern Pakistan (0.8 °C versus 0.5 °C). Precipitation over Pakistan also increased on the average by about 25 %.

Studies based on the ensemble outputs of several Global Circulation Models (GCMs) project that the average temperature over Pakistan will increase in the range 1.3-1.5 °C by 2020s, 2.5-2.8 °C by 2050s, and 3.9-4.4 °C by 2080s, corresponding to an increase in average global surface temperature by 2.8-3.4 °C by the turn of the 21st century. Precipitation is projected to increase slightly in summer and decrease in winter with no significant change in annual precipitation. Furthermore, it is projected that climate change will increase the variability of monsoon rains and enhance the frequency and severity of extreme events such as floods and droughts.

1.5 Major Climate Change Related Concerns:

The most important climate change potential threats to Pakistan are identified as:

- Increased variability of monsoon;

- Rapid recession of Hindu Kush-Karakoram-Himalayan (HKH) glaciers threatening water inflows into the Indus River System (IRS); reduction in capacity of natural reservoirs due to glacier melt and rise in snow line;
- Increased risks of floods and droughts;
- Increased siltation of major dams resulting in greater loss of reservoir capacity;

1.6 Evidence of Extreme climatic events (drought, floods etc.) and no. of people affected :

The target areas have a very long and devastating history of natural disasters. However, in the distant past there has been no proper mechanism to record and maintain data on disaster events and classify them accordingly. However, during the past one decade systematic mechanism has been adopted to establish relevant data on disaster. Some of the historical data given in table-1:

Table 3: History of floods/GLOF in the target areas

Year	Date	Glacier	River	Causes
1929	Not known	**Chung Khumdan**	**Shyok**	Rains
1932	Not known	**Chung Khumdan**	**Shyok**	Rains
1973	Not known	Batura	Hunza	
1974	Not known	Batura	Hunza	
1977	Not known	Balt Bare	Hunza	Rains and heat waves
1978	Not known	Brep, Chitral	Chitral	---
1978	September	Darkot/Barados	Gilgit	
1992	Aug	Yarkhoon	Chitral	Rains and cloud burst
2003	July	Yarkhoon	Chitral	Rains and heat wave
1999	6-Aug	Khalti/Gupis	Gilgit	Monsoon Rainfall
2000	10-Jun	Shimshal	Hunza	High Temperature
2000	27-Jul	Kand/Hushe	Indus	Monsoon Rainfall
2005	July	Brep	Chitral	
2007	5-Apr	Ghulkin	Hunza	Western Disturbance
2007	Aug	Terich	Chitral	Rainfall
2007	July	Sonoghor	Chitral	Rainfall
2008	6-Jan	Passu	Hunza	Western Disturbance
2008	2-Apr	Ghulkin	Hunza	Western Disturbance
2008	22-May	Ghulkin	Hunza	Persistent Rainfall
2008	24-May	Ghulkin	Hunza	---do----
2008	14/15 June	Ghulkin	Hunza	Heat Wave
2009	26-Mar	Ghulkin	Hunza	South Westerly
2010	12 June	Booni	Chitral	Monsoon
2010	26 July,	Bindo Gol	Chitral	Rainfall
2013	31 July	Reshun	Chitral	Rainfall

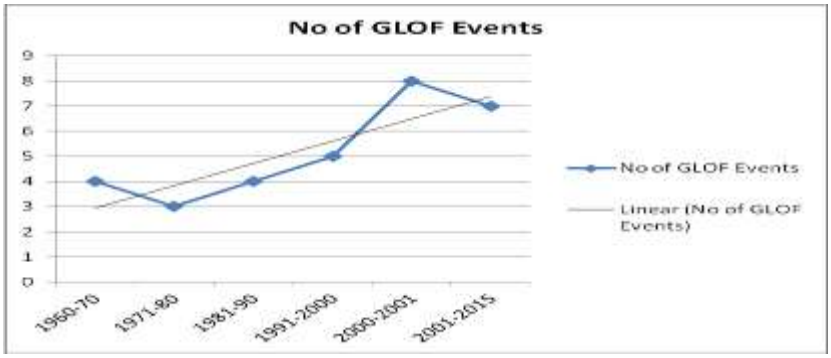
Table 4: Flash Floods and GLOF events during the year 2015:

Date	Glacier	River	Causes
21-July	Khorow Glacier	Braldu, Shigar	Rainfall and Sub Glacial Lake Outburst

Date	Glacier	River	Causes
21-July	Ganche	Skardu	Rainfall
21 July to 4 August	Bagrot	Gilgit	Rainfall, Glacier melt and GLOF
21 July to 1 August	Chitral Gol	Chitral	Rainfall and glacier melt
21 July to 1 August	Reshun	Chitral	Rainfall and glacier melt
21 July to 1 August	Bindogol	Chitral	Rainfall and glacier melt
21 July to 1 August	Garam Chasma	Chitral	Rainfall and glacier melt
21 July to 1 August	Kalash Valley	Chitral	Rainfall and glacier melt
21 July to 1 August	**Kosht**	**Chitral**	**Rainfall and glacier melt**
21 July to 1 August	**Mastuj**	**Chitral**	**Rainfall**
21 July to 1 August	**Booni**	**Chitral**	**Rainfall**

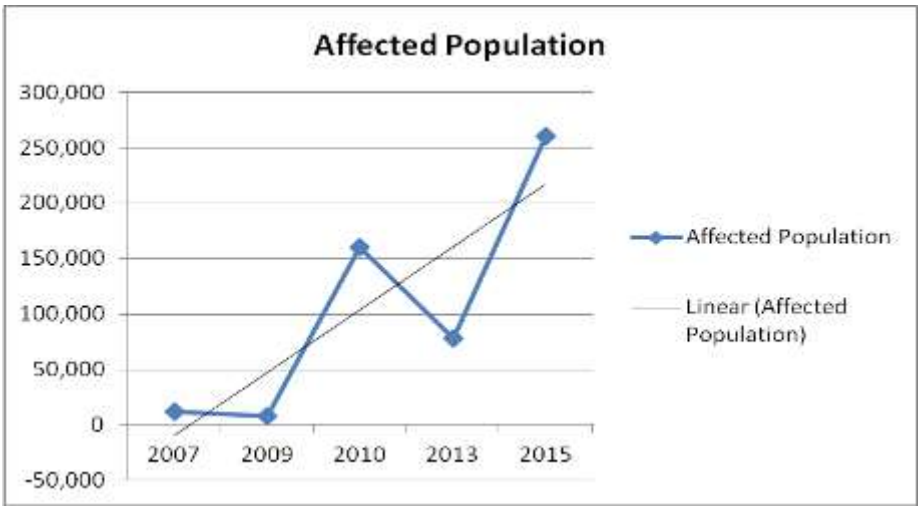
Comparative analysis of GLOF and other climate change induced disasters an upward trend over past two decades, especially in extreme northern parts of the country. The trend line in the graph below indicates a sharp increase in frequency of GLOF events in the district during the last couple of decades. During the same period the severity of the disasters, especially climate change induced disasters in term of destructions has also increased significantly. With each passing year the spectrum of damages caused by natural disasters in remote and glaciated parts of Pakistan is increasing.

Figure 11: GLOF trends in NAs of Pakistan (GLOF Project)



Comparative analysis of population affected by disasters for the last 8 years in district Chitral is given below:

Figure 12: Population affected in last 8 years due floods in NAs of Pakistan



Over the same period the damages inflicted by disasters have also increased many folds. Yearly analysis of the damages inflicted by disasters on infrastructure and livelihood means also show an upward trend for the northern parts of the country.

The chart indicates and upward trend in damages to built infrastructure. The data also reveals that human settlements, communication means (road network) and irrigation channels (water supply) were damaged more severely leading to both direct and indirect negative impacts on social set-up and development process.

Proximal location of the human settlements to vulnerable areas especially to glaciers is one the main cause of increasing damages. Besides, over the period both frequency and severity of extreme climate events and disasters have increased significantly. Damages caused to livelihood means in the target areas is also showing and upward trend for the past 5 years (Source: PDMA/NDMA)

Pakistan Meteorological Department has prepared and updated a detail report on potentially dangerous lakes in the northern parts of the country that could lead to devastating floods in future. Details of the lakes are given in below:

Table 5: Latest inventory of Glacial Lakes in Northern Parts of Pakistan

Basin	Number		Area (sq km)		
	Total	%	Total	%	Largest
Swat	214	7.0	12.5	9.3	0.74
Chitral	116	3.8	5.8	4.3	1.61
Gilgit	660	21.7	37.8	28.1	2.71
Hunza	216	7.1	9.2	6.8	5.78
Shigar	110	3.6	2.3	1.7	0.21
Shyok	270	8.9	6.0	4.4	0.29
Indus	815	26.8	32.4	24.0	2.56

Basin	Number		Area (sq km)		
Shingo	247	8.1	11.8	8.7	1.40
Astore	196	6.4	5.8	4.3	0.49
Jhelum	200	6.6	11.2	8.3	0.98
Total	3044	100.0	134.8	100.0	

HKH region in Pakistan is the most heavily glaciated area in the world and glaciers in region contribute significantly to the overall land cover.

Table 6: Details of glaciers in northern Pakistan

Number of Glaciers	Area of Glaciers (km2)	Volume of Ice (km3)	Ranges
7259	**11780**	**2066**	**HKH**

According to the glacial lake inventory report prepared by PMD, formation of glacial lakes is showing a positive trend. This is reflected in the comparative analysis of glacial lakes for the period from 2001 to 2013.

The positive change in lake formation is significantly high for extreme northern areas of the country including Chitral and Gilgit-Baltistan.

This positive trend, especially in northern most areas further increases the vulnerability to climate change induced disasters like GLOFs.

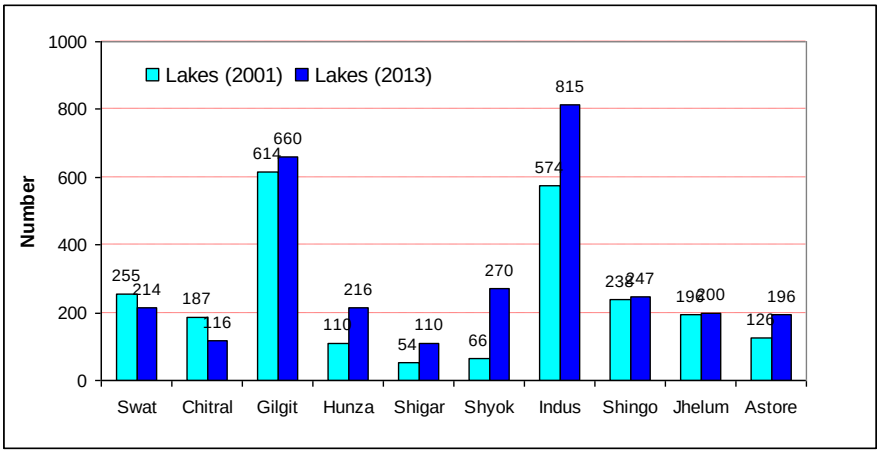


Figure 13: Inventory of Glacial Lakes (PMD)

Table 7: Potentially dangerous Glacial Lakes in Northern Pakistan

S.No.	Basin	GLOF Lakes (2001)	GLOF Lakes (2013)	Change
1	Swat	2	2	0
2	Chitral	1	3	2
3	Gilgit	8	8	0
4	Hunza	1	3	2
5	Shigar	0	0	0
6	Shyok	6	5	-1
7	Indus	15	6	-9

8	Shingo	5	2	-3
9	Jhelum	5	3	-2
10	Astore	9	4	-5
	Total	**52**	**36**	**-16**

(Detail report of PMD is annexed; Annex-1)

Agriculture and livelihood sector estimated damages by floods (Damage Need Assessment Report, 2010)

Table 8: Damages to agriculture and livelihood means in Northern areas of Pakistan in 2010

Province	Crop Area Damaged (000 ha)	Large Animals (000 head)	Small Animals (incl. sheep, goal) 000	Poultry Perished (000)	Watercourses Damages Nos
FATA	7.2	6.2	8.4	101.2	n/a
Gilgit Baltistan	7.9	1.3	10.8	12.9	960
Khyber Pakhtunkhwa	121.4	72.4	67.8	621.3	1,790
Total	**2,092.6**	**315.6**	**1,208.3**	**10,279.7**	**13,042**

The total covered area of Khyberpukhtunkhwa Province is 74521 sq KM. The total population is about 27 million. Agriculture and livestock rearing remain the main sources of livelihood for the local population in Khyberpukhtunkhwa.

According to Bureau of Statistics (2013) the total cultivated (cropped) area in the area is nearly 1650000 Hectares, which is nearly 22% of the total covered area of the province. In 2010 the total cropped area was 1450000 hectares. During the flood of 2010 and later in 2011, 2013 and recently in 2015 agriculture sector of the province suffered huge damages. Nearly 121,000 hectare of agricultural

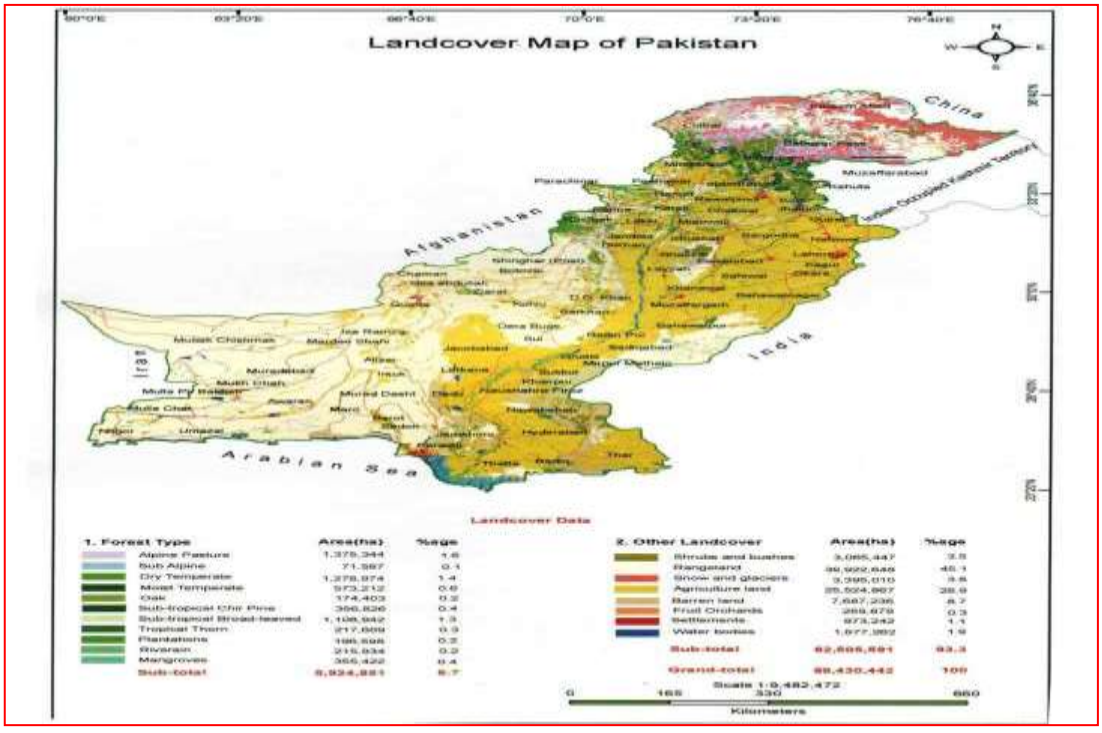


Figure 14:Land Cover Map of Pakistan (Courtesy IUCN)

lands with standing crops were wiped away. Similarly, the livestock also sustained serious damages as well. The total livestock population in Khyberpukhtunkhwa, according to Bureau of Statistics, is about 35,632,579, including cattle, goat, poultry etc.

During 2010 flooding the Gilgit-Baltistan province is also sustained huge damages to agriculture and livestock sectors as well. With a huge covered area, different altitudinal aspects and varying climatic conditions present ideal conditions for agriculture and horticulture to prosper in Gilgit-Baltistan Province. The total covered area of Gilgit-Baltistan Province is about 72500 sq KM. Agriculture is practiced over 1% of the total covered area. Agriculture and horticulture fields were the worst hit livelihood means in GB during 2010 flooding. Details are given in tables below:

Table 9: Damages to irrigation and associated system in KP and GB (DNA Report, 2010)

Province	Barrages/ dams (No)	Canal systems/ breaches (No)	Irrigation schemes (No)	Flood Embankment/ Spurs (No)	Drainage system (No)
FATA			66	52	
Gilgit Baltistan			136		
Khyber Pakhtunkhwa	14	13 systems		7	5

Table 10: Livelihood & social protection sector estimated damages by floods (DNA Report 2010)

Province	Total Households Affected (Millions)	Total Households Eligible for Cash Grants (Millions)
FATA	0.03	0.01
GB	0.03	0.01
KPK	0.36	0.28

Table 11: Transport/Communication sector estimated damages by floods (DNA 2010)

Roads affected (km)	Length of road network			
Provinces	**National Highways**	**Provincial Highways**	**District & Municipal Roads**	**Total**
FATA		294	963	1,257
Gilgit Baltistan	33		349	382
Khyber Pakhtunkhwa	402	259	5,850	6,511

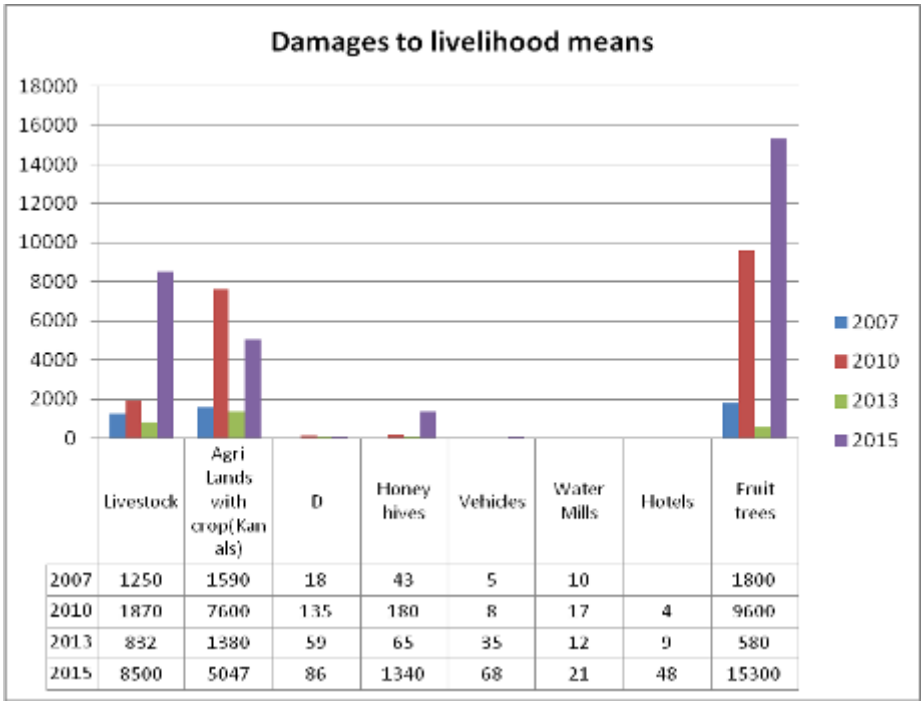
1.7 Forests and agriculture:

Due to its harsh climatic and divers ecological conditions, Pakistan is comparatively poor in vegetation cover and the forests are mostly limited to its northern parts, in the provinces of Khyber Pakhtunkhwa (KP), Gilgit Baltistan (GB) and Azad Jammu and Kashmir (AJK). Regarding Pakistan's total forest area different figures have been quoted by different sources. According to Forestry Sector Master Plan (FSMP, 1992), Pakistan has 4.8% of

its total land area under forests (with 95% natural forests and 5% plantations). Siddiqui (1996) puts the total forest area of Pakistan as 4.2% (with about 97% natural forests and 3% plantations). Bukhari et al (2012) have estimated the total area under forests as 5.1% (96% natural forests and 4% plantations). The latest ones are based on a GIS and RS study conducted by the PFI titled "Land Cover Atlas of Pakistan.

The forests of Pakistan are classified into various types, mainly based on climatic variations. These climatic variations support the growth of different tree species in different climatic regions and divide Pakistan into nine distinct ecological zones, that is, Littoral and Swamp Forests (mangroves), Arid Sub-Tropical Forests, Dry Sclerophylous and Dry Deciduous Forests, Tropical Thorn Forests, Sub-Tropical Pine Forests, Moist Temperate Forests, Dry Temperate Forests, Steppe Forests and Alpine Dry Steppe, Sub-Alpine Scrub and Alpine Meadows (Khan & Akbar, 2005). Most of these forests are naturally regenerated and almost 80% are located in the northern highland watersheds of Khyber Pakhtunkhwa, Gilgit Baltistan region and independent parts of Kashmir (i.e. Azad Jammu-o-Kashmir) The 20% remaining are planted forests, including irrigated plantation, farm plantation, linear plantation and road side and railway plantations and mangroves found in coastal areas of Karachi and Balochistan (FAO, 2010).

Based on the elevation, Northern parts of Pakistan are divided into 4 ecological zones (Table-11). Agriculture is irrigated owing to scanty precipitation and subsequent aridity all over the mountain region. In order to grow arable crops and fodder, farmers divert water from glacial rivers onto their fields through a complex system of irrigation channels. As far as the land usage is concerned, only one per cent area is under agriculture, double of this is arable, four per cent under forest and the rest is covered by range lands, glaciers and mountains. Consequently the agricultural landholding is very small (1-2 kanals or 0.073 to 0.074 ha/capita). Seventy five percent agricultural land falls in single cropped area and 25 percent in double cropped area in the arid mountains.



	Livestock	Agri Lands with crop(Kanals)	D	Honey hives	Vehicles	Water Mills	Hotels	Fruit trees
2007	1250	1590	18	43	5	10		1800
2010	1870	7600	135	180	8	17	4	9600
2013	832	1380	59	65	35	12	9	580
2015	8500	5047	86	1340	68	21	48	15300

Figure 15: Damages to livelihood means in NAs during last 8 years (GLOF Project)

Table 12: Ecological Zones in Northern Areas

Zone	Location	Characteristics
1	At the base of valleys near the Indus River: With Compact Winter village	Elevation 1900m: double cropping zone with typically wheat as a minter crop and maize as a summer crop about one third is the cultivated area
2	At the middle and higher reaches of the valleys: usually with dispersed settlements	Elevation 1900 to 2300m marginal single cropping zone which can be converted into double cropping zone with early maturing wheat and barley varieties like FSD-83, Chakwal 86 and Parwaz-94.
3	High elevated valleys	Elevation 2300 m to 3000m single cropping zone

	High pastures	Elevations above 3000m alpine pastures, no cultivation, snow bound in winter

Source: NASSD 2002

Topography of Northern Parts of Pakistan is mostly dominated by rugged mountains, glaciers, glacial lakes and river beds. Together mountains, rocks, rivers, snow cover and glaciers contribute to almost 66% of the total land cover in northern parts of Pakistan. Total cultivable area accounts for only 1% of the total area. Rangeland and pasture share in total coverage area is about 23%.

Rugged terrain coupled with presence of large number of glaciers, hazardous lakes and extremely fragile ecosystem add to the vulnerability of the target areas to climate change induced disasters.

Table 13: Summary of present land use in Northern Areas (000 hac)

S. #	Type of Land	Area	Percentage
1	Mountains/Lakes/Rivers/Glaciers	**4,810**	**66**
2	Forest: a) Protected = 65 1% b) Private = 219 3% c) Social Agro/Farm = 62 5% **Total Forest = 646 9%**	**646**	**9**
3	Rangeland		**23**
4	Cultivated Area		**1**
5	Cultivatable Area		**1**
6	**Grant Total**	**7,250**	**100**

Source : NASSD 2002

Table 14: Crops and Zone-Wise Cropping:

Districts	Double Cropping Zone	Marginal Single Cropping Zone	Single Cropping Zone
Gilgit & Chitral (KPK)	Wheat (70%), Maize (G&F) Barley Potato (table) vegetables Millet, Oats, Fodder	Only Rabbi Crops, e.g. wheats, maize, buck- wheat, peas, Potato, Barley (on rotational basis_	Barley, Wheat, Potato and peas
Skardu and Dir Upper (KPK)	Due to Snowfall only single cropping system is in practice	Wheat, Barley, Maize, Buckwheats, small grain millet	Wheat, Potato
Diamer, Swat, Ghizer, Hunza, Nagar and Kohistan	Rabbi (below 1800 meters), wheat (70%) Potato Barley, Kharif Maize Beans (Cash Crops)	At 1800 meters to 2400 meters only rabbi crops, wheats, maize, buckwheats, vegetables, small grain millet	Barley, Wheat, potato, peas, other vegetables. Maize

Source: NASSD 2002

The farming system in the target areas is highly integrated in nature with a high degree of inter-dependence between arable cropping, forestry, fruit growing and livestock production. Summer is the main agricultural season when maize, barley, wheat and vegetables are sown and fruits are picked and stored. To avoid crop damage livestock are taken to high altitude alpine style pastures during the summer months. Wheat is grown up to an elevation of 2300 meters only. The region is deficient in food grains and from one quarter to a third of Northern Area's food grain requirements are met from produce bought in from the plains (NASSD 2002).

The region has emerged as an important producer of fruits and vegetable. The vegetables cultivated in the area include potato, tomato, peas, carrots, Chinese cabbage and onion. Area under potato has been on increase since its introduction in the area. Most often seed potato is grown, however, table potato cultivation is also getting popular in the area. Due to lack of storage facilities, the produce is marketed at nominal prices, even then some part of the produce remains un-sold and the percentage of wastage for perishable commodities such as cabbage and tomatoes is quite substantial.

Table 15: Vegetable Production in Northern Area:

Crop	Area (Ha)	Production (T)	Wastage (T)	Consumption (T)	Marketed (T)
Total	5245	108494	3366	30948	74180
Beans	272	3991	-	942	3049
Cabbage	296	3627	288	3113	226
Others	29	864	50	700	114
Peas	395	1494	-	400	1094
Potato	3045	76125	2166	6318	67641
Tomato	481	7853	778	5175	1900
Turnip	727	14540	84	14300	156

Source: NASSD 2002

Table 16: Fruit Production in Northern Areas:

Fruit	Cropped Area in Hectares	Production Area in Tons
Total	7029	170680
Almond	309	883
Apple	1635	24442
Apricot	6368	60305
Cherry	334	1862
Grapes	396	34500
Mulberry	1127	18225
Grapes	145	53
Others	303	4449
Peaches	403	4128
Plums	52	3060
Pomegranate	182	2221
Walnut	802	6552

Source: NASSD 2002

The important fruits produced in the area include apricots, grapes, cherry, almond, pear and apples. However other fruit trees such as mulberry, apples, oranges, peaches, pear and plum are also found in the region.

Potato and beans are main cash crops in the area. Substantial revenue is generated in northern areas of Pakistan through export of fruits and potato to down districts and aboard.

1.8 Conclusion (Observations and Recommendations):

A. Observations

- Increased variability of river flows due to increase in the variability of monsoon and winter rains and loss of natural reservoirs in the form of glaciers;
- Likelihood of increased frequency and severity of extreme events such as floods and droughts;
- Increased demand of irrigation water because of higher evaporation rates at elevated temperatures in the wake of reducing per capita availability of water resources and increasing overall water demand;
- Increase in sediment flow due to increased incidences of high intensity rains resulting in more rapid loss of reservoir capacity;
- Changes in the seasonal pattern of river flows due to early start of snow and glacier melting at elevated temperatures and the shrinkage of glacier volumes (this will have serious implications for storage of irrigation water and its supply for Kharif and Rabi crops);

- Possible drastic shift in weather pattern, both on temporal and spatial scales;
- Increased incidences of high altitude snow avalanches and GLOFs generated by surging tributary glaciers blocking main un-glaciated valleys;
- The need for considerable expansion in reservoir capacity (a) to take care of the increasing frequency and intensity of floods and droughts, (b) to take advantage of the greater water flows over the next two to three decades due to glacier melting as well as to address the expected decreases of flows in the subsequent years after the glaciers have largely melted, (c) to provide regulated minimum environmental flows to the sea to prevent excessive intrusion of sea water into Indus deltaic region, (d) to take care of the loss in reservoir capacity due to silting, and (e) to meet future increases in water demand. (Even without specific consideration of the climate change related impacts, the Planning Commission envisages that without additional storage the water shortfall will increase by 12 per cent over the next decade alone (GoP-PC 2007);
- Increased degradation of surface water quality due to increase in extreme climate events like floods and droughts; and
- Lack of current knowledge and monitoring effort on climate change impacts in the HKH region; also lack of understanding and modelling capability about the patterns of glacier melt and rainfall feeding the IRS and the corresponding impact on IRS flows.
- Increased requirements of irrigation water due to higher evapotranspiration at elevated temperatures;
- Uncertainty in timely availability of irrigation water caused by changes in river flows due to glacier melting and altered precipitation pattern; shortage of irrigation water due to inadequate storage capacity;
- Erratic and uncertain rainfall patterns affecting particularly the rain-fed agriculture;
- Increased frequency and intensity of extreme climate events of floods, drought and cyclones resulting in heavy damages to both crops and livestock;
- Degradation of rangeland and further deterioration of the already degraded cultivated land areas such as those suffering from water erosion,

B. Recommendations

- Integration of adaptation into planning should be given greater attention as well as the development of effective institutional arrangements to support adaption to GLOF events. This will require assessing the institutional systems essential to the development of adaptive capacity; the interfaces between the institutions within these systems; and the factors that make these interfaces more effective in delivering adaptive capacity.
- A focal institution in the government needs to be established, designated, and strengthened to streamline and complement adaptation planning. The institutional arrangements should address the overlapping roles and responsibilities of each sectoral government agency, NGOs, and community based organizations operating at different levels. Defining the working relationship among government institutions, NGOs, and local communities will help in translating policies into practice at the local level.
- Integration of adaptation into planning tools and policies should not be a technocratic process. It needs to engage the public through participatory methods in order to respond to local needs; draw on local knowledge about climate conditions and methods to address them; and create synergies between public and private/formal and informal adaptation interventions. To enable these activities, there is a need to establish a working arrangement at the local level among government agencies, NGOs, and local communities engaged in implementing

adaptation practices. This mechanism would create space for the discussion and negotiation of alternatives.

- Given the limitations of market institutions to adjust to changing conditions, alternatives are required from other formal or informal institutions to encourage climate-friendly behavior by households and private sector actors, whose decisions are largely determined by price signals, which address only short-term supply and demand factors. Further, to develop confidence among people engaged in adaptation, it is necessary to introduce livestock and crop insurance schemes and support for storage and transportation. Market responsive farm products and input, which will promote livelihood diversification. Both public and private sector institutions must take the initiative in this area. The public sector could provide part of the necessary financial and technical support to the private sector, including NGOs and community organizations.
- The public sector and sponsors investing in adaptation to climate change should be aware of the adaptation strategies that people are pursuing and align their support with these strategies. For example, strategies that are based on labor migration allow families to invest more in children's
- Education. Public investment that supports learning materials on the effects of climate change could enhance the contribution of private remittances to household resilience. There are examples of climate resilience schemes in specific areas that are mature for replication or further investigation. Information on these community level responses must be collected, documented, and disseminated for adaptation. Private sector institutions including NGOs and community organizations should undertake these activities with the support of public sector and donor investment.
- Discourage deforestation to safeguard environment and protect carbon sinks, by providing alternate means of fuel and livelihood to the nearby population.
- In order to implement adaptation programmes through local groups and community organizations, financial resources must be allocated at the community level. An effective mechanism for the disbursement and use of financial resources needs to be designed using a participatory approach. The mechanism should prevent undue pressure and protect against the misuse of funds.
- Assist genetically impoverished species or those that have important ecosystem functions by providing natural migration corridors as well as assisted migration in order to keep up with the speed with which their habitats shift with climate change and change in land use.
- Use vast mass of cultivable wasteland as carbon sink to build up organic soil matter and mitigate on pollution in rural Pakistan.
- Develop and adopt new breeds of cattle which are more productive in terms of milk and meat but have lower methane production from enteric fermentation;
- Develop and promote new economical feeds that, on the one hand, provide better nutrition to the cattle and, on the other hand, reduce their methane production activity. Such feeds may be used as supplement to the usual fodder and customary feeds.
- Develop and adopt new methods of rice cultivation that are less demanding of water and also result in lower emissions of methane.

  Explore methods for reducing Nitrous oxide releases from agricultural soils, e.g. by changing the mix of chemical fertilizers commonly used.
- Make use of agricultural and animal wastes to produce biogas and organic fertilizer, thereby providing cost effective disposal of such wastes in an environmentally friendly manner.

- The initiatives being taken by the government to develop new crop and cattle breeds to reduce their vulnerability to climate change that could possibly be adapted to address also the GHG mitigation issue in the Agriculture and Livestock sector.
- Establish Climate Change Cells in EPA, PDMA's and MinFAL to devise adaptive strategies for projected impacts of climate change on agriculture;
- Develop computerized simulation models for assessment of climate change impacts on physical, chemical, biological and financial aspects of agricultural production systems in all agro-ecological zones;
- Improve the crop productivity per unit of land and per unit of water by increasing the efficiency of various agricultural inputs, in particular the input of irrigation water;
- Provide incentives for adoption of water saving technologies such as laser land leveling, furrow irrigation and high efficiency irrigation systems (drip & sprinkler), instead of extravagant flood irrigation;
- Develop quality datasets on crop-, soil- and climate-related parameters to facilitate research work on climate change impact assessment and productivity projection studies;
- Expand and upgrade meteorological services for weather and climate information and make full use of World Meteorological Organization's (WMO) new initiative to create Global Framework for Climate Services (GFCS);
- Enhance the research capacity of various relevant organizations to make reliable predictions of climatic parameters and river flows at seasonal, inter-annual and inter-decadal levels, to assess the corresponding likely impacts on various crops and to develop appropriate adaptation measures; Enhance the capacity of the farming community to take advantage of scientific findings of the relevant research organizations;
- Improve the extension system to allow effective and timely communication of climatic predictions and corresponding advice from research organizations to the farming community;
- Develop capacity based on Remote Sensing and GIS techniques to assess temporal changes in land cover in different agro-ecological zones, and in the extent and intensity of degradation in cultivated areas affected by waterlogging, salinity, and wind and water erosion, particularly in the fragile ecological zones (mountains, coastal areas, hyper-arid areas etc.);
- Develop a proper risk management system to safe safeguard against crop failures and extreme events (floods, droughts etc.); and
- Formulate an agriculture policy for the country in the context of climate change to facilitate development and implementation of various adaptation measures to counter the adverse impacts of climate change.

2: Institutional and beneficiaries' situation analysis and economic benefits of the intervention

2.1: Institutional framework and policies for DRR and EWS

A: Institutional Framework for DRR and EWS:

As mentioned above, the loss of life and property and the challenges that were faced in the aftermath of October 2005 earthquake affecting Azad Jammu and Kashmir and the NWFP province exhibited the need for establishing appropriate policy and institutional arrangements to reduce losses from disasters in future. The earthquake tested the resilience and capacity of Pakistan and its people to overcome catastrophes. The need for strong institutional and policy arrangements has been fulfilled with the promulgation of the National Disaster Management Commission (NDMC), the National Disaster Management Authority (NDMA), and the passing of the National Disaster Management Ordinance, 2006. The Framework for DRR and EWS was prepared with active participation of multiple stakeholders serves as a vision document for leading the way towards a safer Pakistan. The Framework

provides needed guidelines to coordinate activities of different stakeholders. It also sets out priorities for mobilization of resources from donors and development partners of Pakistan to implement strategic activities to plan and implement DRR activities.

Pakistan is vulnerable to disaster risks from a range of hazards including avalanches, cyclones/storms, droughts, earthquakes, epidemics, floods, glacial lake outbursts floods, landslides, pest attacks, river erosion and tsunami. Human induced hazards that threaten the country include transport, industrial, nuclear and radiological accidents, oil spills, urban and forest fires, civil conflicts and internal displacements of communities due to multiple factors. High priority hazards in terms of their frequency and scale of impact are:- earthquakes, droughts, flash floods, Glacial Lake Outburst Floods, Landslides and transport accidents that have caused widespread damages and losses in the past. Recently climate change induced disaster have gained momentum.

Recurrent floods of 2010, 2012, 2013 and now 2015 are clear indication of rapidly changing climatic conditions and more extreme weather events in future. For the past more than 2 decades DRR interventions were being planned and implemented in the country by different organization at national, provincial and district levels. But such activities were mostly carried out in isolation without any proper coordination between the relevant stakeholders.

There was a strong need to give practitioners and relevant organizations directions and sound guidelines to align their activities in line with the true spirit of National Disaster Management Act, 2010 to counter the threats of disasters faced by the country. National Disaster Management Authority (NDMA), being the lead focal agency for disaster preparedness and management, has therefore, embarked upon formulation of a comprehensive National Disaster Risk Reduction Policy through wider consultations with all stakeholders including all provinces, state of AJ&K and regions.

A number of factors lay behind vulnerabilities of Pakistani society to hazards. These include rapidly changing climatic condition, difficult terrain, poor construction practices, poor livestock and agricultural management, fragile natural environment and poverty. Poor communication infrastructure and lack of critical facilities aggravate vulnerabilities of communities. In mountainous regions the non-availability of safer land for construction, scattered settlement patterns and harsh climatic conditions further aggravate vulnerabilities. The size and growth of human and animal population, environmental degradation resulting from poorly managed urban and industrial development processes, climate change and variability are major dynamic pressures that aggravate vulnerabilities of Pakistani society. In coming decades frequency, severity and impact of certain hazards may increase which might lead to greater social, economic and environmental losses.

Realizing the importance of disaster risk reduction for sustainable social, economic and environmental development, the Government of Pakistan has embarked upon establishing appropriate policy, legal and institutional arrangements, strategies and programmes to minimize risks and vulnerabilities. In this regard, National Disaster Management Ordinance has been passed in 2006, the implementation of which would be ensured by the National Disaster Management Commission. The National Disaster Management Authority (NDMA) will be the focal point for coordinating and facilitating the implementation of strategies and programmes on disaster risk reduction, response and recovery. Similarly, Disaster Management Authorities will be established at provincial, district and municipal levels. NDMA would provide technical guidance to national and provincial stakeholders about formulation of plans, strategies and programmes for disaster risk management. NDMA would also work towards capacity development of national, provincial and local stakeholders in collaboration with PDMAs and DDMAs.

The National Disaster Risk Management Framework for the country has been formulated to guide the work of entire system in the area of disaster risk management. It has been developed through wide consultation with stakeholders from local, provincial and national levels.

The vision of this framework is "To achieve sustainable social, economic and environmental development in Pakistan through reducing risks and vulnerabilities, particularly those of the poor and marginalized groups, and by effectively responding to and recovering from disaster impact".

The implication of the national disaster management framework are:

- Develop institutional arrangements and technical capacities of key national (NDMA), provincial (PDMAs) District (DDMUs) and local stakeholders to undertake risk assessments (hazard, vulnerability, capacity mapping) in multiple development sectors,
- Develop coordinated disaster risk management plans at national, provincial, District and local levels;
- Integrate and implement disaster risk reduction strategies in sectoral development plans and programmes of line ministries and departments

The main guiding principles of the framework have also been defined to achieve the objectives of disaster risk reduction (DRR):

- Focus upon most vulnerable social groups; e.g. children, women, elderly, minorities;
- Promote community and local level preparedness culture;
- Follow multi-disciplinary and multi-sectoral approaches
- Combine scientific knowledge with social knowledge;
- Make development policy, planning and implementation risk-sensitive;
- Develop culturally, economically and environmentally relevant technologies for safer construction in different parts of the country;
- Promote sustainable livelihood practices in areas at high risk from multiple hazards;
- Establish and strengthen partnerships amongst multiple sectors; e.g. government, private sector, media, insurance, NGOs, civil society organizations, UN and donors;
- Work with other countries and international community to promote disaster risk reduction; Acquire specific capacities/capabilities keeping in view hazard-risk profile of the country;

Priority areas for Disaster Management have also been identified under the framework that include:

1. Institutional arrangements for DRR in the form of establishment and strengthening of PDMAs and District Level District Disaster Management Units (DDMUs)
2. Legal Arrangement through the formulation National Disaster Management (NDM) Act 2010) and National DRR policy (2013).
3. Formulation of National Climate Change Policy and Policy Guidelines for Protection of glaciers and glacial environment
4. Conduction Hazard and Vulnerability Assessment studies
5. Preparation of National, Provincial and District Disaster Management Plans
6. Training and capacity development of stakeholders and DRM practitioners
7. Promotion of Disaster Risk Management Planning
8. Community and local level risk reduction planning
9. Multi-Hazard Early Warning System including

- Flood Forecasting System
- Tropical cyclone warning center
- Drought Monitoring and Warning system

  (National Centre for Drought/Environment Monitoring and Early Warning System at the PMD)
- Tsunami Early Warning System

To ensure proper Institutional Arrangements for Early Warnings, range of stakeholders are involved in an end-to-end EWS; e.g. hazard monitoring and forecasting agencies, NDMA, PDMAs, Local Communities, media and user departments, e.g. agriculture, health, information, police, fire services, Red Crescent, PNRA, irrigation departments etc. Interface and partnerships amongst these stakeholders are critical. Forums would be established to facilitate communication and dialogue amongst stakeholders for improving the EWS. Under National Framework all departments and agencies will support NDMA in issuing alerts and warnings.

10. Mainstreaming DRR into Development
11. Emergency Response system
12. Capacity development for post-disaster recovery

To further ensure proper planning and implementation of agreed activities the government of Pakistan has established National Disaster Management Commission (NDMC) chaired by the Prime Minister of the country. It is the highest policy and decision making body for disaster risk management. The NDMC is responsible to ensure coordination in its broadest sense; to oversee the integration of disaster risk management issues into sectoral development plans; and to oversee the implementation of DRR policy through the National Disaster Management Authority (NDMA). At provincial level Provincial Disaster Management Authorities have been established and fully functional in KPK, Punjab, Sindh, Baluchistan and GB Provinces.

The flow chart of structural/institutional arrangements for DRR in the country under the framework and DRR policy is as follow:

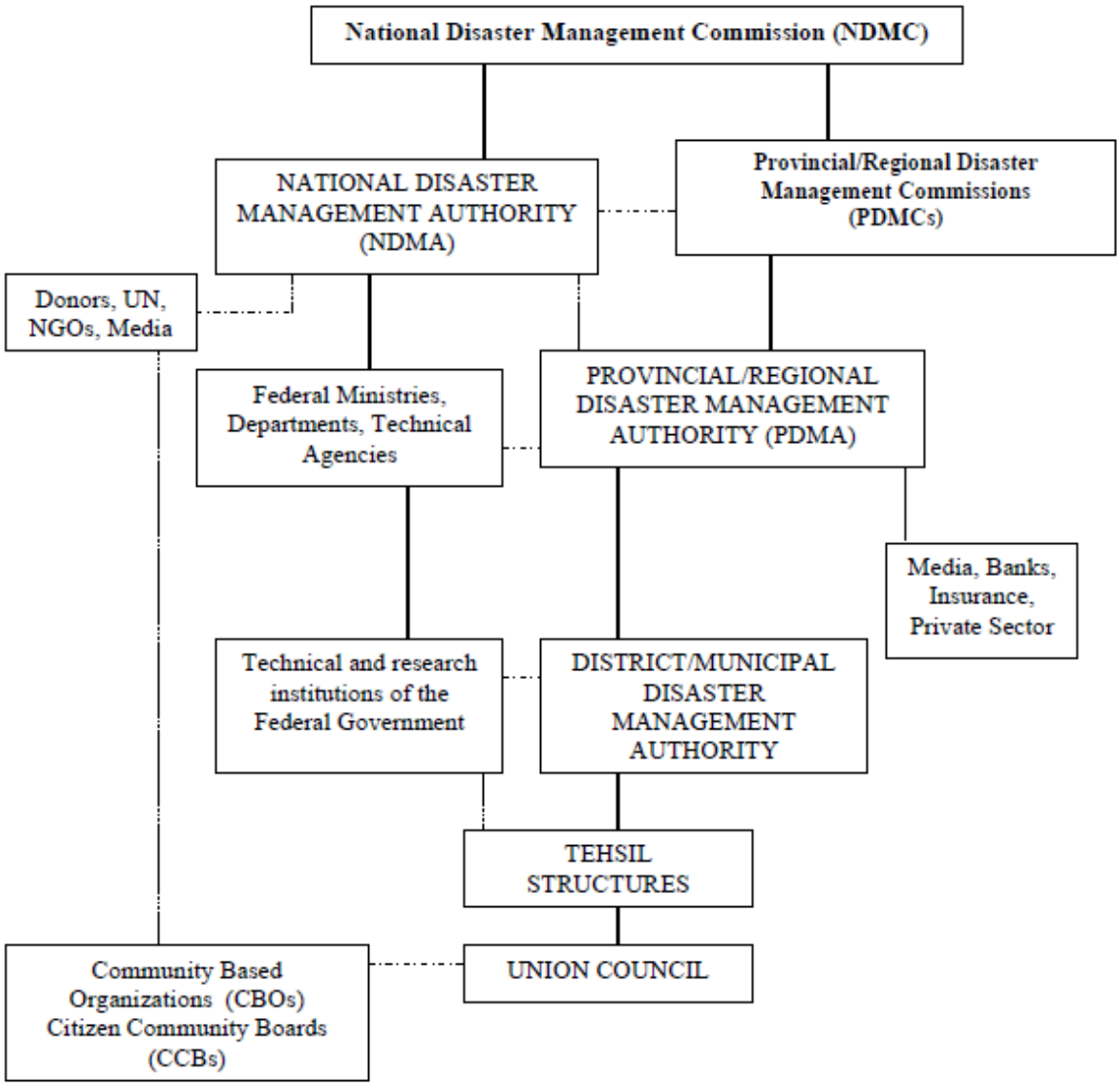


Figure 16: Diagram of structural/institutional arrangements for DRR in Pakistan

In Individual District Disaster Management Units (DDMUs) have also established at district and local levels to carry out the DRR activities under the guidelines provided by their respective PDMA.

Under the framework roles and responsibilities of individual stakeholders and institution have been well defined for DRR activities. Besides, different departments and organizations also working on DRR:

Table 17: Agencies/departments involved in DRR and their role:

Phase	Agency/department
Mitigation and prevention	1. Federal Flood Commission

Phase	Agency/department
	2. Provincial irrigation Department 3. Forest Department 4. Pakistan Nuclear Regulatory Authority 5. WAPDA 6. Work and Services
Preparedness and Response	1. Civil defense 2. armed forces 3. District Emergency Response Cells 4. Fire services 5. PMD 6. Communication and works 7. Police 8. Provincial Relief Commission 9. Food Department 10. Health Department 11. Agriculture and Livestock department 12. Space and upper atmosphere research commission (SUPARCO)
Recovery and Rehabilitation	1. ERRA 2. Irrigation

B: Policy and framework for DRR:

Both the 2005, 2008 earthquake and the 2010 and 2011 floods exposed the vulnerability of Pakistani society, environment and economy to disasters. Damages and losses have been massive but could have been largely reduced if disaster risk reduction measures had been incorporated into physical, social and economic development. The 2005 earthquake provided a wake-up call to move away from an emergency response paradigm, and to devote more attention to prevention, mitigation and preparedness.

2010 Floods caused losses and damage amounted to 5.8% of the Pakistani 2009/10 GDP according to the WB/ADB Disaster Needs Assessment making it considerably more costly – in relative terms – than the 2011 Japanese Tsunami (4.6%).

The National DRR Policy provides an overall guiding framework for addressing the high levels of disaster risk permeating Pakistani Society. It covers both natural and man-made hazards. The policy seeks to promote priority measures to ameliorate already existing vulnerability to hazards, and equally important measures to ensure future development processes and programs strengthen resilience. The policy serves as a guiding framework both for DRR and relevant development plans and programs to focus attention upon priority issues. The National DRR Policy was developed. The policy is based upon an extensive review of existing background documentation including assessments, relevant frameworks, policies and plans. The building blocks of the current DRR policy reflect the priority actions of the Hyogo Framework for Action (HFA) and are within the NDM Act 2010 that decentralized responsibilities for the implementation of DRR to the provincial and district level. The policy is based upon consultations with district, provincial and national government stakeholders as well as civil society actors and development partners.

C: Sector/policies and protocols with links to DRR:

Various policies and protocols have been adopted in the past 3 decades to minimize threats to different sectors including agriculture, biodiversity, water resources, forests, glaciers etc.

- Agriculture Agricultural Perspective and Policy
- Bio-diversity Convention for Biodiversity (CBD), June 1992
- Climate Change Framework Convention on Climate Change (UN FCCC), June 1992
- Desertification Convention for Combating Desertification, October 1994
- Development Medium Term Development Framework 2006-2010, Planning Commission
- Development Ten Year Perspective Development Plan, 2001-2011, Planning Commission
- Development Millennium Development Goals (MDGs), 2000
- Disaster Management SAARC Disaster Management Plan (yet to be finalized)
- Disaster Management ASEAN Regional Forum – Draft Plan for Mutual Cooperation
- Disaster Risk Management Hyogo Framework of Action 2005-2015
- Environment National Conservation Strategy 1992
- Environment National Environment Action Plan (NEAP), 2001
- National Environment Policy 2005
- Environment Stockholm Convention on Persistent Organic Pollutants , 2001
- Hazardous Waste Basel Convention on the control of Trans-boundary movement of hazardous waste and their disposal, 1994 July
- Ozone Layer Vienna Convention for the Protection of Ozone layer and the Montreal Protocol, December 1992
- Poverty Reduction Poverty Reduction Strategy Paper
- Water Resources Draft National Water Policy, 2006

Pakistan is one of the signatories of Sendai Framework for Disaster Risk Reduction (2015 – 2030): Building the Resilience of Nations and Communities to Disasters. At the core of the HFA lies the integration of risk reduction as an essential component of national development policies and programs. The earthquake in 2005 highlighted Pakistan's vulnerability to disaster risks and motivated a shift from the erstwhile response-focused to the current, more proactive approach. This shift found its first expression in the National Disaster Management Ordinance (NDMO, 2006, replaced in 2010 by the current National Disaster Management -NDM Act), followed up by the National Disaster Risk Management Framework (NDRMF) (2007-2012) that outlined a comprehensive national DRR agenda

D. Early Warning System:

Considering the environmental degradation and climate change, the incidence of flash flooding and river flooding in the country is expected to rise in coming years. Therefore enhancement of early warning capacities is an important requirement. The purpose of flood forecasting center and other early warning systems is to provide as much advance notice as possible of an impending flood. The higher reliability of forecasts and additional lead time would result in improved dam water management, flood fighting and evacuations from areas likely to be affected by floods. At present PMD has networking of four radars at Karachi, R. Y. Khan, D. I. Khan and Islamabad. WAPDA also manages a flood telemetry network of 24 stations in upper catchments of Punjab, KP and AJK. Similarly, high attitude Met Weather stations consisting of automated Rain gauges, river discharge measuring system and automated weather station have been installed in Chitral (6) and GB Province (4) to monitoring climatic conditions and possible GLOF events; and generate early warnings to downstream communities. The SoPs for early warning in high altitude areas have been defined by PMD.

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Flow Diagram of PMD Responsibilities:

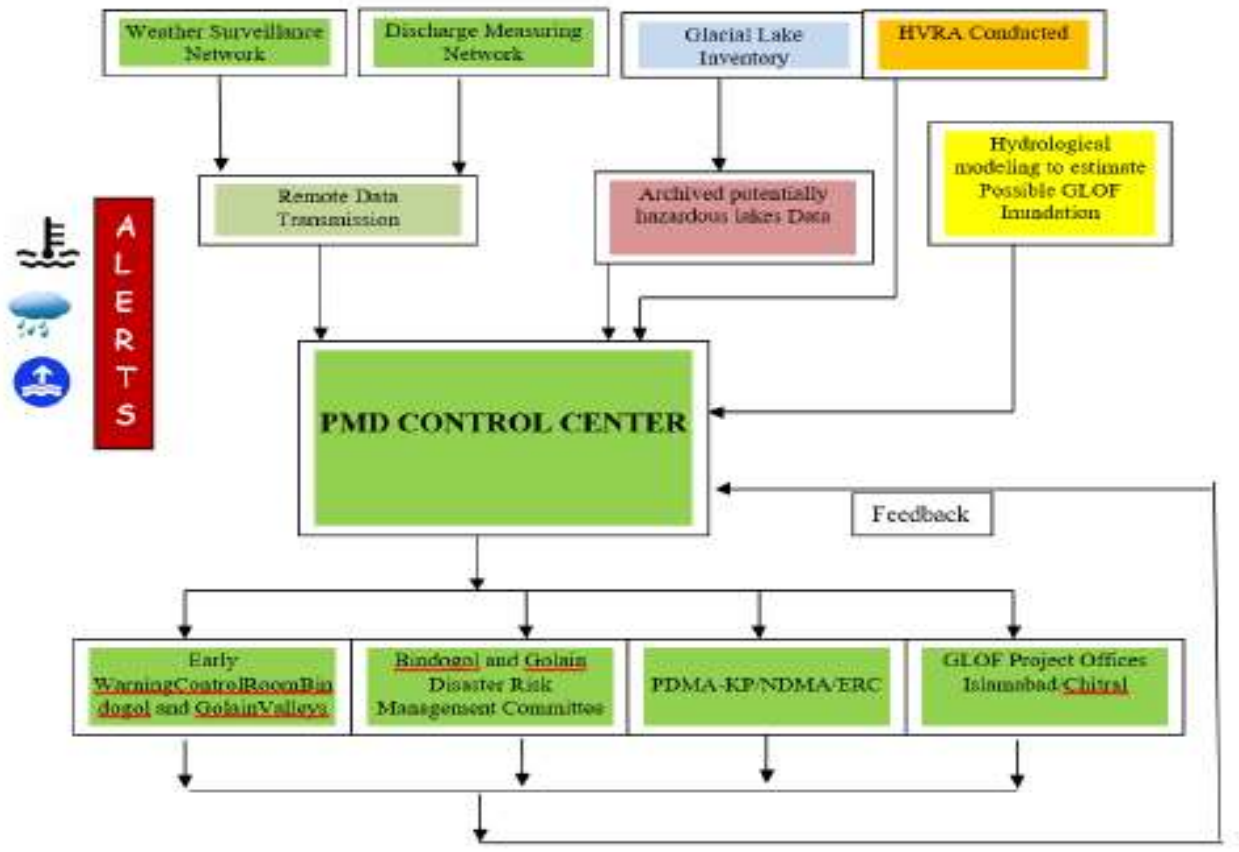


Figure 17: Flow diagram of PMD Responsibilities (PMD)

Some of the institutional arrangements for EWS by PMD have already been discussed under the fore mentioned section of Institutional Framework. The underlying objective is provision of timely & effective information through identified institutions that demands individuals exposed to hazard to take action to avoid or reduce their risk and prepare for effective response. Institutional and structural arrangements have been established under PMD for effective EWS system. The basic components of the EWS consist of:

- Risk Knowledge
- Monitoring & Warning Service
  - Tools & Technologies for Monitoring
  - Capacity to analyze info.
  - Capacity for reliable prediction
- Dissemination & Communication

- Response Capacities

To ensure acquisition of improved data an integrated observing system composed of remote-sensing, telemetric and automatic observation platforms has gradually become in shape, which are space-based, airborne and land-sited, so as to measure continuously multiple parameters of the climate system from all dimensions, with higher spatial and temporal resolution and with higher accuracies. Information and warning flow diagram:

E. Agriculture and Land use:

Pakistan has historically witnessed a volatile growth history and falling potential GDP growth.

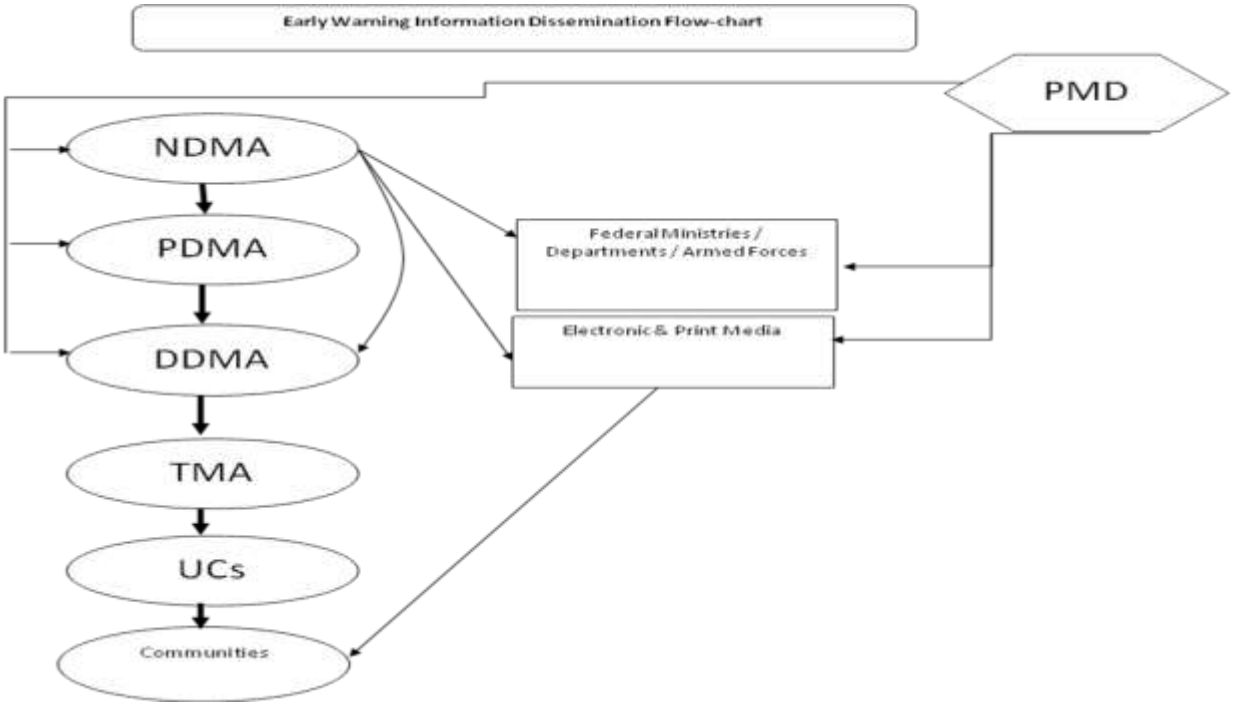


Figure 18: Early warning information Dissemination flow chart

While the regional economies saw rising investment and savings rates, Pakistan performed poorly in terms of resource mobilization, return on private and public investment and utilization of assets including physical and social infrastructure. During a period spanning over the past four decades (1971 – 2009) Pakistan could only achieve an average GDP growth of 4.9 percent with fixed investment to GDP ratio at around 17 percent and domestic savings to GDP ratio at 12 percent.

However during the same period many regional economies that had taken off from a low level of physical and human capital formation rose to join the ranks of industrialized economies.

Table 18: Growth, Investment & Savings 1971 – 2009:

(Annual Average) Country	GDP Growth %	Fixed Investment to GDP	Domestic Savings to GDP	ICOR
China	9.1	32.2	37.9	3.5
India	5.3	23.9	22.0	4.5
Malaysia	6.4	27.4	35.0	4.3

Indonesia	6.0	25.9	29.2	4.3
Thailand	5.9	29.5	28.8	5.0
Pakistan	4.9	16.6	11.9	3.4

(Source: World Development indicator)

Agriculture is an important sector of the economy of Pakistan which contributes about 21% of Gross Domestic Product (GDP) and generates productive employment opportunities for 45% of the country's labor force. Besides meeting the food and fiber requirements of the local population, it supports other sectors of economy such as manufacturing and services because of having very strong horizontal and vertical linkages with them.

In order to improve productivity of agriculture Framework for Economic Growth (2011) was formulated. It provides guidelines for improvement in agricultural productivity and ensure food security based upon required reforms, improved sector governance, adoption of institutional reforms and innovations, up- gradation of agriculture marketing systems, improved trade and competitiveness and sustainability of the system.

Climate change has become a great challenge for the agrarian economy of Pakistan. A serious threat is to the crop sector which is vulnerable to change in temperature and rainfall. This study traced the impact of climate change on the agriculture of arid region by employing a cross sectional data collected through a structured questionnaire in Rawalpindi division in addition to using time series data of climatic variables obtained from metrological stations. A Ricardian approach was operated to test the relationships between Net Farm Revenue (NFR) and climate across the arid region. Wheat crop was the core of the subject matter. It was found that temperature increase has significant negative impact on agriculture production. Moreover, an increase in revenue was visualized with the increase in rainfall. The overall extent of negative impact of temperature is greater than the positive effect of rainfall in the region. It was revealed that one percent increase in temperature would lead to loss of Rs. 4180 to the net revenue per annum. Dissemination of new farming techniques including new irrigation methods, new methods of crop farming and adapted cropping pattern would be the appropriate derivatives of paradigm shift required in the agriculture sector of arid region (Usman Shakoor, Abdul Saboor, Ikram Ali, and A.Q. Mohsin, 2011).

Agriculture is central to human survival and is probably the human enterprise most vulnerable to climate change. The agriculture sector, as the single largest sector of Pakistan's economy, is its lifeline. It accounts for 45% of the labor force, 21% of GDP and 70% of total export earnings. Agriculture in Pakistan is greatly affected by short-term climate variability and could be significantly impacted by long-term climate change. As the duration of crop growth cycles is related to temperature, an increase in temperature will speed up crop growth and shorten the time between sowing and harvesting. This shortening could have an adverse effect on productivity of crops and fodder for livestock. The hydrological cycle is similarly likely to be influenced by global warming, necessitating the agriculture and livestock sectors, particularly in rain-fed areas, to adapt to climate change. In the aftermath of 2010 floods and keeping in view the rapidly changing climatic conditions and resulting disasters in the country the National Climate Change Policy was developed in 2012 to provide needed guidelines.

Since the agriculture sector is heavily dependent on the water sector, a number of adaptation measures identified in the National Climate Change Policy of Pakistan to minimize negative impacts of Climate Change associated problems on agriculture. These adaptation measures as envisaged in the Climate Change Policy include specific activities pertaining to:

1. Improve and promote water storage capacity and establish relevant infrastructure like dams, early rehabilitation and upgrade irrigation infrastructure, develop needed infrastructure to harness potential hill torrents and enforce measure to enhance life of existing storage capacity
2. Ensure water conservation through reducing irrigation system losses, introduce local rainwater harvesting measures and provide incentives for adoption of more efficient irrigation system
3. Integrated water management through water allocation and protecting groundwater through better management practices etc.
4. Ensure water recycling, encourage local farmers in water management along with line departments

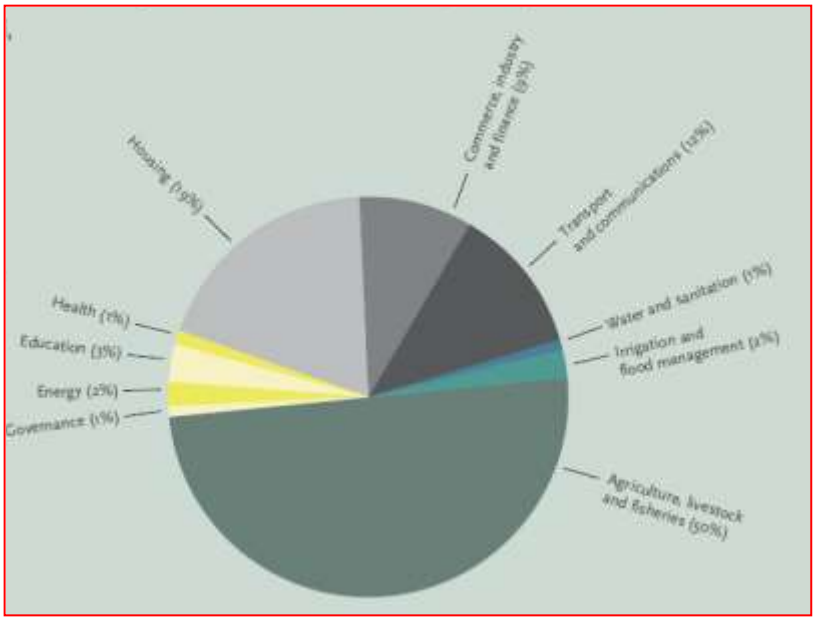


Figure 19: Sectoral Damages by 2010 Floods (Courtesy FAO)

5. Ensure water distribution among provinces in accordance with crop sowing timings and address sea water intrusion into the Indus Delta Region
6. Undertake Take appropriate measures to preserve the ecology of dry river reaches of the Eastern Rivers;
7. Develop contingency plans for short-term measures to adapt to water shortages that could help mitigate drought;

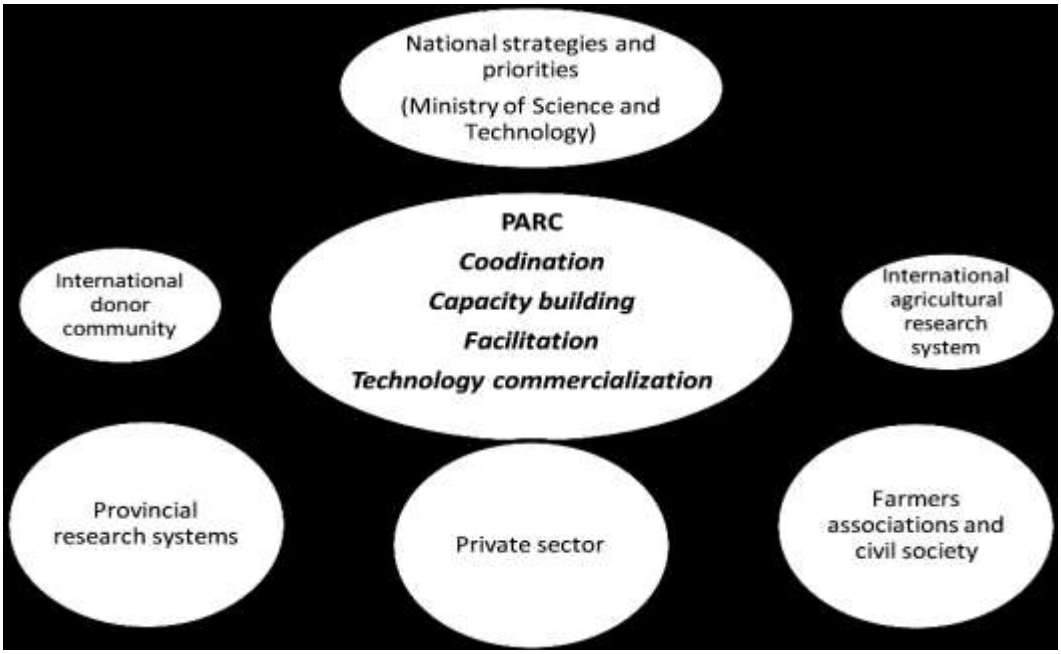


Figure 20: Frame work of operation of PARC

8. Explore the possibility of joint watershed management of trans-boundary catchment areas with neighboring countries;

9. Explore the possibility of entering into a water treaty with Afghanistan;
10. Promote integrated watershed management including ecological conservation practices in uphill watersheds.

According to FAO reports in developing countries the agriculture sector absorbs about 22 percent of the total damages and losses caused by natural hazards. The floods of 2010 costs an economic loss of 10 Billion dollars and floods of 2011 an additional 1.9 Billion dollar losses to agriculture sector (FAO, 2012). Agriculture suffered almost 50% (5 billion dollar) of the total economic impact of 2010 (FAO).

Keeping in view the high vulnerability of agriculture sector to disaster, especially to climate change induced disasters and its significant contribution to national economy the recommendations of National Climate Change Policy and DRR Framework.

With the passing of the 18th Amendment, the devolution of responsibilities for agriculture to the provinces, and the increased recognition of the private sector, NGOs and farmers in agricultural innovations, PARC's role at the centre of the National Agriculture Research System is even more critical.

F: Affected ecosystem:

So far no holistic efforts have been undertaken for the characterization of affected ecosystem in the affected areas except few sporadic studies in isolated valleys. The northern parts of Pakistan located in HKH region and characterized of three tectonic plates. From north to south these are the Karakorum plate, Kohistan island arc and Indo-Pakistan plate.

According to the Forestry Sector Master Plan (GoP 1992), forests, scrub and trees on farmlands cover 4.2 million hectares or 4.8% of the country. However, if plantations (generally single species, and hence of limited biodiversity value) are excluded, the total area of natural and modified coniferous, scrub, riverine and mangrove forests is less than 3.5 million hectares or 4% of the country. If scrub forests are excluded, the total area of 'tall tree' forest falls to just 2.4 million hectares (2.7%), of which four-fifths (2 million) have 'sparse' cover (patchy forests with less than 50% cover). Almost 42 % of the forested area are located in northern parts of the country.

Pakistan has some 28.5 million hectares of rangeland: 12.6 million in Balochistan, 5.8 million in the Punjab, 2.9 million in Sindh, 4.9 million in the NWFP, 1.6 million in the GB and 0.8 million hectares in AJK. Of the rangelands in the KPK, Northern Areas and AJK, 1.05 million hectares are alpine grasslands (GoP 1992). Of Pakistan's non-alpine rangelands 90% have been degraded – 27% of the total area in Pakistan.

The climate of northern parts varies from moist temperate in the extreme south to dry temperate in extreme north. Due to dry climatic conditions, slow regeneration, heavy dependence on forests/natural resources by local communities and recurrent floods the ecosystem in northern in extreme north including GB province and Chitral is heavily degraded as compared to areas located towards the south.

The main root of causes of ecosystem degradation in most northern parts of the country are:

1. Soil erosion due to floods
2. Unsustainable utilization of natural resource base
3. Lack of alternates of domestic fuel and fodder
4. Lack of slope stabilization measures like check dams

5. Unexpected rains
6. Shifting weather patterns
7. Deforestation and over utilization of rangelands
8. Lack of integrated watershed management plans

According to report by WWF-Pakistan, recent flooding (2015) in Chitral Gol National Park has resulted in complete damages to 80% of the samplings of plants. Similarly, 30% of the total covered degraded partially.

About 70% covered area in northern parts of Pakistan consist of rangelands, pastures, mountains, peatlands and snow/glaciers. The slopes gradients are highly steep and consist of loose materials and as such even moderate rains lead to heavy flooding. So far serious and well planned measures have been undertaken in northern remote parts of the country for slope stabilization and prevent soil erosion. Unstable slopes often result in heavy landslides as were witnessed during 2015 floods in 7 different valleys of Chitral.

This situation demands that slope stabilization measures like check dams, extensive plantation campaigns, bioengineering structures and retaining walls should be planned and implemented to prevent further degradation of ecosystem.

2.2 Analysis of the socio-economic conditions of the beneficiaries:

A: Geographic and Demographic Profile:

Northern glaciated parts of Pakistan are home to about 5.0 million people. Northern parts of country are mostly representative of rural population with high percentage of joint family system (92%). Average household size in the area is about 9.2 persons per household. Male to female ratio is about 1:4. Due to extended joint family system the dependency ratio is relatively also very high for northern Pakistan. For GB and Chitral dependency ratio on average stands at 51. The overall literacy rate in the proposed target is areas about 62%.

The dependency ratio varies from 51 (Chitral and GB) in extreme northern parts of the area to 10 in lower southern parts (Swat, Dir and Mansehra).

Literacy rate in the area ranges from 62 in the extreme north (GB and Chitral) to 48% in the south. Sex ratio (Males per 100 female) is about 105 for the whole area. Approximately 38 percent of the total population are below poverty line.

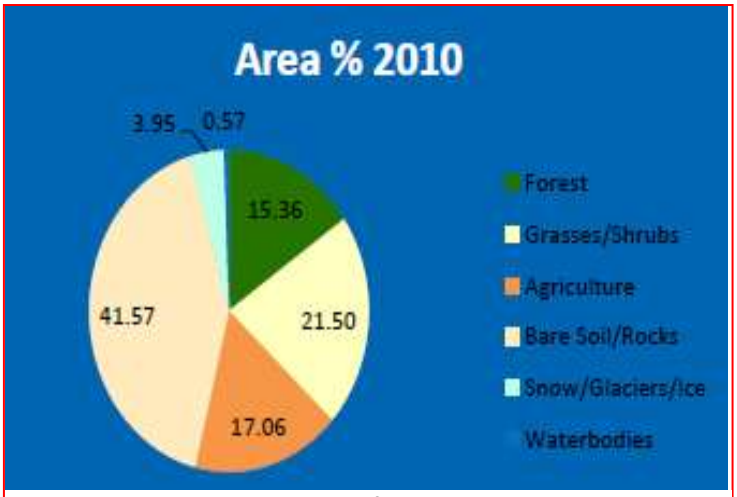


Figure 21: Land cover dynamics of Pakistan

The percentage of active population (16-62 years) is about 47%. Population percentage of Children (0-5 years) about 17% of the total.

The total covered area of the target areas in northern Pakistan is about 10,9000 sq km. Forest contribution to total covered area is about 5 percent of the total. In GB and Chitral total forested area is about 4.8 percent of the total while in down southern parts of Swat, Mansehra, Dir and Kohistan it is about 16.5% of the total.

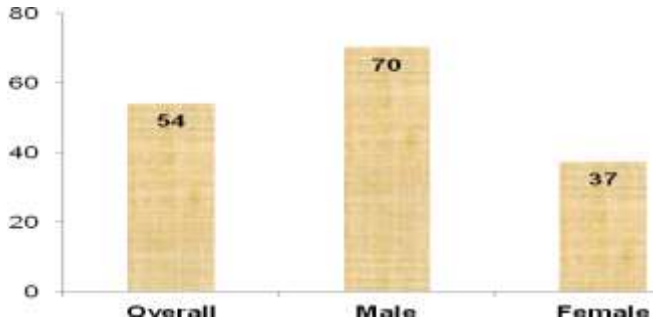


Figure 22: Adult Literacy rate in NAs (AKRSP, 2010):

In the extreme northern parts (GB and Chitral) glaciers and snow cover is about 19.3 percent of the total covered area while in lower southern parts it is about 4 percent of the total. Rangelands, rocks and barren mountains constitute almost 72% of the total covered area in Chitral and GB, while lower districts it stands at 42%.

B. Livelihoods:

Due to difficult terrain, lack of exposure to alternate and diversified livelihood, harsh climatic conditions and recurrent disaster the entire area is haunted by extreme poverty. Being mountain dwellers, the livelihood of the local communities in the target areas mainly revolve round natural resources.

Off-labor, agriculture and livestock rearing remains the predominant sources of livelihood in the northern areas of the country. The nominal per capita income for the northern parts about Rs. 34,500 as against the Rs. 67,400 of the country. The annual off-farm income for women in northern parts is among the lowest in the country and is only Rs: 8500 to 9500. In total only 4 to 5 percent of women hold assets at household level. The major livelihood capitals and there components are given below:

Table 19: Livelihood Capitals and their components for NAs:

Human Capital	Financial Capital	Natural Capital	Social Capital	Physical Capital
• Demography • Education • Health • Skills • Labour	• Income • Occupation • Savings • Credit • Debt	• Land • Water • Forests • Wildlife • Soil	• Community relations • Ethnicity • Conflicts • Gender relations	• Roads • Communications • Housing • Other infrastructure

However, all the dominant livelihood means are highly venerable to climate change and disasters.

Table 20: The vulnerability context in SL for NAs:

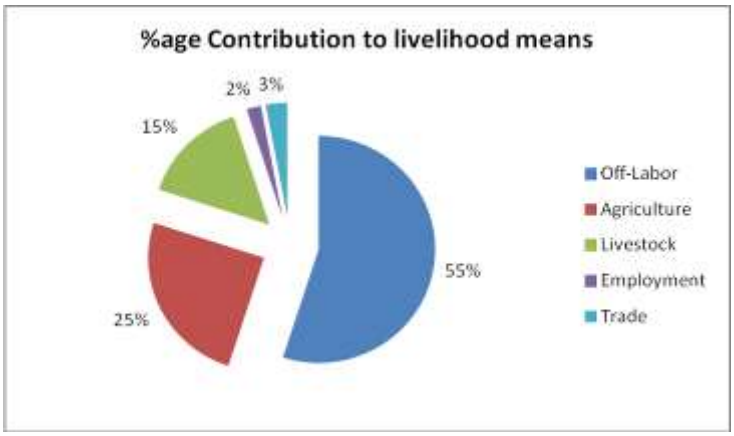
Trends	Shocks	Seasonality
• Population trends • Resource trends (including	• Human health shocks • Natural shocks	• Of prices • Of production

Trends	Shocks	Seasonality
conflict) • Resource use trends • National/international economic trends • Trends in governance (including politics) • Technological trends	• Climate change • Disaster • Economic shocks • Conflict and wars • Crop/livestock health shocks	• Of health • Of employment opportunities

During 2010 and 2015 flooding the farmers lost more than 70% of their standing crops. Nearly 25% of the agriculture were either completely or partially damaged during the same period. Similarly, 10 to 15 percent of fruit trees/orchards were wiped away during the floods of 2010. Being mountainous area majority of the irrigation is carried out through irrigation channels in northern parts.

Over 70 percent of the irrigation system (irrigation channels) in northern areas were destroyed during the flooding of 2010. Similarly, during 2015 flooding in upper extreme parts (Chitral district) about 80 percent of the irrigation system were completely destroyed.

Figure 23: Contribution of different sectors to local livelihoods in NAs



C. Condition of Human assets:

Due to lack of access/availability of health facilities, limited awareness, civic facilities and extreme poverty the condition of human assets in Northern parts of Pakistan is not satisfactory. This is evident from the high infant mortality rate in GB and Chitral district of KP. For GB province it is 23 per 1000 live births, while for Chitral District is slightly high as compared to GB, with 28 per 1,000 live births (AKRSP, 2008).

Health issues are quite high in the entire area. Of the total 45% population has access to safe drinking water. Health facilities are limited throughout the entire area. Due to lack of access/availability of health facilities, limited awareness, civic facilities and extreme poverty the condition of human assets in Northern parts of Pakistan is not satisfactory. This is evident from the high infant mortality rate in GB and Chitral district of KP. For GB province it is 23 per 1000 live births, while for Chitral District is slightly high as compared to GB, with 28 per 1,000 live births (AKRSP, 2008).

The productivity of human asset due to limited skills and exposure is below par with nominal Per capita income of only R: 34,500.

D. Vulnerable Groups:

During past disaster events (2010, 2011, 2015) farmers, herders and marginalized community members (women and underage children) have emerged as the main vulnerable groups. According to FAO report agriculture suffered almost 50% of the damages caused by 2010 floods. The damages sustained by agriculture during 2010 floods are at 5.00 billion dollars. Of the total human casualties and injured during flooding of 2010, 2011 and 2015 women and children contribution is almost 45%.

In hilly areas the percentage is even higher. During 2015 floods of the total 38 human deaths in Chitral, 22 were women and Children.

2.3: Reforestation and reduction in GHGs:

Reforestation is the restocking of existing forests and woodlands which have been depleted, with native tree stock. The term reforestation can also refer to afforestation, the process of restoring and recreating areas of woodlands or forest that once existed but were deforested or otherwise removed or destroyed at some point in the past. The resulting forest can provide both ecosystem and resource benefits and has the potential to become a major carbon sink. The concept of forests as carbon sinks has drawn attention around reforestation as a possible tool in the fight against global climate change. Because trees draw carbon dioxide from the atmosphere in the process of photosynthesis, they can potentially remove this excess greenhouse gas from the atmosphere and help fight global warming.

The total forest cover in Pakistan is from 4 to 4.8 percent of the total covered area. However, different organizations indicate varying percentage. The deforestation rate in Pakistan is the highest in Asia; about -2.1 percent (per annum), as studied by the United Nations Food and Agriculture Organization and only 2.5 percent of the country's total area is forest cover.

Causes of deforestation in Pakistan include:

- Clearing of land for agriculture, residential purposes, construction of dams and barrages etc.
- Unchecked urbanization. Presently 32% of the total population is living in Urban areas
- Industrialization
- Timber logging and cutting for domestic and commercial energy
- Introduction of exotic species

Reforestation activities promote the sequestration of CO^2 from the atmosphere, thereby decreasing the concentration of this gas and consequently play an important role in fighting the intensifying greenhouse effect. The removal of carbon dioxide from the atmosphere is performed thanks to photosynthesis, allowing carbon sequestration in vegetation biomass and soils.

As the vegetation grows, the carbon will be incorporated in the trunks, branches, leaves and roots. About 50% of vegetable biomass consists of carbon, and forests are a large global stock of carbon by the area and biomass density. Added benefits of reforestation are:

- Prevention of soil erosion and floods through slope stabilization
- Water conservation
- Commercial prospects and diversification of local livelihood means
- Enhanced productivity of None Timber Forest Produces for income generation
- Habitat improvement and promotion of Biodiversity Conservation
- Cooling of environment through providing canopy

Reforestation will play a key role in providing sinks for different types of GHGs, especially carbon, and reducing risks of natural disasters like floods, landslides, drought and extreme weather events (heat wave).

A. Linkages between the met services and users:

The currently deployed Community Based Early Warning System in the target valleys of previously completed GLOF I project –financed by the Adaptation Fund - was successfully implemented during the July-August 2015 flooding. The representatives of the met department are taken cordially by the local community people. The acceptance of the met alerts in the remote area was well considered by the community. The community willingly responded to the call of met services since they were previously victims of the mighty disaster in their valley. The call of met services was considered to be a sign of relief to them. The trust of community on met services was developed due to the fact that the met department work in close coordination with the community people in developing the Community Based Early Warning System after understanding the underlying processes of the GLOF disaster in the target valleys. Previously they were aware about the flood but were not aware about its unknown occurrence. But after the intervention, they were able to understand and accept it as a potential threat from which they can protect themselves and reduce their human and material losses.

B: NDMA - Gaps, Challenges, Strengths and Opportunities

Gaps and Challenges

Emergency response has remained a predominant approach in Pakistan to deal with disasters until recently. The Calamity Act of 1958, the national policy for disaster management prior to the passing of National Disaster Management Ordinance 2006, was mainly concerned with emergency response. Pakistan Civil Defense was the focal agency for responding to disasters till 1970. In the aftermath of 1970 cyclone in the then East Pakistan (now Bangladesh), the Emergency Relief Cell (ERC) was established, which became the government's focal point for emergency relief in disaster hit areas. Reasons behind this reactive approach by policy makers might be related to the relatively lower socio-economic impact of disasters in the past. By no means, it implies that no work was being undertaken on disaster risk management in the country. Organizations like the FFC, PARC, and a number of NGOs have been implementing programs and initiatives in relation to drought, earthquake and flood mitigation. Communities in drought prone areas have developed ingenious methods to reduce the negative impacts of droughts. However, disaster risk management remains a relatively new concept for majority of the policy makers, UN agencies, donors, civil society organizations and for common people. Historically disasters have been occurring in localized areas in each province or region, and their affects have been limited mainly to the local communities. Consequently, the establishing of appropriate policy, institutional and legal arrangements to deal with issues of risk and vulnerability was not given priority at higher levels. Therefore, Pakistan lacked such mechanisms and institutions. There was a lack of political will and capacities for risk analysis and risk reduction. Lack of disaster risk management plans also remains a major gap. Even the districts and regions that have suffered from frequent hazards don't have plans, except a few. Pakistan lacks application of building codes for construction of housing and infrastructure in hazard prone areas. This could be attributed to lack of political will, lack of trained construction workforce, lack of monitoring and evaluation mechanisms, corruption, and apathy. Although specific agencies (e.g. WAPDA, FFC) have developed systems and procedures to deal with certain hazards, Pakistan also lacks an effective system for emergency response, e.g. Emergency Operations Centers, response plans, SOPs to deal with various hazards and capacities in search and rescue, firefighting, medical first response, evacuation etc.

Strengths and Opportunities

A number of situations in the aftermath of October 08, 2005 earthquake could be described as favorable opportunities to promote disaster risk reduction in Pakistan. These include:

- Heightened awareness among highest level decision-makers, officials, media and civil society about disaster risks and vulnerabilities,
- Enhanced commitment of donors and the UN for establishing institutional arrangements and developing capacity on disaster risk management,
- Approval of the National Disaster Management Ordinance 2006, establishment of NDMC, and the NDMA, and
- Commitment of the NDMA leadership. Existing disaster risk management system also has a number of strengths. For example, Pakistan has relatively well developed systems for flood mitigation, preparedness and response. Provincial revenue departments have policies, systems and procedures in place for disaster relief, particularly for floods and droughts. Pakistan armed forces are generally well experienced in managing various kinds of disasters. A number of departments including agriculture and irrigation departments have been implementing drought mitigation strategies. Some NGOs have extensive experience in community level disaster risk reduction and preparedness. NDMA will build upon the above mentioned strengths and opportunities, while developing systems for disaster risk management

SWOT Analysis of Agriculture Department:

Strength	**Weaknesses**
▪ Diverse and productive area ▪ Diversity in geo-climatic conditions ▪ Abundant Water Resources ▪ Well build structural facilities ▪ Motivated staff member ▪ Potentially large and suitable area for introduction of new breeds of crop ▪ Responsive and organized community ▪ Needed technological equipments in place ▪ Indigenous varieties of crops to promote ▪ Availability of infrastructure and technological equipments	▪ Poorly equipped human asset ▪ unskilled staff members ▪ Weak private sector involvement ▪ Shortage of required technology and equipment ▪ Limited resources for research and innovation ▪ Limited technological resources ▪ Small and fragmented farms ▪ Lack of communication and coordination with other departments ▪ Limited mobility of staff members due lack of needed resources
Opportunity	**Threats**
▪ Well motivated and cooperating farmers ▪ Diverse landscape and climatic conditions ▪ Potential for investment in fruit and vegetable sector value chain ▪ Plenty of water resources in glaciated areas to harness for development ▪ Potential to initiate and promote public private partnership	▪ Geo-climatically unfriendly areas ▪ Rapid Population growth ▪ Impact of globalization ▪ Extinction of indigenous germplasm ▪ Increasing attacks of new varieties of pests and lack of resources to fight the situation

The coordination between the met services and local users and communities always have some weaknesses in addition to coordinated strengths.

B: SWOT Analysis of Met-Department:

Strengths	**Weaknesses**
▪ Close coordination with the end users ▪ Close coordination with the local level disaster management organizations ▪ Establishment of Village Hazard Watch Groups Disaster Risk Reduction Committees organized at valley level. ▪ Effective Mechanism of generating alert so that a false alert may be avoided. ▪ Inclusion of indigenous knowledge in Early Warning System ▪ Policies and frameworks in place ▪ Well trained and highly motivated staff members ▪ Working linkages with communities and government institutions ▪ Efficient communication system ▪ Well established data base ▪ Documenting IEWS and blending IEWS with modern tech	▪ The sustainability of the EWS in place after the closure of the project activities. For smooth working of EWS it is necessary that proper continuous maintenance of the hydro-meteorological equipment could be ensured. ▪ The communication systems is quite well but still needs to be effective, especially in the transmission of real time weather data from the hydro-met equipment installed in the target sites. ▪ This is due to the fact that GSM communication in the target sites are less operative with no or weak signals. Moreover, there is no communication at high elevation stations for real time data transmission which is necessary in issuing timely alerts. ▪ Scarcity of observational stations and data ▪ Shortage of funds for maintenance and repair
Opportunities	**Threats**
▪ Development of High elevation weather data ▪ There is an opportunity for local organization and local administrative office to work closely with a federal organization in coping with a disastrous situation. ▪ Local community persons get awareness about the weather data and its importance in their livelihood. ▪ Private sector could get in for developing some mitigation plans and their improvements ▪ Geo-climatically Diverse landscape to work and explore	▪ Untrained communities to efficiently look after Hydro-met equipment installed in distant and high altitude areas. ▪ Minimum lead time for GLOF events ▪ Some of the equipment, which couldn't be avoided for EWS, are installed in hazardous area. For example discharge measuring equipment has to be installed over the river stream, and may be in the flood plain. Thus in case of disaster some of the equipment may get damaged. ▪ Lack of political to recognize and provide support for climate change initiatives

C: SWOT Analysis of Forest-Department:

Strengths:

- A total of 1.4 million acres demarcated State forests (42.62% of total area) is managed by Forest Division.
- Availability of 1216.23 million cft of growing stock of various tree species with sustainable timber yield of 7.06 million cft and fuel wood production of 30.01 million cft per annum
- Availability of infrastructure, including office buildings, inspection huts, forest check posts, forest roads, vehicles, equipment and working tools
- Availability of trained professional forest managers and supportive staff
- Well defined roles and duties and work codes and procedures
- Working Plans for systematic forest management
- Long institutional presence and credibility in public
- Public mandate and legislative cover for professional working
- Provider and custodian of multiple forest ecosystem services
- Revenue generation for Government
- Employment creation and skill development
- Budgetary allocation from public exchequer
- Contribution to rural poverty alleviation
- Promotion of eco-tourism
- Close liaison with public through plantation and awareness campaigns
- Supporting forest communities in livelihood activities
- Regulatory powers for granting timber permits.

Weaknesses:

- Rigidity in structure and working procedures
- Large forest compartments as administrative and management units
- Dependency on other Government organization and bureaucratic hurdles
- Lack of arrangements for preparation and updating of Working Plans
- Lack of proper control on working of forest contractors
- Lack of adequate capacity for massive afforestation
- Budgetary constraints and lack of adequate financial resources
- Lack of adequate planning and control on grazing and rangeland protection
- Political interference and pressures
- Delays in preparation of new Working Plans
- Lack of authentic resource database
- Lack of skills and training opportunities in new emerging fields related to forestry
- Absence of specialized units for forestry research, planning, monitoring, evaluation, human resource development, community development, and non- timber forest produce
- Lack of emphasis on participatory forest management and involvement of local communities in forest management
- Lack of incentives for carrier progression and reward mechanism
- Inadequate logistic facilities
- Lack of adequate strength for apprehension of forest offenders and prosecution
- Non representation of stakeholders in decision making

Opportunity:

- Availability of blank areas for afforestation/reforestation to increase forest area and cover

- Continued major role in forest protection, conservation and development
- Gap between supply and demand of timber and fuel wood
- Potential for improvement in Alpine pastures and rangelands
- Potential for micro hydel power generation
- Enhanced emphasis and market value of ecosystem services
- Enhanced emphasis on protection and development of watersheds
- International focus on conservation of biodiversity
- Availability of international funding for forest carbon sequestration through REDD plus and CDM
- Potential of forests for mitigation of climate change

Threats:

- Deforestation and forest degradation
- Increasing population pressure
- Imbalance in supply and demand of timber and fuel wood
- Rising trend of illicit logging
- Excessive traditional timber use in construction
- Excessive cutting of Deodar and Blue pine by concessionists
- Greater pressure of livestock and unregulated grazing regimes
- Negative impacts of climate change
- Spreading of invasive alien species
- Damages due to forest fires, floods, droughts, earthquake, land sliding and pest and insect attacks
- Undue interference of vested interests in official working
- Conversion of forest land to other uses
- Indiscriminate rural road construction and mining activities in forest areas

B: Challenges to Sustainable Agriculture and reforestation:

In Pakistan, agriculture is still the single largest sector, contributing about 21 % to the GDP and employing 44% of the workforce. More than two-thirds of Pakistan's population lives in rural areas and their livelihood continues to revolve around agriculture and allied activities. Like other developing countries, poverty in Pakistan is largely a rural phenomenon; therefore, development of agriculture will be a principal vehicle for alleviating rural poverty. Empirical evidence suggests that higher growth in agriculture on a sustained basis had a lasting impact on poverty reduction in Asia in the 1970s and 1980s. In later decades the impact of agriculture on poverty reduction became weaker as the Asian countries in general, and South Asia in particular, began to witness productivity gains stagnating on account of structural issues, including limited investment in research, Disasters and extension services. The recent global food crises, while creating difficulties for net food importing countries, is equally providing opportunities for developing countries like Pakistan to get their acts together and benefit from the current situation by giving more serious attention to agriculture (GoP, 2008).

However, despite being largest contributor to the GDP agriculture sectors struggling for sustainable development. There many challenges and issue derailing the sustainable development of agriculture sector.

- **High vulnerability of agriculture to Disasters (Drought and Floods):** During the year 2010 agriculture suffered damages equivalent to 5 Billion $. And in 2011 another 1.9 Million US Dollar (**Impact of Disasters on Agriculture and Food Security, FAO, 2015**)

- **Lack of adaptation measures:** No proper adaptation measures so far been undertaken on large scale to make agriculture sector disasters resilient.
- **Variability in water availability and rains:** Due to climate change and lack of proper harvesting system, the flow of water in river systems of Pakistan is facing unexpected variation from season to season. This variability is badly affecting the productivity of agriculture. Similarly, weather patterns especially rains have also shifted significantly. A huge chunk of agricultural lands are rain fed in Pakistan.
- Limited Technological advancement in agriculture sector and lack of proper land use plans
- Scarcity and high prices of Agricultural input are some other issues hindering sustainable development of agriculture

Pakistan receives more than 60% of its fresh water requirements from melting glaciers in the north. These glaciers are rapidly melting leading to short term disasters in the form of floods, increased flow in rivers untimely and will lead to chronic shortage of water for irrigation and drinking in the longer term if the present trend continued in the future. There is a dire need to undertake immediate measures to ensure sustainable management of water resources and disasters.

C. Maintenance of the ecosystem services envisaged (re-forestation):

Province	Total area ('000 ha)	Forest area ('000 ha)	Percentage
NWFP	10 170	1 410	13.9
Azad Jammu Kashmir (AJK)	7 040	770	11.0
Balochistan	34 720	720	2.1
Sindh	14 090	680	4.8
Punjab	20 630	630	3.1
Northern Areas	1 330	360	27.0
Total/average	**87 980**	**4 570**	**5.2**

Figure 24: Forest cover (Pakistan Forest Policy)

Deforestation is one of the main environmental issues Pakistan is currently facing. According to historical data at the time independence the forest cover of the country was about 12%. For the past two decades the forest cover in Pakistan is decreasing at the rate of 1.5 to 2.1 percent.

The underlying factors contributing to depletion of forest in Pakistan are:

- Weak enforcement of existing policies in true spirit
- Lack of proper and integrated watershed shed management initiatives
- Over utilization of resources
- Climate Change
- Ecosystem degradation/disasters
- Lack of technical capacity and logistic support for forest conservation

Except KPK Province, and that's too recently, no province has undertaken initiatives to improve the vegetation cover. To maintain and sustain the integrity of natural forests in the country, especially in the northern fragile ecosystem following activities need to be implemented immediately:

1. Development and implementation of integrated watershed management plans for each area
2. Promote slope stabilization measures in the form of check dams, bioengineering structures and large scale plantation to control soil erosion and ecosystem degradation
3. Undertake research activities to understand possible impacts of climate change on forests

4. Formulate policies or efforts to practically integrate local communities in management of forested areas
5. Identify and introduce environment friendly energy means for in-house use

2.4: Analysis of Potential barriers:

There are several barriers curtailing sustainable approach to dealing with climate change and DRR activities in the target areas. The analysis shows that elimination of potential barriers is the key to successful and sustainable adaptation to climate change in the target areas. The barriers are of different typology belonging to different sectors:

1. Barriers associated with Human assets: These barriers are mainly related with technical capacities to take on adaptation measures. At present human asset is low in needed skills and required logistics to deal with climate change induced disaster.

2. Barriers associated with institutions: Lack of needed institutional setups for DRR activities especially focusing on climate change is one of the main barriers specifically in the proposed target areas. Present institutional arrangements for DRR in the country are not sufficient both quantitatively and qualitatively to address emerging challenges associated with climate change.

3. Barriers associated with financial assets: Due to fragile and poor economy the country is not in position to provide needed finances for wide scale promotion of DRR activities. Lack of needed financial assets is also the main reason to strengthen concerned departments/institution to respond effectively to climate change and disasters associated.

4. Barriers associated with generation of needed information/Data: The target areas poorly researched and studied for a number of reasons. Availability of authentic data plays a key role in planning and sustaining activities in the long run. At present the arrangement collect real time data on geo-climatic conditions and disasters very limited. This needs to be strengthened through innovation, mechanization and automation of institutions involved in data collection. Lack of climate info remains of the top ranked barrier to understand respond to climate change induced disasters in the country.

5. Lack of structural arrangements for DRR: The structural adaptation arrangement like gabions, floodwalls, spurs, check dams, protective measure to prevent damages to irrigation channel headwork, embankments, slope stabilization measures etc. are not sufficient both in quantity and quality.

Majority of the barriers are related to limited technical capacities of relevant institutions and communities to implement and sustain adaptation measures. Lack of technical equipment is another issue denying access to authentic relevant information. Limited awareness level and lack of coordinated efforts other potential barriers affecting negatively the DRR initiatives in the target areas at present. Some of the barriers directly emerge from the geo-climatic conditions of the target areas. Difficult topography and harsh climatic conditions at times affect the planned activities and emergence of unexpected challenges.

2.5 Description of the benefits of climate information:

As investment and policy decision-makers grapple with the implications of climate change, benefits are seen in making available to them climate information at spatial and temporal scales that match the realms within which those decision-makers operate. For such an endeavor to have lasting economic and social benefits, however, the information must be carefully placed within the broader environmental, economic, social and institutional context within which decisions are made.

One way to think about climate change is as a lens through which to view already existing inefficiencies in land-use planning, infrastructure management, public health and ecosystem health, as well as social justice. Societies have developed institutions and governance structures to address a wide range of threats to system performance. To these threats they now need to add climate change. This means making climate information at fine temporal and spatial scales readily available to the communities that deal with land-use planning, infrastructure management, public and ecosystem health, as well as social justice. It also means developing new capacities and potentially new institutions that facilitate dialogue between those who generate climate information and the end user communities to ensure that the science and modelling are carried out in ways that indeed connect with end-user needs and that the vehicles for information sharing and the process of communication are meaningful to all parties.

Assuming that climate change functions as a multiplier of already existing threats to system performance, then climate-information by itself is only one of many inputs into the investment and policy decision-making process. Engineering information on the performance characteristics of infrastructures, demographic information on the size, composition and location of populations, geographic information on land use and land cover changes, environmental information on ecosystem health, economic information on consumptive behaviors all must, and do, inform mitigation and adaptation strategies.

However, if climate change functions as a multiplier of existing threats, then climate information itself can have a multiplier effect for the value of other pieces of information that enter investment and policy decision-making. Realizing that multiplier function can have both a danger and great opportunities for generating environmental, social and economic benefits.

Climate change has become a global problem affecting especially the world's poorest people in developing countries. Well documented failures of developing programs to address climate change issues have shown that at times modern technologies and concepts may not fit the cultural context of many developing nations. Sustainable solutions need to draw on blending indigenous knowledge with climate info that is compatible with the local culture.

Local communities have long been recognized as being particularly vulnerable to the impacts of climate change due to the close connection between their livelihoods, culture, spirituality and social systems and their environment. At the same time, however, this deep and long-established relationship with the natural environment affords many local communities and indigenous peoples with knowledge that they have long used to adapt to environmental change, and are now using to respond to the impacts of climate change.

Providing climate information to local communities and mixing it with IK will enhances the social acceptability and promotion of climate change adaptation endeavors readily and on the other will better place local communities to develop and implement their own strategies through better understanding future trends and threats associated with climate change.

Climate information is the back bone of EWS anywhere in the world. Without climate information or absence of climate information means vulnerable areas and impending disaster/hazards are not monitored e.g. drought or rainfall conditions are not monitored for important agricultural crops, rains are not monitored for areas vulnerable to flash floods, heat waves are not monitored for areas vulnerable to GLOF and rapid rise in river

leading to riverine floods all go unnoticed. As such, many potentially threatening hazards are not forewarned because of a lack of access or availability or arrangements to collect and disseminate climate information.

Therefore, it is mandatory that real time information on climate should be collected and shared to trigger the EWS with purpose forewarn vulnerable communities. Climate info has a very basic role in conceptualizing, designing and functioning of WES and ground implementation of other DRR adaptation measure efficiently. For example without knowledge of river flow at different season one can't build a protection wall. Similarly, formulation contingency plans for DRR also need climate info for successful and sustainable implementation.

The economic impact of natural hazards has risen from USD 10 billion per annum in 1975 to almost USD 400 billion in 2011. Private investors continue to develop their economic activity in many of the world's most vulnerable locations, often in floodplains or in areas that experience extreme weather or geophysical risks. Impacts from natural hazards and climate change can affect a company directly through its own operations or indirectly through its value chain. 'Direct' impacts include physical asset damage, reduced operational performance, and staff and workplace disruption. 'Indirect' impacts amplify losses beyond individual operations and can often be felt across companies, sectors and countries due to the globalization of value chains and market.

Natural hazards and climate change have a greater impact on 'sensitive' economic sectors such as agriculture, those with high value fixed assets (e.g. extractives, energy, utilities), and those with extensive supply chains (e.g. retail and consumer products). Those that are exposed to interruption from extreme weather and geophysical events (e.g. utilities, telecoms), or those with commodities that cannot be easily substituted (e.g. specific product lines for major food and retail organizations or technology manufacturers) are most at risk.

Opportunities to scale up public-private collaboration on building resilience are largely untapped. This is partially because resilience is often viewed as the responsibility of the public sector. Successful businesses are those which best adapt in a continually changing market; building resilience to direct and indirect risks whilst seizing market opportunities to sell new products and services that build the resilience of others.

Relevant and timely flow of climate information is primary prerequisite for making private sector resilient to hazards.

PART- B: Logic of the intervention:

1. Theory of change / logic framework – baseline and indicators:

1.1 Barriers to be addressed:

In developing countries like Pakistan building of community, institutional and infrastructural resilience to climate change induced disasters is derailed by multidimensional barriers including technical, financial, social, lack of apt awareness level, geo-ecological and institutional barriers.

No proper institutional setup is there to support community resilience to disasters, communicate EWS effectively, planning and undertaking adaptation measures and providing sustained finances for disaster risk reduction activities at local level. Through successful demonstration of EWS, integration of local communities in DRR activities and introducing institutional arrangements have been made in previous target areas of Pakistan GLOF-Project, however, replications of these success stories to other potential areas needs huge investments and institutional support. Similarly, lack of effective communication and wide range of WES in proposed target areas render the local communities highly vulnerable to impending disasters.

1. Limited resources (financial) to build disaster resilience adaptation measures at village/valley:

The mountain communities of northern Pakistan have been living under hazardous conditions since centuries. Over the period they have developed indigenous resilience to live in harmony with nature.

To reduce disaster risks to lives and properties the communities have developed their own tools of Early Warning System, and later on rehabilitate disaster hit infrastructure, especially those related to their livelihood means like irrigation channels, drinking water supply and restoration of agriculture fields. In remote mountain areas of Pakistan rehabilitation of disaster hit irrigation channels, drinking water supply system and other common property resources is mostly carried out by communities on self-help basis.

However, during past few decades both the intensity and frequency of disasters have increased many folds due to rapid climate change. Shortage of financial resources for rehabilitation of social and physical infrastructure in the target areas is posing serious threats to productivity of both agriculture and human assets. Provision of more financial resources for construction of disaster resilient adaptation structures and equipping communities would better place the local communities to protect their livelihood means against disasters and expedite the rehabilitation process in the post-disaster situation.

Existing government institutions are also constrained with limited financial and logistical resources to provide services to a population of over 48.00 million people and huge geo-climatically unfriendly areas in northern parts of the country. Relevant government institutions are often underfunded to fill the gap between demand and supply. Lack of strong and vocal local leadership and suitable representation at national and provincial levels (Assemblies) further limit the allocations and flow of resources from federal and provincial level.

2. Geo-climatic barriers:

Harsh geo-climatic conditions in the target areas often constrain research, data collection and establishment of foolproof EWS system. Difficult and rugged topographic features of the area often deny access to target areas by researchers and planner to collect baseline data from glaciers and surroundings.

There is increasing demand for technological innovation to collect remote controlled data (Automated) from remote areas on glaciers, climatic conditions and other aspects. Such data will help in establishing effective and all weather EWS for the area.

3. Barriers in hydro met/EWS, agriculture and ecosystem services:

The barriers to Early Warning System (EWS), sustainable agriculture, forestry and delivery hydromet services are multifaceted in Pakistan. Pakistan being a developing country lacks much needed technical and institutional arrangements for DRR activities, especially in northern remote parts.

Delivery of EWS and hydromet services require highly sophisticated equipment and technology to monitor the floods and other disasters at sources high up in the glaciated areas and communicated with communities at the reconvening end. Harsh climatic conditions, lack of trained human capital at local level, limited awareness and difficult rugged topography further derail the process of effective services delivery to the mountain communities in the target areas.

A: Hydromet Services/EWS:

Early Warning Systems and Hydro-met service delivery requires a number of technologies and expertise in many areas. The first thing is the procurement of equipment and its proper installation and thereafter the proper transmission of the real time data. The communication of the data needs to be addressed effectively under the project since the equipment will be installed in very remote locations where there might be no GSM signals and satellite communication option may be opted. Good data is the challenge for the development of effective EWS since the equipment will be installed at remote location and rectification needs couple of days in reaching there. Thus it will be ensured that equipment acquired should store data in best possible way to minimize malfunctioning of the data recording and transmission. The sensor of the equipment should be in good working conditions. Moreover dense network of equipment is needed to be installed to analyze the data for effective and efficient exact information to be dissemination in the shape of advisories to the end users and alerts.

The effective EWS requires alerts to be disseminated prior to the disaster event which in this case is difficult due to very less lead time usually in minutes. So the understating of the real time data in connection with prevailing thermal regimes of the area will be addressed properly and information dissemination should be quick for early response from the community. In brief following are the main barriers derailing efficient delivery of hydro met services/EWS:

- Lack needed financial allocations to procure updated technological equipment
- Poor accessibility to the glaciated and other hazard prone areas due geo-climatic constraints
- Limited knowledge and capacity of the local communities to collaborate
- Mobility constraints to ensure timely access to the equipment installed in high altitude areas and rectification of data
- Shortage of staff
- Unreliable communication system in northern areas
- Due to steep slopes and proximal location of glaciers to human settlements lead time for GLOF is less

To overcome these obstacle more financial, social and human resources are needed to make the system more efficient and time effective.

4. Lack of updated needed data on glaciers, glacial lakes and climatic conditions:

South Asia in general and remote mountain areas of Pakistan in particular are least researched areas. Baseline data on glaciers, glacial behavior, glacial lakes and history of disaster is almost none-existence. In absence of such crucial baseline data planners often face difficulties to design, plan and implement DRR activities.

However, during past decade efforts have been made by national institutions and NGOs to establish scientific data on the target areas. But, data is never enough to meet future planning requirements.

During the GLOF 1 project sufficient data was collected from the target and adjoining areas. Acquisition of relevant through surveys and automated system will help in formulating future policies and developing strategies for adaptation in the future.

5. Limited guidelines to mainstream DRR into development:

Despite the growing demand for mainstreaming DRR activities into development process through an integrated approach, no clear and well defined guidelines have been defined in this context. This situation has resulted in further complications of development and DRR activities.

This situation stresses on the need of enhancing the understanding of climate change and associated problems among communities, institutions, development planners and policy makers.

6. Lack of coordinated efforts:

The spectrum of climate change induced disasters is growing wider and wider over the past two decades in the target areas. Therefore, it can't be addressed in isolation. Broader collaboration and coordination among all stakeholders is needed to address the prevailing situation. At present there is no proper mechanism to ensure coordinated response for DRR, especially before disasters, in the proposed target areas.

7. Limited Awareness:

In Pakistan climate change is a relatively new subject. Awareness about climate change and its possible impact is very limited both at community and institutional level. Besides, relevant information and data on climate change for dissemination and propagation is also very limited.

There are no formal and informal institutional setups for knowledge management on climate change, disasters and DRR activities in the country. The situation is even worse in proposed target areas. Acquiring and getting accustomed to integrate DRR to improve community infrastructure, watershed, and sustainable development is mainly derailed by lack of needed technical guidelines, lack of much needed information and limited knowledge about the issues associated with climate change.

To address this situation a package of proper adaptation measures should be identified, planned and introduced in the proposed target areas with the objectives of building their knowledge about the impending disasters. Adoption of such package by institutions, stakeholders and above all by communities will help to reduce disaster risks in future.

Proper understanding and access to weather forecasting and EWS always play a crucial role in minimizing disaster risks and making communities and institutions disaster resilient. Strengthening capacities and capabilities of local communities and institution to store and analyze data will help to understand dynamics of climate and disasters.

8. Lack of capacities at community level to design and implement integrated solution for DRR:

In addition to technological and financial constraints the communities in the target areas also lack behind in needed capacities to undertake measures to make local infrastructure disaster resilient. Communities are also constrained to ensure appropriate participation of all segments of the society in DRR planning and implementation; and manage communal conflicts over resources. Besides, participation of women and other marginalized groups in decision making is very low, especially for target areas where religious orthodoxy prevails.

Besides, communities due to their limited knowledge and exposure, lag behind in needed skills to implement adaptation measures and maintain appropriate complex geo-climatic data. However, in some target areas vibrant and technically sound Local Support Organizations are present and working

in diverse fields to ensure sustainable development. Technical discrepancies of communities and community based organizations will be removed through trainings and exposure activities.

9. Lack of access and affordability of alternates:

Local communities in northern parts of the country usually depend on natural resource base (forests/pastures) to fulfill their in-house need of fuel and timber. This is one of the main causes of habitat degradation in the area. Due physical isolation of the areas and extreme poverty alternate sources of timber, domestic fuel and diversified means of livelihoods are neither accessible nor affordable by the local communities. With increasing population and shrinking resources the dependency ratio on natural resources for livelihood and subsistence is also rising day by day.

1.2 Approach to address the barriers:

There is a growing concern about rapidly changing climate and its negative impacts on social, economic and ecological components in the country in general and proposed target areas in particular. To cope with this situation different institutional and policy level arrangements including evolution of Climate Change Ministry, development of Climate Change Policy, incorporation of climate change induced disaster in National Disaster Management policies and guidelines etc.

As climate change and associated disasters are multifaceted in nature and as such an integrated approach will be adopted to plan activities against individual sectors to address the barriers. At initial stage of adaptation planning and implementation, special attention will be given to strengthen existing response measures both at local and national levels, effective utilization of existing data at initial stage of risk assessment, establish structures within government agencies/departments to promote adaptation, and give adequate priority to adaptation within policies, plans and future programs.

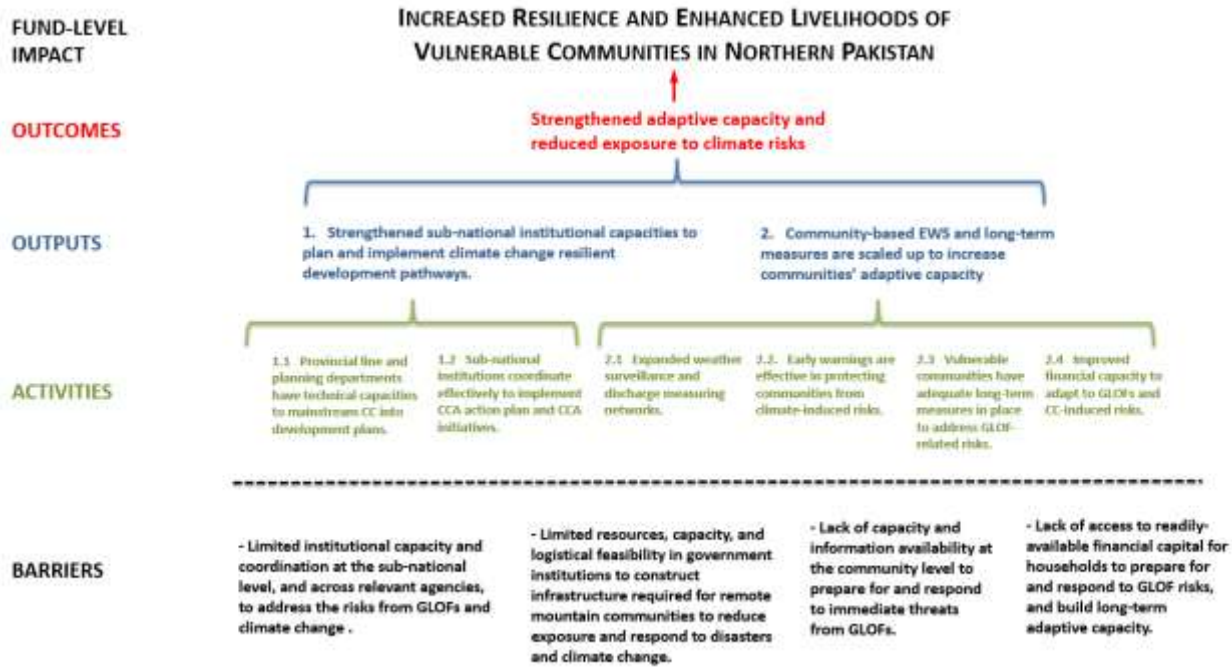
Besides, to initiate immediate measures/efforts to mitigate disaster risks (short term) to lives and livelihoods will be initiated where socio-economic benefits are clearly higher in terms of cost.

Ecosystem-based Adaptation (EbA) process will be adopted in collaboration with stakeholders (communities and forest department) to reduce vulnerability of local communities to climate change impacts and provide significant co-benefits.

Short, medium and long-term measures will be planned and implemented to enhance the adaptive capacities of the vulnerable community, local and national institutions. To encourage urgent and immediate response and mitigate short term impacts, that have a likelihood of arising from climate change, will be undertaken at valley/village level through integrating local communities. Medium and longer term measures, that are necessary to enhance adaptive capacities in a way that contribute efficiently to prevent and mitigate impacts of Climate Change like assess the risks, control the impacts, reduce vulnerability and strengthen resilience will be planned and implemented at local, provincial and national levels. Medium and long terms include construction of risk reduction structures (gabion, floodwalls, check dams etc), development of relevant hazard maps, institutional arrangements, acquiring of technological logistic, capacity development of available human asset, raising awareness, consolidation of information and promotion of research and technological, development in the target areas and beyond.

1.3 Theory of change:

The project presents a holistic model of climate-resilient development to enable one region in Pakistan to manage the risks from GLOFs and other impacts of climate change, incorporating top-down regulatory support, bottom-up community preparedness, short-term disaster response capacitation, and long-term planning for sustainable and climate-resilient use of natural livelihood assets. These activities, working in concert with each other and existing initiatives on the ground for livelihoods development, greatly enhance the region's endogenous adaptive capacity. The barrier each activity addresses, and its ability to support strengthened adaptive capacity and reduced exposure to risks, is illustrated in the theory of change presented below.



The project districts cover 99% of the glaciated area of Pakistan, and targets all those communities which are currently most vulnerable to GLOF events. Therefore, given that GLOF risks within Pakistan are idiosyncratic to these project sites, specific core activities, such as GLOF EWS and protective structures, may not be directly replicable in a national context. However, the design of and lessons learned from the implementation and use of these components may prove useful in developing response and preparedness measures in other vulnerable communities where GLOF risks are present across the Himalaya, Hindu-Kush, Karakoram, Tien Shan, and Andes mountain ranges.

Further, the model that the project presents – combining sub-national institutional capacity building and support with hard and soft adaptation measures to address risks specific to particular communities – may be easily scaled up and replicated within Pakistan. Following the 18th Amendment, institutional responsibility for addressing climate change has been devolved to the provincial level, but like in KP and GB, there has been little progress on institutional support and planning for climate change and disaster risk management in the other provinces of Pakistan – Punjab, Balochistan, and Sindh, where 1,332 people recently died from a major

heatwave in June 2015. Following this project as a model, disaster risk management and climate change policies and integrated action plans can be developed at the provincial level in concert with hard and soft adaptation measures, and natural resource management plans, tailored to specific risks present in these other provinces.

Within the project area, the activities will catalyze impacts well beyond the scope of the 5-year project. Based on our economic analysis, benefits from avoided loss of life and property and livelihoods developments will continue to increase over 25 years, with an overall net internal rate of return (IRR) for the project of 24.6%.

In non-monetary terms, in the holistic approach of the project, activity streams feed off each other to produce and maintain a meaningful paradigm shift that enables the long-term resilience of the region. For example, slope stabilization through re-vegetation would not be sustainable beyond a one-off investment in the absence of a natural resource management plan. This project ties this ecosystem-based adaptation measure with the mainstreaming of climate change risks and solutions at an institutional level within sub-national agriculture departments and environmental protection agencies, and the development of a land and pasture management strategy for the region. Further, it capacitates communities to pursue alternative livelihoods (e.g. sustainable community forestry) which are less demanding of natural resources and more resistant to climate change, catalyzing a shift in land, water, and natural resource use practices. Together, these activities ensure that the forest resources planted for slope stabilization and their intrinsic protective value against GLOFs and other climate risks are conserved in the long term.

1.4 Logic framework – baseline and indicators

1. Paradigm Shift Objectives and Impacts at the Fund level[1]						
Paradigm shift objectives						
Increased climate-resilient sustainable development	The project presents a holistic model of climate-resilient development to enable one region in Pakistan to manage the risks from GLOFs and other impacts of climate change, incorporating regulatory support, community preparedness, disaster response capacitation, and long-term planning for sustainable and climate-resilient use of natural livelihood assets.					
Expected Result	**Indicator**	**Means of Verification (MoV)**	**Baseline**	**Target** Mid-term (if applicable)	**Assumptions** Final	
Fund-level impacts						
A1.0 Increased resilience and enhanced livelihoods of the most vulnerable people, communities and regions	1.1 Change in expected losses of lives and economic assets (US$) due to the impact of Extreme climate-related disasters in the geographic area of the GCF intervention.	-Project reports: annual reports; mid-term and final evaluations. - Field visits to engineering structures -Satellite imagery of glacier lakes and vulnerable sites before and after the project.	There are 33 potentially dangerous lakes in KP and GB. 960 destructive outburst floods are in KP and GB areas in last two decades.		By the end of the project, 275 concrete engineering measures are in place to reduce the impact of GLOF events on vulnerable communities in each target valley (as appropriate: check dams, mini dams,	The political situation stays stable throughout the project duration. Stakeholders are able to perceive reductions in vulnerability over the time-scale determined by project duration. No flooding disasters in target communities occur throughout the project lifetime.

[1] Information on the Fund's expected results and indicators can be found in its Performance Measurement Frameworks available at the following link (Please note that some indicators are under refinement): http://www.gcfund.org/fileadmin/00_customer/documents/Operations/5.3_Initial_PMF.pdf

					ponds, spill ways, slope stabilization, tree plantation, and controlled drainage).	

2. Outcomes, Outputs, Activities and Inputs at Project/Programme level						
Expected Result	**Indicator**	**Means of Verification (MoV)**	**Baseline**	**Target**		**Assumptions**
				Mid-term(if applicable)	Final	
Project/programme outcomes	**Outcomes that contribute to Fund-level impacts**					
7.0 Strengthened adaptive capacity and reduced exposure to climate risks	7.2: Number of males and females reached by [or total geographic coverage of] climate related early warning systems and other risk reduction measures established/ strengthened	-Review of climate change, DRM and development policies and plans at the national, district, and community levels. -Review of Disaster Management Act, DRM policies, plans, and institutional structures. -Project reports: annual reports; mid-term and final evaluations. -Site visits before/after the project	GLOF early warning system in KP and GB covering two districts Vulnerable households are not able to receive and react to GLOF early warning messages in the KP and GB. No physical structures in place to mitigate		By the end of the project, 100% of households in KP and GB target communities are able to receive and respond to early warnings and take the appropriate actions following the warning	Government remains supportive to link longer-term climate change planning with current disaster risk management initiatives No tampering with early warning system installations. Community workforce available to support engineering measures.

		-Questionnaire-based surveys (QBS)/Interviews at the beginning, mid-term and end of the project.	the effect of GLOF events.			
Project/programme outputs	**Outputs that contribute to outcomes**					
1. Strengthened sub-national institutional capacities to plan and implement climate change resilient development pathways.	No. of institutions with increased capacity to minimize human and material losses from GLOF events. Number of policies introduced to address GLOF risks or adjusted to incorporate GLOF risks.	Questionnaire-based surveys (QBS)/Interviews) at the beginning, mid-term and end of the project. Impact assessment at the end of the project. Satellite imagery of glacier lakes and vulnerable sites before and after the project.	National, provincial and local disaster management institutions and development planners are unable to design, finance and analyze GLOF risk reduction measures on the basis of reliable, comprehensive information. Only 2 comprehensive disaster management guidelines exist for the KP and GB regions.		By the end of Year 3, 100% of the national and 90% of district and community authorities in the KP and GB regions are able to prioritize and plan measures to minimize potential losses from GLOFs. By the end of the project, at least two policies have been reviewed and/or revised to address or incorporate GLOF risk reduction.	The political situation stays stable throughout the project duration. Stakeholders are able to perceive reductions in vulnerability over the time-scale determined by project duration. No flooding disasters in target communities occur throughout the project lifetime.
2. Community-based EWS and long-term measures are up-	.1. Number of vulnerable households in KP	QBS with households.	Vulnerable households are not able to receive and		By the end of the project, 100% of households in target	No tempering with the early warning system installations,

scaled to increase communities' adaptive capacity.	and GB covered by a GLOF early warning system. 2.2. Number of Community-based organizations trained in the operation and maintenance of the EWS. 2.3. No. of physical assets constructed to withstand the effects of GLOF events.	Mock drill protocols. Field visits to EWS sensor, relay and communication sites. Site visits before/after the project	react to GLOF early warning messages. 24 GLOF early warning system for KP and BG in place. No physical structures in place to withstand the effect of GLOF event		communities are able to receive and respond to early warnings and take the appropriate actions following the warning. (696,342 people: 348,171 men, 348,171 women) By the end of the project , at least 24 CBOs are trained in the operation and maintenance of the EWS and ensure its continued functionality. By the end of the project, at least 250 targeted engineering structures have been established to withstand the effects of GLOF events on livelihood assets.	Functioning backup systems in place. Communities are receptive to the adoption of mitigation measures and participate actively in construction efforts.
Activities	**Description**		**Inputs**		**Description**	
1.1.Provincial line and planning departments have technical capacities to mainstream CC into development plans	Capacity building activities to integrate CC and GLOF risk into development plans and instruments.		1.1.1.Develop integrated provincial CCA action plan encompassing key sectors (mainstream CC risks into DRM, Agriculture, Livestock, and Water Sectors) in KP and GB, linked to NCCP 1.1.2. Completion of the KP Provincial CC policy which will serve as framework for the CCA action plan.		Technical training activities on developing provincial CCA action plans that address GLOF risks from a sectorial perspective, focusing primarily in Agriculture, Livestock and Water in GB and KP.	

1.2. Sub-national institutions have improved capacities to coordinate, plan, and implement CCA measures across sectors.	Strengthen sub-national institutional and coordination arrangements including financial, planning and budgeting processes and other requirements for implementing CCA action plans and CC initiatives in GB and KP	1.2.1. Establish/ strengthen provincial-level CC coordinating entities within the Planning and Development Departments (involving CBOs, NGOs, and EPA) to coordinate CC response across key sectors. 1.2.2. Raise awareness at the local level (district authorities, NGOs, and CBOs) to effectively coordinate CC initiatives and play key roles in implementing CCA action plans across key sectors.	Through multi-stakeholders participation, coordinate response to CC and GLOF risks.
2.1. Expanded weather surveillance and discharge measuring networks.	Increase the area coverage by hydro-meteorological instruments and equipment to address GLOF risks.	2.1.1. Installation of 22 weather monitoring stations in KP and 28 in GB. 2.1.2. Installation of 170 river discharge gauges/ sensors etc. in KP and 238 in GB. 2.1.3. GBDMA and KPDMA provide extension to PMD on installation and maintenance of equipment.	Installation of hydro-meteorological infrastructure to expand EWS in 7 valleys.

2.2. Early warnings are effective in protecting communities from climate-induced risks..	Expansion and development of tailored warnings for GLOF risk through Pakistan Meteorological Department.	2.2.1. PMD conducts hydrological modeling to generate flood scenarios and calculate GLOF lead time. 2.2.2.Village hazard watch groups are set up (expanded) and capacitated to monitor GLOF and disseminate early warnings	The installation of 50 automatic weather stations (22 in KP and 28 in GB) and the installation of 408 river discharge gauges/sensors (170 in KP and 238 in GB) [Input 2.2.1 & 2.2.2) will provide data to conduct hydrological modelling to generate flood scenarios and to capacitate village hazard watch groups that will be part of a local-level early warning system.
2.3. Vulnerable communities have adequate long-term measures in place to address GLOF-related risks	GLOF response expanded, small-scale infrastructures constructed and increased natural protection through vegetative cover to protect lives and property downstream of each valley. Implement water efficient farming technologies to increase yields to promote food security to cope with GLOF events.	2.3.1. DRM Committees and emergency response cells are expanded to act as first responders and manage drills and simulations. 2.3.2. GBDMA and KPDMA train communities and DRM committees on GLOF preparedness and response. 2.3.3.Construction of 250 small infrastructure to reduce risks of floods i.e.(gabion walls, check dams, spillways) 2.3.4. Expand slope stabilization to mitigate disaster risks from debris slides (Increase vegetative cover i.e. 100,000 ha in KP and 140,000 ha in GB). 2.3.5. Installation of 240 water efficient farming technologies i.e. Micro Irrigation System, Drip	Expansion of DRM Committees and emergency response cells by providing basic necessary equipment regarding communication and relief. Small-scale hard adaptation structures will be constructed and vegetative cover expanded to reduce risks of floods and from debris slides. Increase the capacity of subsistence farmers and women to address CC impacts by installing micro-irrigation systems, and household gardening in targeted valleys

		Irrigation System, Sprinkle Irrigation and rehabilitation of irrigation channels in 24 targeted valleys.	
2.4. Improved financial capacity to adapt to GLOFs and CC-induced risks	Enable communities and households to prepare for weather shocks and to build adaptive capacity.	2.4.1. Scale-up revolving community-based disaster risk management fund i.e. $ 50,000 USD per CBDRMC. 2.4.3. Relevant stakeholders (i.e. micro-credit lenders, insurance companies, SMEs, Gov agencies, etc.) trained and working in ways to improve coordination and delivery of the CBDRM Fund and DRM initiatives on the ground in GB and KP.	Expansion of a community-based disaster risk management fund for disaster risk management cells to provide support *ex ante* and *ex post* GLOF events. Workshops and trainings targeted specifically for local public and private entities to be made aware of their risks and risk management related to GLOFs.

PART-C: Technical specifications:

1. Equipment and infrastructure works:

The data available from the Northern areas of Pakistan include met and weather related data. The prevailing situation in the area needs to be analyzed to properly understand the expected climate related hazards.

1.1 Cost estimates and technical specifications:

Technical specification and cost estimates of proposed individual activities/components as indicated in the GCE proposal are given below:

A: Availability, type and characteristics of equipment:

The Pakistan Meteorological Department is both a scientific and a service department, and functions under the Ministry of Defense. It is responsible for providing meteorological service throughout Pakistan to wide variety of interest and for numerous public activities and projects which require weather information. In its services to aviation the department responsibility goes to some extent beyond national boundaries in fulfillment of accepted international agreements and obligations which include, among other things, the collection and rebroadcast of meteorological data.

So far 10 Automatic Weather Stations (AWS), 05 Automatic Rain Gauges, 5 Discharge Measuring Equipment has been installed in the glaciated zone and manual observatories are in operation in the valleys of the target region. These stations are capable of recoding and communicating meteorological related information of these remote areas. Now a GLOF Liaison office and GLOF Research Center have also been established by PMD in Gilgit-Baltistan Province and Chitral District of KP. These offices are mainly responsible to develop linkages with relevant stakeholders, ensure coordinated efforts, monitor climatic conditions and collect and maintain applicable data on climate change and associated disasters in the target areas

However, many more stations need to be installed to understand the weather systems of the complex topographic terrain of the mountainous areas of the Northern Pakistan. The area hosts more than 7000 small and large glaciers distributed from an elevation of 2400 m.a.s.l. to more than 7000 m.a.s.l. These glaciers are a source of triggering glacier related hazard and observatory stations in the vicinity of these frozen reserves are needed to understand the climatic situation of the area for monitoring behavior of the glaciers and developing EWS. The Automatic Weather Stations (AWSs) and other equipment capable of measuring and storing data is needed for the target sites. Moreover to analyze the precipitation regimes of the area at different elevations rain and snow gauges need to be installed. A temperature sensor with this will be an added advantage since temperature and precipitation are the most important parameters for understanding climate change patterns. The lake level monitoring devices are also needed to monitor the level of glacial lake present in the area. Sudden erratic changes in the level of lake(s) in any specific valley should be communicated to the end users and relevant community so that they become vigilant to cope with any unforeseen situation like Lake Outburst. Finally discharge measuring equipment at the start of the valley from where the river stream may be originating and at the end of the valley is needed for complete hydrological assessment of the valley. These combined hydro-meteorological stations are needed for the understanding of complete hydrological regime of a particular valley. This will pave the understanding for EWS for specific valley and resultantly for the whole target area. The department has a system for recording, storing, analyzing, interpreting, disseminating and maintaining climatic data on daily basis at regional, national and local level.

However, a strong and flawless communication system is also needed for proper implementation of an early warning system and some kind of auto alert mechanisms needs to be devised under EWS.

Moreover to deliver information to the farmers in the Northern Pakistan more efficient and updated Agro-meteorological instruments need to be acquired.

B: Human resources and capabilities available at national and local level.

Technically PMD is sound to deal with the GCF project related to GLOF disaster in the Northern part of the country. The department has now PhD qualified personnel in the related disciplines and qualified engineers to deal with the hydro-met equipment and data generation. Meteorologist, hydrologist and glaciologist available with the department are capable of understanding the underlying principles of the system in question. The dealing of similar kind of disaster in the past over three valleys has also built capacity of the human resources of the department. Moreover, the local and international training conducted by using department's link in the subject field is an added advantage. So far many officers has been given one year training on disaster risk mitigation and management policies from Government of Japan. Some opportunities and training has also been obtained in the field of glaciology and hydrology. PMD personals have been trained on mass balance, mountain hydrological modeling, and ice core analysis over glaciers and related disciplines in glaciology.

The field experience of the technical staff and scientists of the department in dealing with research on glacial and para-glacial environments helps in understanding the ground realities. This experience when amalgamated with the additional desk based analysis and remote sensing tools helps in generation and analysis of realistic view of the situation and accordingly results are deduced.

C. Data storage and management

There is a proper methodology of data storing received from the hydro-met equipment already installed in the target areas. The real time communication of the data from the couple of stations installed at remote locations were transferred to a databases. These datasets are then analyzed to deal with unambiguous data and measures are taken to rectify the equipment taking false/erroneous reading and to eliminate the errors in recording data. The obtained datasets are thereafter analyzed to deal with prevailing climatic situation in the target area.

D. Gap analysis:

The area still needs much to be done at ground level. The first phase is the installation of the hydro-met equipment in the target areas to increase the observational network. Hence hydro met equipment are needed for the installation of one complete EWS for a specific valley in the target area depending on the area of that specific valley. On average, two AWSs, two Automatic Rain gauges along with temperature loggers, lake monitoring sensors depending on the number of lakes in the target valley and at least two discharge measuring equipment needs to be installed to cover one valley for EWS. In some valleys we may need surveillance cameras to keep an eye on the glacier morphology from where the glacier related disaster seems to originate.

Then couple of experiments need to be done for the analysis and understanding of GLOF and flash floods for example mass balance experiments understanding the behavior of the glaciers associated with the glacial lakes, Ground Penetrating Radar profiling so ascertain sub-glacial lakes and cavities capable of developing lake. The profiling and field survey of the glacial lakes declared hazardous for the GLOF phenomenon needs to be done to understand the triggering mechanisms. The volume of water, its damming conditions, geomorphology of the associated area and effect on the downstream community.

The local community needs to be trained to deal with the concepts of GLOF disasters and mitigation and adaptation measures. The situation of the river streams, their capacity to retain water, probability

of sediment flow and lead time of flood wave at different location of the valley needs to be ascertained.

E. Equipment (Analysis, suitability and cost):

The acquisition of these hydro-met related equipment for the development of EWS will be a milestone to be accomplished under the project. The Automatic Weather Stations are best option for these remote locations as there is no option for manual observations over the whole year.

The early alert of the system will save many human and material losses. These instruments once operational will minimize the economic cost of local community incurred as a result of disaster in case of expected damage. This ultimately will have long term effects on the lives of the community and on the economy of the country as a whole. The possible destruction of their limited agriculture lands and necessities will ultimately be reduced as a result of the intervention of EWS developed under the project.

F. Type of information (agro-meteorological products/Services, etc.):

National Agromet Centre (NAMC) is an important division of Pakistan Meteorological Department (PMD) which has been established in 1988 under WMO project to relate meteorological services to the most important agriculture sector of the country so as to promote the overall status of farming community. NAMC has thus been extending its services since its establishment.

- **NAMC Network**

  * The present network of NAMC consists of its main office of NAMC Islamabad and 33 Agromet observatories throughout the country. Out of these Agromet observatories 16 are established in the already working PMD met observatories network with additional Agromet instruments and responsibilities and the remaining 17 are purely Agromet observatories established in different provincial agriculture related offices.

  * This network of Agromet observatories includes 5 Regional Agromet Centers at Rawalpindi, Faisalabad, Tandojam, Quetta and UstaMuhammad. RAMCs also prepare crop reports of the standing crops at different RAMCs. These reports are further analyzed and their results are included in different products for the benefit of agriculture community of the country.

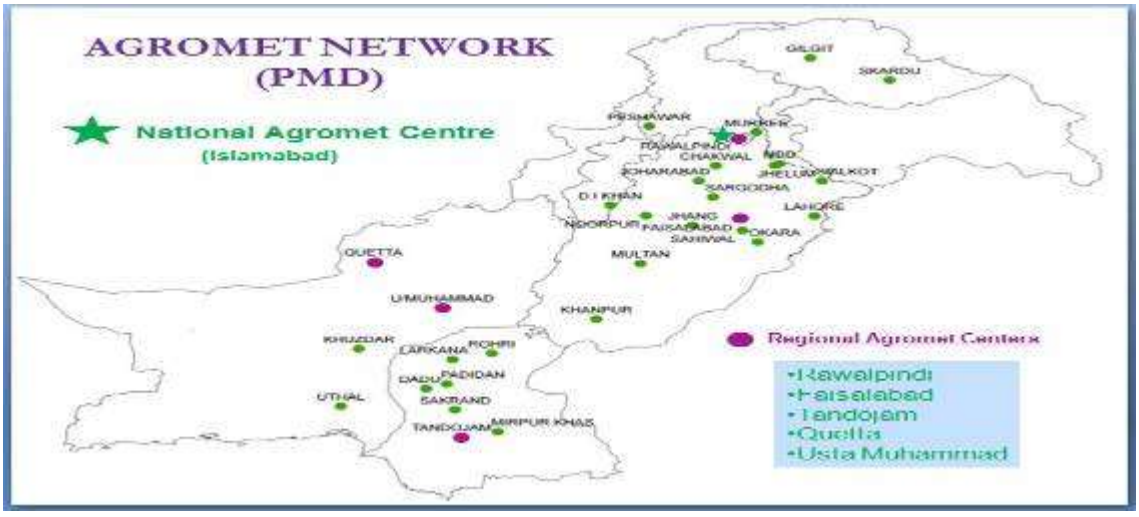


Figure 25: Agro met Network in Pakistan (PMD)

- ***NAMC* Products *for Farmers***

  ∗ At present NAMC is doing its best to produce valuable Agromet products for farming community throughout the country. It has made easier for farming community to take right decision before cultivation, harvesting, irrigation, fertilizer intake, spraying chemicals etc. It tries to inform in time the farming community before any bad weather like heavy torrential rains/flash flooding, wind storms, heat waves, frost etc. and also gives suitable guideline to farmers regarding any bad weather event.

  ∗ The NAMC network records data, three times a day, which is received at NAMC. This data is computerized after scrutiny into excel sheets in recommended formats for further use.

  ∗ This data is used to produce different Agromet products like Weekly/Decadal and Monthly Bulletins, regularly uploaded on NAMC web page for farming community. These Agromet bulletins inform farming community about present status of weather and crop water requirement and expected weather, crop water requirement, any possible water stress and any possible impact of expected weather on crops and livestock in the near future (through weekly and decadal bulletins) and for longer periods through monthly basis. Monthly bulletin is produced both in English and Urdu to make it easier to understand for farmers.

  ∗ Agromet data is also used to produce seasonal Agromet reports as input for decision makers like Federal Committee on Agriculture (FCA) and provincial agriculture departments on regular basis especially before cultivation of Rabi and Kharif crops.

  ∗ Agromet data is provided free of cost to agriculture related researchers and agriculture departments throughout the country. Different projects related to agriculture use Agromet data as input in various crop-yield models and crop water requirement models etc.

  ∗ Farming community is also guided through NAMC telephone service. NAMC network also guides the farming community through different seminars/workshops arranged by PMD/ agriculture universities/different NGOs.

GCF resources will expand the weather surveillance and discharge measuring networks by installing 50 automatic weather stations (AWS) and 408 river discharge gauges/sensors. These monitoring instruments will provide the requisite data to conduct hydrological modeling to generate flood scenarios that will feed into a flood early warning system to enable the dissemination of flashflood warning signals on a 24-hour basis. AWS and river discharge sensors will provide information to capacitate village hazard watch groups that will be part of a local-level early warning system. Small-scale hard adaptation structures will be constructed (gabion walls, spillways, check dams) to protect human lives and household's assets in combination with bioengineering interventions to stabilize slopes slides, reducing the risk of debris slides. In Pakistan EIAs are not required for smaller infrastructure projects. The protective capability of these structures will be amplified by additional resources channeled to the communities ex ante and following a GLOF event through the scale up of already established, revolving community-based disaster risk management fund. Pakistan Meteorological Department (PMD) will be custodian of the installed equipment, Survey, Site feasibility and operation and maintenance of the equipment will be responsibility of PMD. Below Table shows the cost per year against the number of equipment required to enable Early Warning System at full strength.

Table 21: Cost estimates of Met/EWS equipment

	Component	Relevant Activity (from Logframe)	Costs per Unit (US $)x 1000						Number of Units		
			Year 1	Year 2	Year 3	Year 4	Year 5	Total	KP	GB	Total
Early Warning System	**Weather Monitoring Stations**	**2.1.1**							**22**	**28**	**50**
	Equipment		100	300	300	300	200	1,200	**Cost given per year is cumulative of total number of equipments used per District (i.e. for 2 valleys) not individual cost**		
	Labor		30	90	90	90	60	460			
	Oper. & Maint.		100	300	300	300	200	1,200			
	River/Discharge Gauges/Lake Monitoring Devices	**2.1.2**							**170**	**238**	**408**
	Equipment		150	150	150	150	150	750			
	Labor		30	30	30	30	30	150			
	Oper. & Maint.		100	100	100	100	100	500			
	Communications	**2.1**									
	Communications		30	30	30	30	30	150			
	Satellite Communication										
	For Real Time Data		120	120	120	120	120	600			
	Assessment & Survey	**2.1**									
			60	60	60	60	60	300			

The project will facilitate the updating of river discharge and meteorological information into the Pakistan Meteorological Department (PMD) network to address the vulnerability of the identified target area and provide information for the development of an Early Warning System. The installation of 50 automatic weather stations (22 in KP and 28 in GB) and the installation of 408 river discharge gauges/sensors (170 in KP and 238 in GB), used to measure lake volume, flow and discharge rates, will provide data to conduct hydrological modeling to generate flood scenarios and to capacitate village hazard watch groups that will be part of a local-level early warning system. In addition, the capacity for processing, validating, and interpreting river discharge and meteorological information will be strengthened at the national (PMD), and at the department level by GB Disaster Management Authority (GBDMA) and KP Disaster Management Authority (KPDMA). PMD will integrate AWS as part of its networks, therefore it will cover M&O costs after the project has finalized.

The capacity to better analyze how climate changes causes floods caused by glacial lakes will also be strengthened at the local and regional levels of the Project will enable more accurate predictions for the intensity and breadth of GLOF, and for defining and implementing adaptation measures. The new automatic

weather stations will be part of the national network; thus, the stations will generate information that will also be useful outside of the project target area in assessing climate change, particularly in other areas of GB and KP.

The new automated stations will provide data at a significantly greater frequency, recording physical parameters (i.e. rainfall, wind, temperature, etc.) every minute, in all weather conditions, day and night all year around. The technology will also provide accurate and useful data on extremes in climate (i.e., maximum rainfall intensity, maximum wind gusts, etc.) for the development of an effective early warning system that will help decision-making aimed at saving lives and avoiding high economic losses from GLOF.

Indicative inputs for the above activity include:

- Installation of 22 weather monitoring stations in KP and 28 in GB: to collect meteorological data in the catchment areas in order to understand parameters with flood peaks.
- Installation of 170 river discharge gauges/ sensors in KP and 238 in GB: to collect river flood data in order to understand and predict flood peaks
- GBDMA and KPDMA provide extension to PMD on installation and maintenance of equipment

This hydro-meteorological equipment with communication system will collectively form the warningsystems. Although it is not possible for the system to reduce or obstruct or prevent a flood or disaster, the system, coupled with early warning communications, will have reduce the risk of loss.

- **Early warnings are effective in protecting communities from disasters:**

Existing flood early warning systems in the target area will be established to enable the dissemination of flash flood warning signals on a 24-hour basis. Information generated by AWS and river discharge gauges (170)/ sensors (22) will be used by Pakistan Metrological Department (PMD) to conduct hydrological modeling to generate flood scenarios and calculate GLOF lead time. GLOF hazard maps developed previously developed and updated hydrological modeling will be utilized to estimate the probable flood inundation sites and the alerts will be issued accordingly.

Therefore, the warning dissemination mechanism should be very effective to save the communities from the probable GLOF disaster. Moreover, the lead time will also be estimated with the help of hydrological modeling so that expected time for the inundation at particular location may be estimated. Vulnerable areas prone to GLOF will be ranked (High, Moderate and Slight Vulnerable) based on assigning weights to different characteristics of the lakes, such as **processes** and records of past events, geo-morphological and geo-technical characteristics of the lake with the help of hydrological modeling and different scenarios of flood inundation will be generated. For more information on the physical conditions of the surrounding area that may be considered before declaring a lake to be potentially dangerous.

AWS and river discharge gauges/ sensors information will be gathered and analyzed at the Main Control Room at PMD, where an analysis of thresholds for potential GLOF risks will be carried out, and were triggered, PMD will issue meteorological and hydrological alerts regarding possibilities of GLOF event in the target valleys. The communication channels for PMD to disseminate the alerts will be mobile phones (Call + SMS), sirens, FM Radio, Internet website (GLOF II Page). Most effective communication is GSM technology which is available in most of the valleys. However, where the GSM technology is not available, sirens or declarations from mosques are very common source of communications, moreover, satellite based communication.

- **Integration of climate information from the weather stations with satellite observations, etc. to release agro-meteorological products, multi-hazard EWSs, etc.:**

The data received from the installed stations in the target area will be converted into meaningful and useful information, especially in a language with is more receptive to the local communities. The prevailing situation of the weather in the area coupled with the real time data analysis from the area will be helpful in generating alerts under EWS developed and accordingly local authorities and communities. This coupling of weather models analysis with local conditions of the prevailing weather will also help in minimizing false alerts and thus built trust of the local authorities and community on the alert issuing authority.

The established EWS will facilitate government and people about the weather forecast and issue alerts in case of expected severe weather events. The generation of three days advanced forecast for the whole Gilgit Baltistan Region. The Alerts/warning services on GLOF will be issued in case of heavy rains or persistent high temperatures. Gilgit Baltistan authorities will have immediate coordination and communication with the PMD's office in the presence of effective communication and information dissemination system. In this regard the local field offices will play an important role being liaison at the local level. The dissemination of information and educational knowledge which is extremely necessary to cope with a natural disaster will be readily available from this local liaison office. This office will fill the gap of weaknesses raised due to effective communication, coordination and dissemination of weather information in the area. This office will create a link with inline departments and related private organizations/ NGOs to effectively address the natural disasters.

Table 22: Cost estimates for infrastructure activities

	Component	**Relevant Activity (from Logframe)**	**Costs per Unit (US $)x 1000**						**Number of Units**		
			Year 1		Year 2	Year 3	Year 4	Year 5	Total	KP	GB	Total
Other DRM	**Community Disaster Training**	**2.3.2**							**40**	**77**	**117**	(Villages)
	Labor		234	234	234	234	234	1,170				
	Hazard Watch Group Training	**2.2.2**							**40**	**77**	**117**	(Villages)
	Labor		234	234	234	234	234	1,170				
	Hydrological Modeling	**2.2.1**							**10**	**14**	**24**	(Valleys)
	Labor		60	60	60	60	60	300				
	Community Disaster Fund	**2.4.1**							**10**	**14**	**24**	(CBDRMCs)
	Endowment		100	300	300	300	200	1,200				

G. Restoration of degraded Forests:

- **Purpose and scope of *Ecosystem* restoration:**

Two common motivations/purposes for ecosystem restoration are: (1) the improvement of the environment and accompanying natural resources (i.e., environmental benefits) and (2) the provision of "the benefits people obtain from ecosystems" (i.e., ecosystem goods and services). Although this distinction may appear semantic, ecosystem goods and services are ecosystem structures and functions that are of benefit to or otherwise demanded by humans. Environmental improvement may be gauged through changes in both ecosystem structure and function.

Overgrazing, disasters, climate change, drought and human disturbances caused severe degradation of rangelands in Northern Parts of Pakistan. The degradation processes of rangelands include changes in composition of desirable species, decrease in rangeland bio-diversity and productivity, reduction of perennial plant cover, and soil erosion leading to floods.

The need for an effective and low cost forest and biodiversity restoration and rehabilitation methods is now highlighted in the face of climate change and the global phenomenon of rapid loss of forests and biodiversity. An estimated 850 million hectares of degraded forests exist globally.

In Pakistan forest cover is declining at a rate of 2.1% due to various reasons. Conifer forest, mostly located in northern glaciated parts of the country are declining at rate of 1.3% per annum since 1992 due to different reasons associated with climate change i.e. temperature rise and variability in rains (Shiekh.S.A, 2012).

The task of forest restoration and rehabilitation of degraded forest is especially daunting for developing countries with inadequate financial resources required for the rehabilitation of critical areas to bring back lost biodiversity and ecosystem services. Keeping this in view low cost techs like Assisted Natural Regeneration (ANR) of forests, are preferable for regeneration of degraded forest in developing country like Pakistan.

ANR is a method for enhancing the establishment of secondary forest from degraded grassland, forests and shrub vegetation by protecting and nurturing the mother trees and their wildlings inherently present in the area. ANR aims to accelerate, rather than replace, natural successional processes by removing or reducing barriers to natural forest regeneration such as soil degradation, competition with weedy species, and recurring disturbances (e.g., fire, grazing, and wood harvesting). Seedlings are, in particular, protected from undergrowth and extremely flammable plants. In addition to protection efforts, new trees are planted when needed or wanted (enrichment planting). With ANR, forests grow faster than they would naturally. Besides, bioengineering structures will be used to

Engineered re-vegetation to stabilize denuded mountain slope sides and mitigate the risks from land and debris slides, the project will also promote reforestation within valleys to provide for sustainable livelihood activities and restore other ecosystem services.cost.

I. Infrastructure works:

- **Rationale and purpose:**

Addressing the role disasters play in perpetuating the cycle of poverty and in undermining development is increasingly being recognized as a major global challenge that demands attention. Approximately 70% of recent disasters are weather-related and this proportion is likely to grow as climate change processes increase the unpredictability and intensity of weather events.

Broad consensus exists on the need for implementing a wide variety of DRR techniques, ranging from designing physical structures to fostering the growth of social networks and institutions, which could potentially mitigate or alter the nature of the risk.

In Disaster and particularly in flood management, there are two types of measures that can be used: structural and non-structural. Experience has shown that the common strategy to cope with floods has been the implementation of the former whereby civil works such as floodwalls, transversal protection works, embankments, gabions conduits and reservoirs, have been constructed to protect the built-in environment up to an acceptable risk threshold. Structural measures tend to mainly consider the hydrological and hydraulic implications of flooding.

Such types of structure prove extremely useful in protecting habituated areas, communication networks (roads & trails) and above all livelihood means (agricultural land) against high level of waters during flooding times, preventing year-round undercutting of edges and water intrusion into settled areas; and soil conservation.

In hilly areas/glaciated areas like northern parts of Pakistan, where due to steep gradients of slopes (50-60%), flood water comes down at a high velocity construction of gabions, floodwalls, check dams etc. of different typology and dimensions play a role of shock absorber for floods and reducing disaster risks to lives and livelihood means. There are numerous success stories of role of such structures throughout in northern Pakistan. During project duration of previously implemented Pakistan GLOF Project such measures were constructed in target sites of the project on the request of local communities. These structures acted as first line of defense during the worst flooding of 2015 and reduced significantly the disaster risks. The same was highly acknowledged in local and national media (http://www.chitraltoday.net/bindo-gol-flooding-glof-project-interventions-minimized-losses/). In the meantime, keeping in view the successes of the project interventions communities from other disaster prone areas also approached the project (previous) for needed technical and financial support to construct protective measures in their respective areas as well. However, due to limited financial resources and short timeframe of the project it could not be accomplished.

There is a strong need for construction of such structures in more disaster prone areas for the dual purposes of reducing disaster risks to lives and livelihood and maintaining the integrity of ecosystem.

The total area of proposed plantations has been determined according to what is feasibility with the availability of resources through GCF funds. The need for reforestation is extremely high as most of the watershed areas of GB and KP are without vegetation. Reforestation through water harvesting has been demonstrated in Bagrote and Bindo Gol valleys through the ongoing GLOF project. Based on successfully reforested land area in the ongoing GLOF project, the above proposed reforestation is determined to be feasible.

Small-scale hard adaptation structures will be constructed, expanding on the design of the pilot project activities carried out in GLOF I project financed by the Adaptation Fund. In May 2014, a gabion wall built during that project proved successful in protecting the houses, agricultural land, livestock and orchards of 1,350 people in Chira village in Bagrote Valley of GB during a GLOF event.

Gabion walls reinforce spillway banks and protect villages and property from flooding and erosion. Both gabion spurs and check dams retard the velocity of outburst flood waves, attenuating its destructive force and providing greater lead time for communities to prepare and evacuate. Gabion spurs are permeable structures constructed perpendicular from the bank, extending into the stream. Check dams extend across the entirety of the stream and can be constructed from different material (gabion material, dry masonry, and vegetation/soil) depending on the particular conditions and size of each spillway site. Small additional spillways will be constructed near the glacial lake outlet to regularly drain and divert excess water, helping to prevent the buildup of pressure from meltwater accumulation that can lead to an outburst flood. The exact size, specifications and placement of each of these protective structures is dependent on the particular conditions of each lake, outlet stream, and valley. Detailed design and environmental and social safeguard assessments will be undertaken

prior to installation. None of the hard structure will be of a significant size to warrant EIAs (these will be low to medium risk activities). The protective capability of these structures is amplified when used in concert with additional risk mitigation measures, such as slope stabilization through bioengineering.

A major risk related to climate change in the region is increased probability of land and debris slides, produced by intensification of acute rainfall events and cloudbursts. Debris slides can also be both an effect of glacial lake outbursts, resulting from reduced slope stability due to bank erosion and flood scars, and a cause, as occurred when a major landslide blocked the outlet of the glacial-fed Attabad Lake in Hunza District, GB, in January 2010, leading to flooding of the Karakoram Highway and five upstream villages.

Many slope sides in vulnerable valleys have been denuded of vegetation, increasing the risk of a slide. Bioengineering helps stabilize slopes at risk through reforestation and vegetation, reinforcing the structural integrity of slope sides and increasing their shear resistance. Because many slopes were degraded due to human exploitation of vegetation, this activity will be linked to the sustainable land and pasture management plan (Input 3.1.2) to ensure that the vegetative cover and the stabilization it provides will be maintained in the long term. Choosing local indigenous species for re-vegetation will help conserve and restore natural ecosystems in the project area, and sustainable harvest of those with economic value contributes to income generation. During the pilot project, demonstration sites were established for slope stabilization through these bioengineering techniques in two locations. These demonstration sites will be used to train communities and local support organizations from the 12 districts included in this project.

Indicative inputs for the above activity include:

DRM Committees and emergency response cells are expanded to act as first responders and manage drills and simulations.

GBDMA and KPDMA train communities and DRM committees on disaster preparedness and response.

Construction of 250 small infrastructure to reduce risks of floods (gabion walls, check dams, spillways).

- **Designs and dimensions of Gabion wall (prototype):**

Designs and cost estimates of prototype various physical structures are given below:

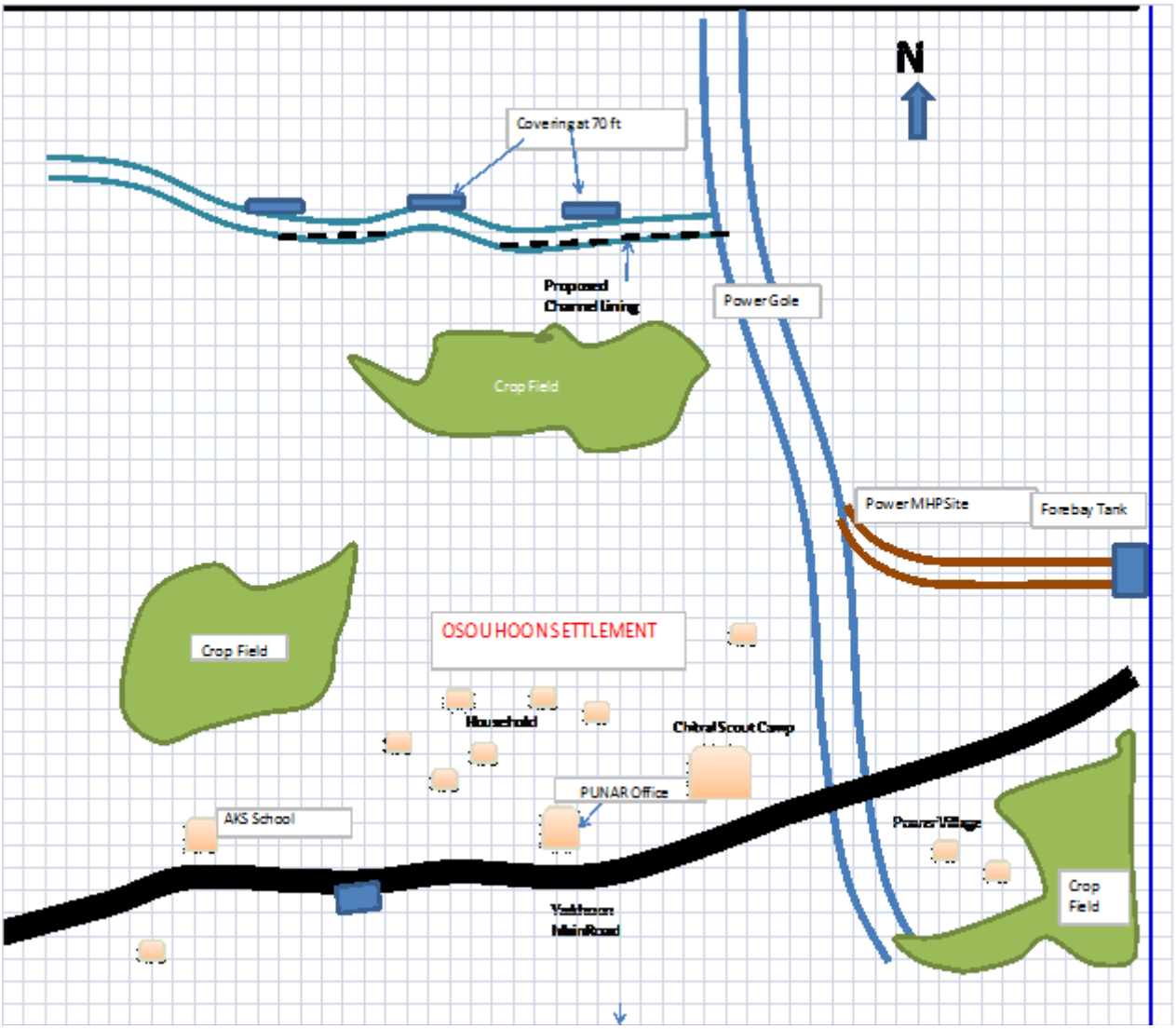


Figure 26: Layout of proposed floodwalls (gabion) for channel protection

X-Section of the Proposed Gabion

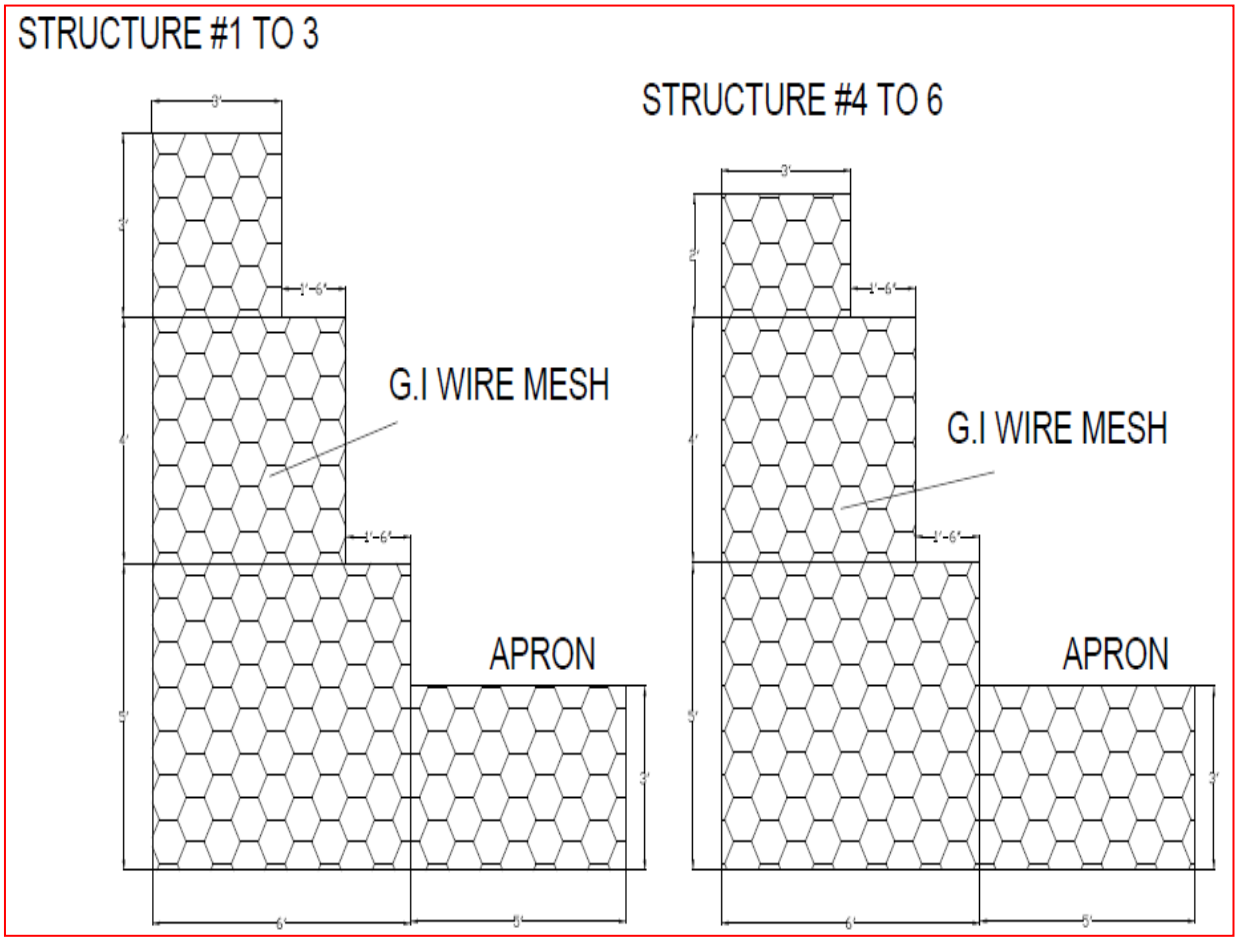


Figure 27: Design of gabion wall

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Table 23: Cumulative cost estimates for infrastructure activities

	Component	Relevant Activity (from Logframe)	Costs per Unit (US $)x 1000						Number of Units			
			Year 1	Year 2	Year 3	Year 4	Year 5	Total	KP	GB	Total	
Protective Mitigation Structures	**Gabion Walls**	**2.3.3**							**45**	**63**	**108**	(Number)
	Equipment		648	648	648	648	648	3,240				
	Labor		108	108	108	108	108	540				
	Oper. & Maint.		108	108	108	108	108	540				
	Check Dams	**2.3.3**							**20**	**28**	**48**	(Number)
	Equipment		9.6	9.6	9.6	9.6	9.6	48				
	Labor		1.450	1.450	1.450	1.450	1.450	7.250				
	Oper. & Maint.		4.8	4.8	4.8	4.8	4.8	24				
	Spillways	**2.3.3**							**10**	**14**	**24**	(Number)
	Equipment		192	192	192	192	192	960				
	Labor		24	24	24	24	24	120				
	Oper. & Maint.		12	12	12	12	12	60				
	Slope Stabilization	**2.3.4**							**10**	**14**	**24**	(Valleys)
	Equipment/Vegetation		720	720	720	720	720	3,600				
	Labor		72	72	72	72	72	360				
	Drip Irrigation/Sprinklers	**3.1.1**							**625**	**875**	**1,500**	(Hectares)
	Equipment		450	450	450	450	450	2,250				
	Labor		45	45	45	45	45	225				
	Oper. & Maint.		35	35	35	35	35	175				

- **Cost Estimates of Gabion Wall (prototype):**

Table 24: Cost analysis for Gabion floodwall

Technical Specifications of Gabion								Analysis of labors and Construction Materials						
Sub-Task#	**Description**	**Length**	**Width**	**Height**	**No**	**Qty/Area/No**	**Unit**	**Skilled Labor M-Days**	**Un-skilled labor M-Days**	**Stone (cft)**	**GI Wire (kg)**	**Blasting No**	**Tools & Implements**	**Sign Board**
#1	**Structure #1 & 2(50ft each)**													
1.1	**Excavation**	100	11.00	6	1	**6,600**	Cft		143			20		
1.2	**RRM Dry 70% & 30% stone filling in wire crates**													
	1st Step	100	6.00	5	1	3,000	Cft							
	2nd Step	100	4.50	4	1	1,800	Cft							
	3rd step	100	3.00	3	1	900	Cft							
	Apron	100	5.00	3	1	1,500	Cft							
	Sub-total (1.2)					**7,200**	**Cft**							
	RRM Dry 70% in wire crates					**5,040**	**Cft**	78	110	5,040				
	Stone filling 30% in wire crates					**2,160**	**Cft**		22	2,160				
1.3	**Steel wire crates 8SWG-A Class Galvanized, mesh size**													

Technical Specifications of Gabion								Analysis of labors and Construction Materials						
Sub-Task#	**Description**	**Length**	**Width**	**Height**	**No**	**Qty/Area/No**	**Unit**	**Skilled Labor M-Days**	**Un-skilled labor M-Days**	**Stone (cft)**	**GI Wire (kg)**	**Blasting No**	**Tools & Implements**	**Sign Board**
	6"*6"													
	1st step, Top, Bottom & both sides	100		22	1	2,200	Sft							
	2nd step, Top, Bottom & both sides	100		17	1	1,700	Sft							
	3rd step, Top, Bottom & both sides	100		12	1	1,200	Sft							
	Apron	100		16	1	1,600	Sft							
	Ends													
	1st Step		6.00	5	4	120	Sft							
	2nd Step		4.50	4	4	72	Sft							
	3rd step		5.00	3	4	60	Sft							
	Apron		5.00	3	4	60	Sft							
	Sub-Total (1.3)					**7,012**	**Sft**	47	47		1,402			
#2	**Structure #3**													
2.1	**Excavation**	100	8.50	10	1	**8,500**	Cft		185			18		
2.2	**RRM Dry 70% & 30% stone filling in wire crates**													
	1st Step	100	6.00	5	1	3,000	Cft							
	2nd Step	100	4.50	4	1	1,800	Cft							
	3rd step	100	3.00	3	1	900	Cft							
	Apron	100	5.00	3	1	1,500	Cft							
	Sub-total (2.2)					**7,200**	**Cft**							

Technical Specifications of Gabion								Analysis of labors and Construction Materials						
Sub-Task#	**Description**	**Length**	**Width**	**Height**	**No**	**Qty/Area/No**	**Unit**	**Skilled Labor M-Days**	**Un-skilled labor M-Days**	**Stone (cft)**	**GI Wire (kg)**	**Blasting No**	**Tools & Implements**	**Sign Board**
	RRM Dry 70% in wire crates					**5,040**	**Cft**	78	110	5,040				
	Stone filling 30% in wire crates					**2,160**	**Cft**		22	2,160				
2.3	**Steel wire crates 8SWG-A Class Galvanized, mesh size 6"*6"**													
	1st step, Top, Bottom & both sides	100		22	1	2,200	Sft							
	2nd step, Top, Bottom & both sides	100		17	1	1,700	Sft							
	3rd step, Top, Bottom & both sides	100		12	1	1,200	Sft							
	Apron	100		16	1	1,600	Sft							
	Ends													
	1st Step		6.00	5	4	120	Sft							
	2nd Step		4.50	4	4	72	Sft							
	3rd step		5.00	3	4	60	Sft							
	Apron		5.00	3	4	60	Sft							
	Sub-Total (2.3)					**7,012**	**Sft**	47	47		1,402			
#3	**Structure #4,5 &6(60ft**													

Technical Specifications of Gabion								Analysis of labors and Construction Materials						
Sub-Task#	**Description**	**Length**	**Width**	**Height**	**No**	**Qty/Area/No**	**Unit**	**Skilled Labor M-Days**	**Un-skilled labor M-Days**	**Stone (cft)**	**GI Wire (kg)**	**Blasting No**	**Tools & Implements**	**Sign Board**
	each)													
3.1	**Excavation**	180	8.50	10	1	**15,300**	Cft		333			31		
3.2	**RRM Dry 70% & 30% stone filling in wire crates**													
	1st Step	180	6.00	5	1	5,400	Cft							
	2nd Step	180	4.50	4.0	1	3,240	Cft							
	3rd step	180	3.00	2	1	1,080	Cft							
	Apron	180	5.00	3	1	2,700	Cft							
	Sub-total (3.2)					**12,420**	**Cft**							
	RRM Dry 70% in wire crates					**8,694**	**Cft**	134	189	8,694				
	Stone filling 30% in wire crates					**3,726**	**Cft**		37	3,726				
3.3	**Steel wire crates 8SWG-A Class Galvanized, mesh size 6"*6"**													
	1st step, Top, Bottom & both sides	180		22	1	3,960	Sft							
	2nd step, Top, Bottom & both sides	180		17	1	3,060	Sft							

Technical Specifications of Gabion								Analysis of labors and Construction Materials						
Sub-Task#	**Description**	**Length**	**Width**	**Height**	**No**	**Qty/Area/No**	**Unit**	**Skilled Labor M-Days**	**Un-skilled labor M-Days**	**Stone (cft)**	**GI Wire (kg)**	**Blasting No**	**Tools & Implements**	**Sign Board**
	3rd step, Top, Bottom & both sides	180	10		1	1,800	Sft							
	Apron	180	16		1	2,880	Sft							
	Ends													
	1st Step		6.00	5	6	180	Sft							
	2nd Step		4.50	4	6	108	Sft							
	3rd step		5.00	2	6	60	Sft							
	Apron		5.00	3	6	90	Sft							
	Sub-Total(3.3)					**12,138**	**Sft**	81	81		2,428			
#4	**Tools and Implements**					**1**	**No**						1	
#5	**Sign Board**					**1**	**No**							1
	Total Quantity							**465**	**1,326**	**26,820**	**5,232**	**69**	**1**	**1**

- **Designs, dimensions and cost estimate/analysis of a sample Spur:**

  Spurs are usually constructed to shift the power of the river or regulate the flow to prevent undercutting of the river edges and subsequent damages to surrounding settle areas or lands. In recent years due to rapid and increased melting of glaciers in northern areas average flow of

  Water in rivers have increased on seasonal basis. This increase flow often results in riverine floods of severe nature. Roads networks, agricultural lands etc. are washed away as a result. Design and plan of typical spur is given below:

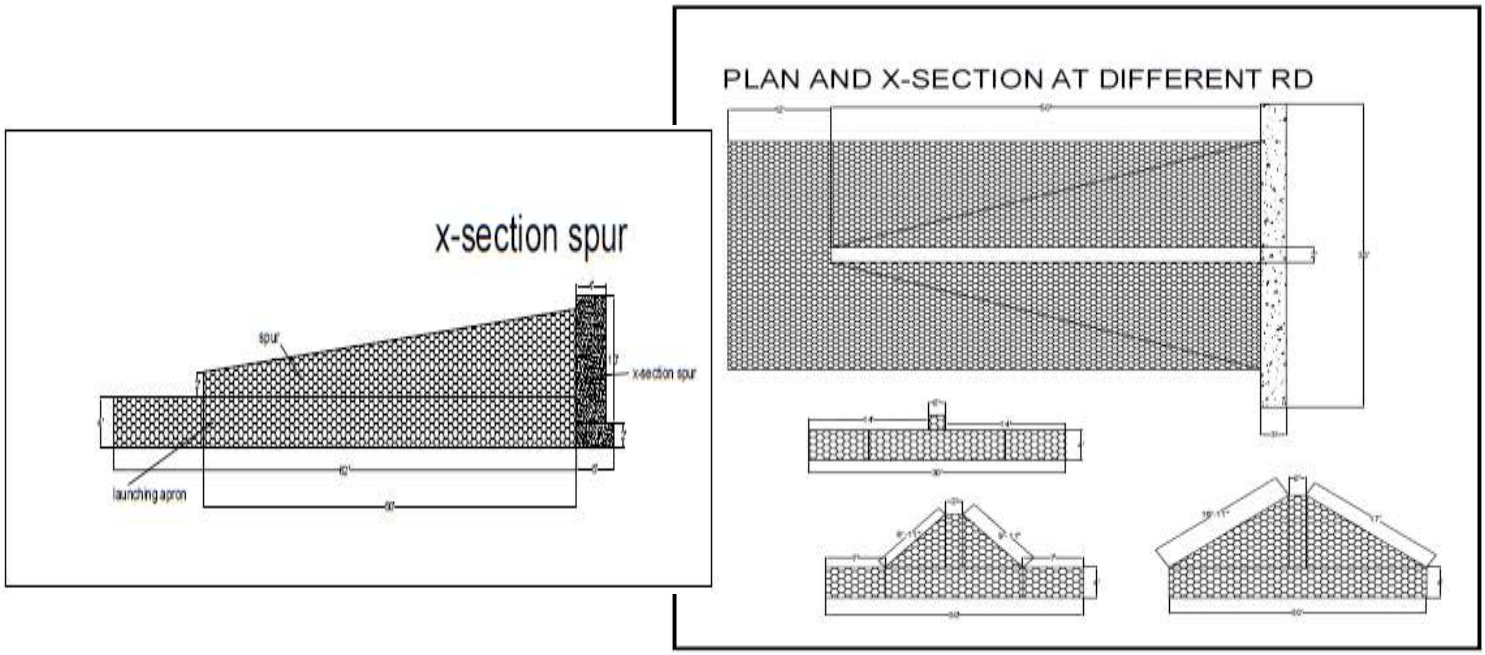

Figure 28: Design and plan of Diversion Spur:

Table 25: Technical specification and cost estimates for diversion spur:

Technical Specifications of Spur								Analysis of labors and Construction Materials											
Sub-Task#	Description	L	Width	Height	No	Qty/Area/No	Unit	Skilled Labor M-Days	Un-skilled labor M-Days	Excavator Hrs	Cement (Bag)	Sand (Cft)	Gravel (Cft)	Stone (cft)	GI Wire (kg)	Blasting No	Tools & Implements	Shuttering	Sign Board
#1	**Structure#1, Spur**																		
1.1	**Excavation for spur body**	30	6.00	4	1	720	Cft		4	1						4			
1.2	**Plum Concrete (1:3:6) 50% stone**																		
	1st Step in foundation	30	5.00	2	1	300	Cft												
	2nd Step (Body of Spur)	30	4.00	12	1	1,440	Cft												
	Sub-total (1.2)					1,740	Cft	27	70		107	401	802	870					
1.3	**Excavation for spur**	62	32.00	4	1	7,936	Cft		43	10						40			
1.4	**Lunching Apron & Spur structure made by Gabion**																		
1.4.1	RRM Dry 70% & 30% stone filling in wire crates																		
	Lunching Apron I	10	15.00	4	10	6,000	Cft												
	Lunching Apron II	10	6.00	4	6	1,440	Cft												
	Block 1	26	93		1	2,406	Cft												
	Block 2	26	22		1	580	Cft												
	Sub-total (1.4.1)					**10,426**	**Cft**												
	RRM Dry 50% in							80											

	wire crates					**5,213**	**Cft**		116					5,213					
	Stone filling 50% in wire crates					**5,213**	**Cft**		52					5,213					
1.4.2	**Steel wire crates 8SWG- Galvanized, mesh size 6"*9"**																		
	Lunching Apron-I	10	38		10	3,800	Sft												
	Lunching Apron-I	10	20		6	1,200	Sft												
	Block 1, Top, Bottom & both sides	26	50		1	1,300	Sft												
	Block 2, Top, Bottom & both sides	26	22		1	572	Sft												
	Ends																		
	Lunching Apron-I		60		20	1,200	Sft												
	Lunching Apron-II		24		12	288	Sft												
	Block 1		93		2	185	Sft												
	Block 2		22		2	45	Sft												
	Sub-total (1.4.2)					**8,590**	**Sft**	57	57						1,976				
	Total Quantity							**164**	**342**	**11**	**107**	**401**	**802**	**11,296**	**1,976**	**44**	**-**	**-**	**-**

Table 26: Cost summary of diversion spur:

Cost summary					
S.No	**Items**	**Unit**	**Quantity**	**Unit Rate**	**Cost**
1	Skilled Labor	Man Days	164	1000	164000
2	Un Skilled Labor	Man Days	342	400	136800
3	Excavator	Hours	11	4500	49500
4	Cement	Bag	107	860	92020
5	Sand	Cft	401	60	24060
6	Gravel	Cft	802	60	48120
7	Stone	Cft	11296	45	508320

8	G.I Wire	Kg	1976	125	247000
9	Blasting	No	44	400	17600
10	Tools and Implements	LS	0	45000	0
11	Shuttering	LS	0	40000	0
12	Sign Board	No	0	10000	0
	Total Cost				**1287420**
	Supervisory Cost(4% of total cost)				**51497**
	Grant Total				**1338917**
	Community Share(7% of Grant Total)				**93724**
	GLOF Project Share				**1245193**

- **Check dams and different types of bioengineering structures:**

In mountainous areas the slope are often very steep and in times of rain water run down the slope at a very high speed leading damages to soil erosion and posing serious threats to downstream communities. Major of the floods in these areas of this typology. There is a dire need of slope stabilization and prevent erosion of soil leading to habitat degradation through employing check dams and other biological structures. Cost estimates of a representative check dam and some bioengineering structures are given below:

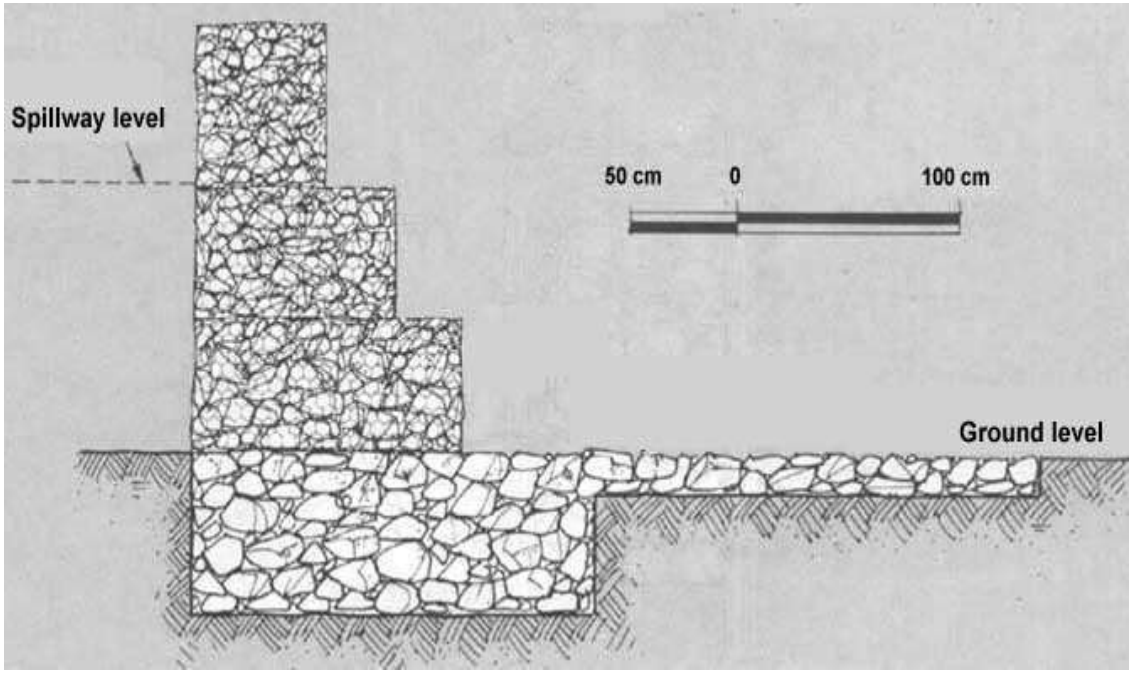

Figure 29: Design of Check dam:

Table 27: Specification and cost estimates for check dams and bioengineering structures:

Cost estimates:					
Gabion Check dams -1					
Length	**Width**	Hight	Volume	Unit cost	Cost
First layer					
30	**6**	**3**	540	110	59400
Second layer					
40	**6**	**3**	720	110	79200
Third layer					
40	**6**	**3**	720	110	79200
Fourth layer					
45	**4**	**3**	540	110	59400
Free board					
25	**3**	**3**	225	110	24750
Apron					
30	**4**	**2**	240	110	26400
Vegetated Pole check dam					
16	4	5	320	40	12800
Vegetated brush wood check dam					
20	3	6	360	40	14400
Vegetated Loose stone check dam -1					
14	4	5	280	35	9800
8	4	4	128	35	4480
Vegetated loose stone wall along the road crossing the stream					
48	4	4	768	35	26880
Vegetated soft gabion wall along the channel below the landslide					
120	3	10	3600	40	144000

Staking below the soft gabion wall					
No. of stakes			120	10	1200
Vegetated soft gabion & stone wall below the Channel					
15	3	10	450	40	18000
Brush layering (length)			350	40	14000

- **Design, dimensions and cost estimates for Irrigation Channel:**

Irrigation channel are the life line of Pakistan especially the extreme northern glaciated areas in Pakistan. Pakistan has one of the world's most extensive irrigation systems. In northern Pakistan where other means of irrigation are neither available nor feasible, irrigation channels remain the most effective and dominant source of water supply. In these areas nearly 100% agriculture irrigation is carried out by irrigation channels. Irrigation channels are also used to meet in-house requirements of water supply including drinking, livestock feeding, washing etc. During past disasters nearly 80% of the irrigation channels were destroyed.

Irrigation channel are by virtue of their location and loose structural composition are highly vulnerable recurrent floods in streams. Heads of all irrigation channels are located inside the channels in mountainous areas and are protected by soft/loose stone masonry work. Even minor floods result in heavy damages to irrigation channels in these areas and disruption of water supply. During 2010, 2011 and 2015 floods standing crops mostly destroyed indirectly due to disruption of water supply. This situation demands that heads of the irrigation should be strengthened with reinforced concrete structures to minimize damages chances and ensure continued supply of water to communities.

Design, layout and cost estimates for proposed structure to make irrigation channels disaster resistant are given as:

Table 28: Cost analysis for irrigation channel headwork

Technical Specifications of Head Work	Analysis of Labors and Construction Materials

Sub-Task#	Description	L	Width	Height	No	Qty/Area/No	Unit	Skilled Labor	Un-skilled labor	Cement	Sand	Gravel	Stone	Steel	GI Wire	Blasting	Shuttering	Tools & Implements	Sign Board
1.0	**Structure#1**																		
1.1	**Excavation for Plum Concrete**	70	5.0	4	1	**1,400**	**ft**		30							7			
1.2	**Plum concrete 1:2:4 (60% Stone&40% Concrete)**																		
1.2.1	**Ist Step**	70	2	1	1	140	Cft												
	Sub-total (1.2)					**140**	**Cft**	2	6	10	25	50	84						
	Labor for Shuttering					**140**	**Cft**	1	1										
2.0	**Structure#2**																		
2.1	**Excavation for Head Protection Work**	70	10.0	5	1	**3,500**	**Cft**		76							25			
2.2	**Plum concrete 1:2:4 (60% Stone&40%Concrete)**																		
2.2.1	Ist Step	70	4.0	5	1	1,400	Cft												
2.2.2	2nd Step	70	3.00	4.0	1	840	Cft												
2.2.3	3rd Step	70	2.00	3	1	420	Cft												
	Sub-total (2.2)					**2,660**	**Cft**	41	106	187	468	936	1,596						
	Labor for Shuttering					**2,660**	**Cft**	1	1										

2.3	**RRM Dry 70% & 30% stone filling in wire crates**																		
	Apron	70	4.00	3	1	840	Cft												
	RRM Dry 70% in wire crates					**588**	**Cft**	9	24				588						
	Stone filling 30% in wire crates					**252**	**Cft**		3				252						
2.4	**Steel wire crates 8SWG-A Class Galvanized, mesh size 6"*6"**																		
	Apron																		
	Apron top Buttom and Both Sides	50	14.00		1	700	Sft												
	Ends of Apron		4.00	3	2	24	Sft												
	SubTotal(2.4)					**724**	**Sft**	5	5						145				
3.0	**Widening of Channel**																		
3.1	**Rock Cutting**	**100**	**1.00**	**1**	**1**	**100**	**Cft**		7							90			
4.0	**RCC Covering**					**-**													
4.1	RRM Dry as Side wall	35	3.00	3.00	2	630	Cft	14	28				630						
4.2	RCC(1:2:4)	35	3.00	0.50	1	53	Cft	1	2	9	23			117					
#5	**Shuttering**				1	**1**	**LS**										1		
#6	**Tools & Implements**				1	**1**	**LS**											1	
#7	**Sign Board**				1	**1**	**LS**												1
	Total							**74**	**289**	**206**	**516**	**986**	**3,150**	**117**	**145**	**122**	**1**	**1**	**1**
Cost summary																			

S.No	Items	Quantity	Unit	Unit Rate	Cost
1	Skilled Labor	74	Man-Days	1000	74000
2	Un-skilled labor	289	Man-Days	450	130050
3	Cement	206	Bags	785	161710
4	Sand	516	Cft	25	12900
5	Gravel	986	Cft	25	24650
6	Stone	3150	Cft	45	141750
7	Steel	117	Kg	110	12870
8	GI Wire	145	Kg	135	19575
9	Blasting	122	No	700	85400
10	Shuttering	1	LS	40000	40000
11	Tools & Implements	1	LS	35000	35000
12	Sign Board	1	No	10000	10000
	Total Cost				**747,905**
	Supervisory Cost (5% of Total Cost				**37,395**
	Grand Total				**785,300**
	Community Share (7% of Grand Total)				**54,971**
	GLOF Project Share				**730,329**

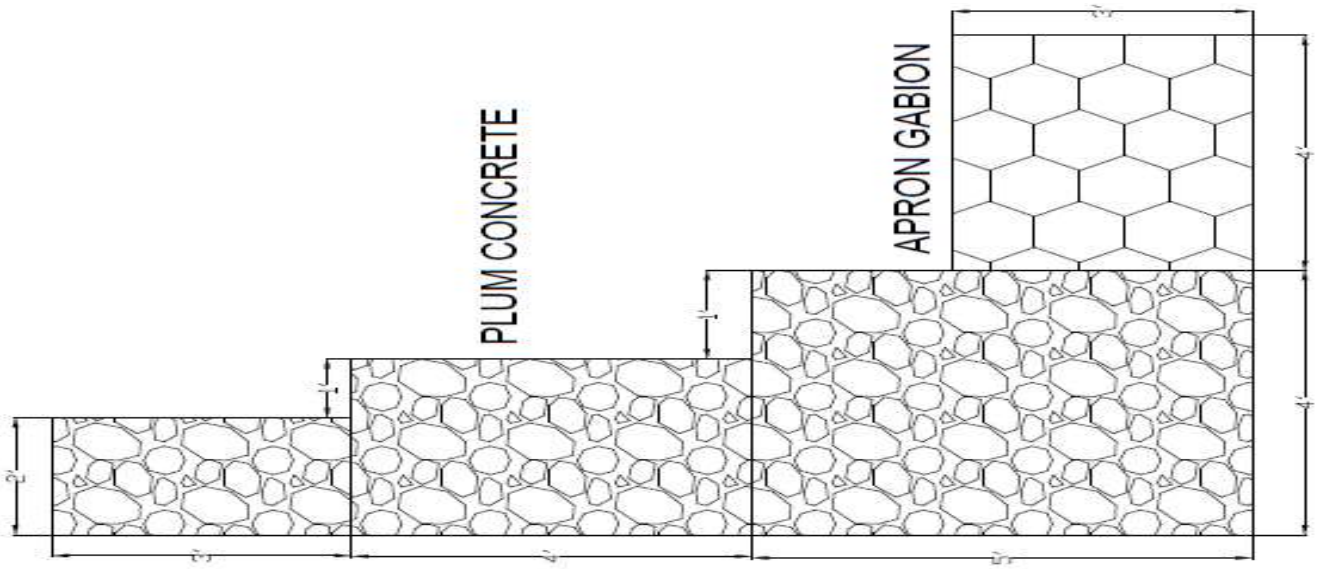

Figure 30: Design of soft/loose stone check dam:

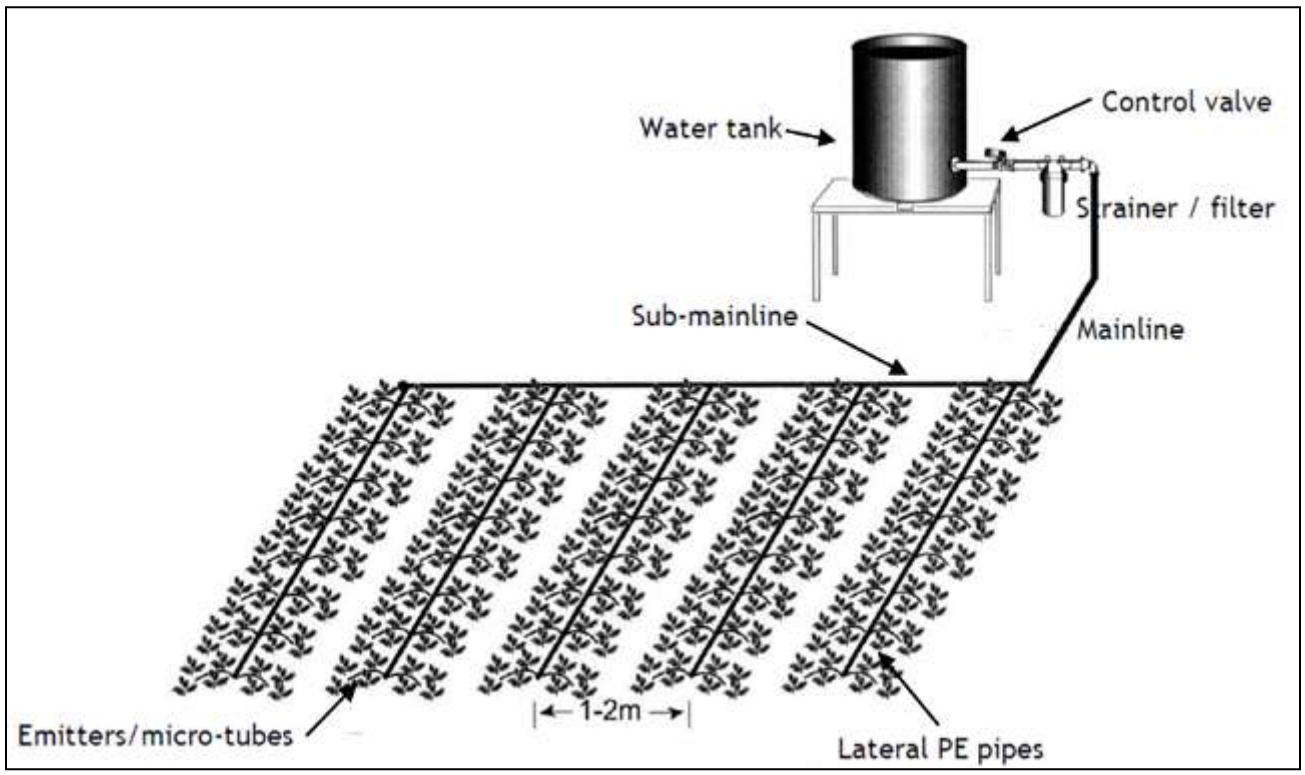

Figure 31: Layout of drip irrigation system:

Figure 32: Accessories for Drip Irrigation:

1.2 Sustainability of Proposed Interventions:

Sustainability means providing long-term solutions to stakeholders' needs that the beneficiaries can maintain after the end of the project. For this to happen, the project during its duration will undertake measures to ensure that sustained human and financial resource are mobilized for continuation of activities in post-project scenario. Climate change induced disasters are multifaceted in nature. As such multidimensional approach will be adopted to provide, political, financial, institutional, Environmental and technical sustainability of the adaptation activities in future.

A. Integration of relevant stakeholders in DRR activities:

DRR activities need coordinated efforts among all the stakeholders including communities, departments (GOs/NGOs) private sector. To ensure this community based organizations for DRR will be established or existing Community Based Organizations (CBOs) will be established and strengthened at local level. At district level a Forum (District DRR Forum) comprising of district administration, Local Bodies and relevant organizations will be established to provide needed support to project and local communities. The practical integration of stakeholders in the planning, implementing and monitoring levels of activities will better place them to understand and continue activities in future.

B. Infrastructure and community based Adaptation measures:

In rural mountain communities like Northern Pakistan, maintenance/repair of irrigation channels, in valley roads/routes/walking trails, etc are the priority responsibilities of local communities. Support will be provided to communities at local to stockpile needed equipment for repair and maintenance work. Home gardening/kitchen gardening are mostly by womenfolk to supplement their in-house nutritional needs and save some income. Local community based organization especially women organizations will be linked with concerned organization. Besides, training will be organized to refine the skills of communities in kitchen gardening. At present communities in the previous target areas managing DRR activities and running Disaster Risk Management Cells at their own successfully.

B. Political Sustainability:

Political sustainability ensured through government commitment, development of relevant framework and policies/legislation, and advocacy and lobbying.

C. Social Sustainability:

Social acceptability/ownership is one of main pillars of sustainability. To ensure this acceptance communities will be organized, sensitized and mobilized at grassroots level to get involved in activity planning, implementing and monitoring activities. Community commitment will be ensured through ensuring community contribution (in kind or in cash) to the cost of community level initiatives.

D. Institutional Sustainability:

Existing relevant institutions at government level (District, provincial and national levels) will be strengthened, logistically and technically, to plan and implement DRR activities at their own even after the expiry of project's timeframe. At community level institutions (DRR Committees and village level watch groups) will be established and strengthened to carry forward the mandate of integrated DRR initiatives during and after project's life. Relevant Letter of Agreements (LoAs) and Terms of Partnerships (ToPs) will be drafted and signed with communities and concerned government departments.

E. Financial/economic sustainability:

Constant investment in DRR activities is mandatory for their sustainability, especial at community Level. A community level (for each valleys) Disaster Risk Management Fund will be established to provide continued support to community DRR institutions and risk management activities. Financial sustainability for the climate-resilient land-use and water management techniques and restoring forest ecosystems services targeting subsistence farmers, women and community members, will be achieved through their active participation and ownership during implementation. Improved production yields at the farm level will provide additional gains that will be partially reinvested as way to contribute to the sustainability of the interventions; to this end, the project will establish agreements with the property owners that will specify their responsibilities in maintaining the adaptation measures established through the project.

F. Technical sustainability:

Human capacity of relevant departments and local communities will be developed through trainings and exposures to refine their skills in DRR, organizational management, maintenance of equipments, data collection and generation of resources for DRR activities. A five (5) year Disaster Risk Management Plan (DRMP) will be developed for individual Districts and valleys to provide guidelines to streamline and continue DRR activities in future.

During the project tenure technical equipments like Manual and Automated Rain gauges, river discharge measuring instrument, automated weather stations, lake monitoring sensors, etc. would be installed and put into function in collaboration with relevant local departments and communities. During the implementation of previous GLOF-project a collaborative system was adopted to ensure technical sustainability of installed equipment. Being a parent organization Pakistan Met Department will bear the responsibility to provide orientation and training to local communities and concerned departments. The responsibility of maintenance/repair of equipments rests with PMD, while communities and authorities are mainly responsible physical safety of the equipments. Community members bear the additional responsibility of collecting data from manual weather observatory. The same collaborative approach will be used to ensure technical sustainability of the project interventions.

G. Environmental:

Focused efforts and interventions have been planned in the main proposal document ensure environmental sustainability. To ensure that quality of soil, water and integrity of ecosystem is not compromised Environmental Impact Assessment of individual activities will be conducted. Activities proposed in the project will contribute positively to rehabilitate degraded ecosystem and improve the health of the environment. Reforestation techniques like Assisted Natural Regeneration will employed to restore degraded watershed. The success of the ANR and other innovative habitat restoration activities would motivate the stakeholders to replicate them in other areas as well.

H. Commitment of Government of Pakistan:

Pakistan is signatory to several multilateral agreements covering environment, including the three major Rio1992 agreements of Conventions on Biological Diversity (CBD), United Nations Framework Convention on Climate Change (UNFCCC), and the convention on Combating Desertification (UNCCD).

The Public Sector Development Programme, under the MCC, is the main instrument for providing budgetary resources for development projects and programmes and its budget was US $ 115 million in 2013-2014. In addition, the Ministry has the Climate Finance Unit that is designed as a focal authority responsible for coordinating and implementation of the climate-related initiatives that will chair the Project Board.

The goal of the Climate Change Policy of Pakistan (2011) is to ensure that climate change is mainstreamed in the economically and socially vulnerable sectors of the economy and to steer Pakistan towards climate resilient development. The Policy also recommends setting up appropriate mechanisms to monitor the development of glacial lakes and develop evacuation strategies in case of Glacial Lake Outburst Floods (GLOF) for vulnerable areas in Pakistan. The proposed GCF project will directly support the federal Climate Change Policy in this regard.

The project is also aligned with the "Vision 2030" elaborated by the Pakistan Planning Commission in 2007, which aims for equitable sharing of environmental benefits, increasing community management of national resources, and integrating environmental issues into socio-economic planning to achieve sustainable development.

The Government of Pakistan (GoP) ratified the National Climate Change Policy (NCCP) in 2012, which aims to ensure that CC is mainstreamed in the economically and socially vulnerable sectors of the economy, and to steer Pakistan towards climate-resilient development. In 2012, the Ministry of Climate Change (MCC) expressed an interest in undertaking a Climate Public Expenditure and Institutional Review (CPEIR) to assess the level at which the GoP has so far been able to respond to the challenges of CC, and to identify opportunities for further strengthening its response.

The proposed project has been designed and developed with full ownership of the GoP through a series of consultations, at community, district and national levels. As the proposed project aims to scale up current ongoing activities, consultations were carried out with diverse stakeholders including government ministries and departments, NGOs, Civil Society, private sector and development partners to obtain input and feedback into the development of the proposal. All key partners were consulted individually as well as collectively to gain and in-depth understanding of the needs and also solicit ideas on how the needs could be addressed through the proposal. The National Designated Authority (NDA) was involved in the entire process. Further details on stakeholder engagement are provided in Section E.5.3. Noting that the design of the proposal has taken into consideration the national priorities and relevant strategies highlighted above, the NDA has issued a 'no objection' letter for the submission of the proposal to the GCF. As an expression of commitment and ownership, the regional governments also provided co-financing for the project.

1.4 Knowledge Management and Learning:

Although victim of climate change and its induced disasters, for decades, the understanding of climate change and associated hazards is low particularly in developing countries. There is a dire need that understanding of climate change and adaptive capacities of the communities and relevant organizations should be build.

Glaciers and the phenomenon of GLOF are least studied and known subjects in Asia. The project during its implementation is supposed to generate immense knowledge base on climate change and its impacts. Results from the project ad knowledge generated from the project's activities will be disseminated both within and outside of GB and KP through a number of existing knowledge/information-sharing networks and forums. Ministry of Climate Change (Executing Entity) conceived this project as a pivotal experience for developing tools and information to reduce the vulnerability of local communities to the effects of climate change, and to facilitate the incorporation of adaptation measures into policy and planning processes at the local and regional levels. At the national level, the project will capture and disseminate lessons learned through the MCC's web page, project's own website, electronic and print media in the form of Information Education and Communication materials (IEC), seminars, documentaries etc. Official webpage of Ministry of Climate Change (MCC) and previous GLOF-Project have been developed to provide access to the public for climate change-related information and to improve national capacity to address GLOF risks. In this way the project results will be shared with a wide variety of stakeholders at the local, provincial, national and international levels. The

technical officers of the Ministry of Petroleum & Natural Resources, the Ministry of Food Security and Research and the Ministry of Water & Power working on areas where climate change will have adverse impact will be the key ministries for disseminating the results of the project.

Besides, reports, assessments and findings of the project will contribute significantly for future development planning and policy/legislation formulation as well. Capacity building of local communities in weather forecasting and their practical integration in EWS would help them gain basic knowledge about climate variables and plan their activities accordingly. During the project implementation period progress reports, Disaster Risk Management Plans, awareness materials, baseline reports, publication etc will be produced to develop and maintain proper database. These documents could be used to define guidelines for Operation and Management procedure for future. The documentation would be made available to local and international stakeholders through websites, seminars, conferences and outreach activities.

Annexes:

Annex-1: Stakeholder Consultation

Meeting Minutes

Name	Designation	Department	Date
Mr. Shareef	Chief Meteorologist	Glacier Monitoring Unit, Research and Development Department, Pakistan Meteorological Department (PMD), Islamabad	07-March-2016 and 09-March-2016
Mr. Adnan Shafique	Meteorologist	Glacier Monitoring Unit, Research and Development Department, Pakistan Meteorological Department (PMD), Islamabad	07-March-2016 and 09-March-2016
Discussion Points: • Design, cost and functions of Early Warning System • PMD's Strength, weakness, opportunity and threats • Past and Present PMD Data available • Policies and Framework of Early Warning System • Strategies • Availability of Data			

Meeting Minutes

Name	Designation	Department	Date
Mr. Sohail Ashraf	Director – Operations	National Disaster Management Authority (NDMA)	08-March-2016
Mr. Shahid R. Kiani	Deputy Director – DRR	National Disaster Management Authority (NDMA)	08-March-2016
Discussion Points: • Policies and Framework of DRM • Disaster Profile • Damage Need Assessment Report • SWOT Analysis of NDMA • Disaster Insurance Framework • DRR & DRM Plans and maps • Data Availability • Available Reports, Surveys and assessments			

Meeting Minutes

Name	Designation	Department	Date
Mr. Ayaz	Meteorologist	Agro-Met Division, Pakistan Meteorological Department (PMD), Islamabad	09-March-2016
Discussion Points: • Agro-Met Framework • Information Dissemination and Service provision • Agro-Met Strategies. • Data Availability			

Meeting Minutes

Name	Designation	Department	Date
Dr. Bashir	Director	Environment Protection Agency (EPA), Islamabad	08-March-2016
Discussion Points: • EPA Framework • Available Reports, Surveys and assessments • Strategies • Ongoing and Closed Project Details			

Meeting Minutes

Name	Designation	Department	Date
Dr. Imtiaz A. Qamar	Director	Rangeland Research Institute, National Agriculture Research Institute (NARC), Islamabad.	10-March-2016
Discussion Points: • Forest and Rangeland Policy and Framework • Challenges and Opportunity • Forest and Rangeland Management Strategy • Available Reports, Surveys and Assessments (Report			

Meeting Minutes

Name	Designation	Department	Date
Dr. Arshad Ashrad	Principle Scientific Officer	Climate Change, Alternate Energy and Water Resource	10-March-2016

		Institute (CAEWRI), National Agriculture Research Institute (NARC), Islamabad.	

Discussion Points:

- Agriculture Policy and Framework
- Challenges and Opportunity
- Agriculture Management Strategy
- Available Reports, Surveys and Assessments (Report

Meeting Minutes

Name	Designation	Department	Date
Muhammad Zubair Anwar	Principle Scientific Officer	Social Sciences Research Institute (SSRI), National Agriculture Research Institute (NARC), Islamabad.	10-March-2016

Discussion Points:

- Kitchen Gardening Framework
- Kitchen Gardening Strategy
- Available Reports, Surveys and Assessments (Report

Meeting Minutes

Name	Designation	Department	Date
Ajaz Ahmad	Assistant Director	Directorate of NTFP, Chitral Office	March 08, 2015

Discussion Points:

- Forest and Rangeland Policy and Framework
- Gaps identification and analysis
- Discussion on DRR activities in Chitral
- Present and possible future role of Department in DRR
- Potential
- Collection of reports and assessments

Meeting Minutes

Name	Designation	Department	Date
Shafiqullah Khan	Manager	WWF-Pakistan, Chitral office	March 08, 2015

Discussion Points:

- Discussion on impact of climate change on ecosystem
- Potential of Kitchen gardening as mean of livelihood
- Identification of capacity building measures for communities

- Linking DRR with NRM
- Potential
- WWF-Pakistan activities linked to DRR also discussed
- Identification of plant species for slope stabilization measures and bioengineering structures

Meeting Minutes

Name	Designation	Department	Date
Hussain Ahmad & Bilal Ahmad	Institutional Development Officer/Research Analyst	AKRSP, Chitral	March 08, 2015

Discussion Points:

- Discussion on social mobilization for DRR
- Gap analysis
- Collection of reports and assessment studies from AKRSP

Meeting Minutes

Name	Designation	Department	Date
Rashidul Ghafoor	Assistant Disaster Management Officer, Chitral	District Disaster Management Unit, Chitral	March 08, 2015

Discussion Points:

- Collection of historical Disaster Data
- Overiview of District Emergency Reponse Cell established through Financial Assistance of Pakistan GLOF Project
- Need Assessment
- Role of DDMU/DERC in DRM
- Potential for improvement

Meeting Minutes

Name	Designation	Department	Date
Maghfirat Shah	District Nazim, Chitral	Head of Local Government, Chitral	March 09, 2015

Discussion Points:

- Discussion on overall situation (DRR) in Chitral
- Need analysis
- Rehabilitation of irrigation channel and other crucial infrastructure
- Possible role of local bodies representatives in DRR
- Collection of reports and Data

Meeting Minutes

Name	Designation	Department	Date
Asif Ali Shah	Sub Divisional Forest Officer, Chitral	Chitral Forest Division	March 09, 2015

Discussion Points:

- Discussion on forest policies and collection of relevant documents
- Need identification
- Rapid SWOT analysis of Forest Division, Chitral
- Role of Forest Division in DRR
- Avenues of collaboration with Disaster Management Authorities

Meeting Minutes

Name	Designation	Department	Date
Amir Muhammd	Regional Programme Manage, FOCUS, Chitral	FOCUS Humanitarian Assistance, Chitral	March 10, 2015

Discussion Points:

- Present DRR activities under FOCUS in Chitral
- Identification of hurdles
- Collection of data

Meeting Minutes

Name	Designation	Department	Date
Karam Ali	Regional Programme Manager	AKBPS,	March 09, 2015

Discussion Points:

- Discussion on DRR issues in Chitral
- Gaps identification and analysis

Meeting Minutes

Name	Designation	Department	Date
Tahir Rasheed	General Manager, LEAD-Pakistan, Islamabad	LEAD-Pakistan, Islamabad	March 10, 2015

Discussion Points:

- Forest and Rangeland Policy and Framework
- Gaps identification and analysis
- Discussion on DRR activities in Chitral
- Present and possible future role of Department in DRR
- Potential
- Collection of reports and assessments

Annex-2: Details of Equipment and cost:

Equipment to be installed in one valley for developing Early Warning System:

Necessary Equipment needed for one valley of the target area. The total equipment will be ascertained and quantified for number of valleys selected. Number of equipment needed per valley is also mentioned and rate of station per valley is calculated. The rates are exclusive of any taxes that may impose in the policy of UNDP and procurement costs. Final rates must be ascertained after incorporating these costs

Equipment	Detail of Sensors	Specs	Unit Rate (USD $) Rates are exclusive of any type of taxes and procurement costs etc	Rate per valley USD $)
Automatic Weather Stations (three AWSs needed for each valley)	Combined Humidity and Temperature Sensor	For Humidity Measuring range 0-100% resolution 0.1% accuracy +/-2% For Temperature Measuring range -40°C to +60°C Resolution 0.1°C Accuracy +/- 0.3°C	24118/-	72354/-
	Wind speed	Measuring range0.5 -35 m/s Operation temperature -40°C to +60°C Operating humidity range 0-100%		
	Wind Direction	Measuring range0 -360° Operation temperature -40°C to +60°C Operating humidity range 0-100%		
	Rain Gauge (Weighing Mechanism)	Weighting Rain Gauge Orifice area 200 cm^2 Collection Volume 7500 mm Accuracy +/- 2% Resolution 0.1 mm Operation temperature -40°C to +70°C Operating humidity range 0-100%		
	Four component Net Radiometer	Upper and lower Pyranometer for radiation (short wave) Upper and Lower pyrgeometer for infrared (long wave)		

Equipment	Detail of Sensors	Specs	Unit Rate (USD $) Rates are exclusive of any type of taxes and procurement costs etc	Rate per valley USD $)
		310-2800 nm shortwave spectral range 4.5 to 42 micrometer long wave spectral range		
	Snow Depth Sensor	Range 0-6 meters		
	Snow Scale	Measuring Range 0-3000 mm SWE Resolution 0. km/m^2 equivalent to 0.1 mm SWE Measuring Surface 6.72 m^2 Dimensions 2800x2400x103(LxWXH mm) Operating temperature -40 to +80°C		
	Logger, fittings and communication modules, solar panels batteries for power supply			
Automatic Rain Gauges (four stations per valley required)	Rain Gauge (Weighing Mechanism)	Weighting Rain Gauge Orifice area 200 cm^2 Collection Volume 7500 mm Accuracy +/- 2% Resolution 0.1 mm Operation temperature -40°C to +70°C Operating humidity range 0-100%	7852	31408/-
	Logger, fittings and communication modules, solar panels batteries for power supply			
Temperature Loggers (Ten stations per valley)			673	6730

Equipment	Detail of Sensors	Specs	Unit Rate (USD $) Rates are exclusive of any type of taxes and procurement costs etc	Rate per valley USD $)
Discharge Measuring Equipment (three stations per valley)	RQ 30-a Radar	Dimensions 338mmx333mmx154mm Total weight 5.4 kg Operating Temperature -35 to 60°C Water level measuring range 1 to 15 meter standard version and 0 to 35 m extended version Resolution 1 mm Velocity measurement range 0.1 to 15 m/s Resolution 1 mm/s Measurement interval 8 sec. Measurement	17948	53845
	Logger, fittings and communication modules, solar panels batteries for power supply			
Water Level sensor (at least two per valley)	Peizometric water level sensor	20 meter compensable cable	3365	6730
	Logger, fittings and communication modules, solar panels batteries for power supply			
Surface temperature of glaciered surfaces (ten for each valley)	Sensor (Pyrometer)	Operating environment -55 to 80°C	4487	44870
	Logger, fittings and communication modules, solar panels batteries for power supply			
Communication Cost per station (at least 15 per valley) (This is first time cost	GPRS Modems	Omni directional antennas, cable for serial data communication	6731	100965/-
	Iridium modems for Satellite communication	Beam patch dual mode antenna		
	Softwares			

Equipment	Detail of Sensors	Specs	Unit Rate (USD $) Rates are exclusive of any type of taxes and procurement costs etc	Rate per valley USD $)
Data Transmission cost (for 15 stations per valley)	Satellite and GSM data transmission cost per year		1010 per year	15150/-
TOTAL COST OF EQUIPMENT WITH DATA COMMUNICATION PER VALLEY				332041/- (In USD $)
COST FOR MAINTENANCE OF EQUIPMENT DURING PROJECT TENURE SALARY FOR 03 WATCHMAN PER VALLEY			940 per year per person	2820
GRAND TOTAL				**$666,913/-**

Annex-3: Sustainability of the equipment and project interventions:

For a reasonable dataset/products the instruments operation should be maintained at least for 20 years. Detail of each financial head is prepared as below for each valley. Total cost will be ascertained by multiplying the valley cost to the number of valley selected:

APPROXIMATE BUDGET:

Sr. No.	**Financial Breakups (**Dollars $**)**	**1st year**	**2nd year**	**3rd year**	**4th year**	**5th year**	**6th year**	**7th year**	**8th year**	**9th year**	**10th year**	**11th year**
1	Salary of 03 Watchmen @ Euros € 840/annum with the increment @ Euros € 10%/annum on initial value	2827	3231	3635	4038	4442	4846	5250	5654	6058	6461	6865
2	Sets of Spare Parts/ Sensors (Annex-IV(a))	136462	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
3	Satellite Data Communication *	1010	1010	1010	1010	1010	1111	1111	1111	1111	1111	1212
4	Hardware Repair Annex-IV(b)	393	393	393	393	393	393	393	393	393	393	393
5	Rent of Vehicles/Travelling (Annex-IV(c))	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344
6	Porters/supporting staff (Annex-IV(d))	3365	3365	3365	3365	3365	3365	3365	3365	3365	3365	3365
7	Daily Subsistence Allowance (DSA) (Annex-IV(e))	20192	20192	20192	20192	20192	20192	20192	20192	20192	20192	20192
8	Miscellaneous	2804	2804	2804	2804	2804	2804	2804	2804	2804	2804	2804
	Sum	**176,396**	**40,338**	**40,743**	**41,146**	**41,550**	**42,055**	**42,459**	**42,863**	**43,267**	**43,670**	**44,175**

Sr. No.	**Financial Breakups (**Euros €**)**	**12th year**	**13th year**	**14th year**	**15th year**	**16 th year**	**17th year**	**18th year**	**19th year**	**20th year**	**Total**
1	Salary of 03 Watchmen @ Euros € 840/month with the increment @ Euros € 10%/annum	7269	7269	8077	8481	8884	9298	9692	10096	10500	**132,873**
2	Sets of Spare Parts/ Sensors (Annex-IV(a))	-----	-----	-----	-----	-----	-----	-----	-----	-----	**136462**
3	Satellite Data Communication *	1212	1212	1212	1212	1312	1312	1312	1312	1312	**23225**
4	Hardware Repair Annex-IV(b)	393	393	393	393	393	393	393	393	393	**7860**
5	Rent of Vehicles/Travelling (Annex-IV(c))	9344	9344	9344	9344	9344	9344	9344	9344	9344	**186880**
6	Porters/supporting staff (Annex-IV(d))	3365	3365	3365	3365	3365	3365	3365	3365	3365	**67300**
7	Daily Subsistence Allowance (DSA) (Annex-IV(e))	20192	20192	20192	20192	20192	20192	20192	20192	20192	**403840**
8	Miscellaneous	2804	2804	2804	2804	2804	2804	2804	2804	2804	**56080**
	Sum	**44579**	**44579**	**45387**	**45791**	**46194**	**46608**	**47002**	**47406**	**47810**	**1,014,018**

* Data communication charges are subject to an increment of 10% on initial value after 5 years

Annex-3: Procurement/budget and work plan:

Project Outcomes	Donor Name	Atlas Budget Acc. Code	Budget Account Description	Amount Year 1 (USD)	Amount Year 2 (USD)	Amount Year 3 (USD)	Amount Year 4 (USD)	Amount Year 5 (USD)	Total (USD)
1) Strengthened sub-national institutional capacities to plan and implement climate change resilient development pathways	GCF	71300	Local Consultants	389,880	304,200	304,200	256,230	199,222	**1,453,732**
	GCF	72100	Contractual Services-Companies	379,800	291,510	291,510	252,630	191,871	**1,407,321**
	GCF	71600	Travel	387,000	294,750	294,750	255,060	205,704	**1,437,264**
	GCF	74200	Audio Visual&Print Prod Costs	201,089	173,160	173,160	124,092	120,492	**791,993**
	GCF	75700	Training, Workshops and Confer	204,570	184,860	184,860	156,060	167,940	**898,290**
			TOTAL Outcome 1	**1,562,339**	**1,248,480**	**1,248,480**	**1,044,072**	**885,229**	**5,988,600**
2) Community-based EWS and long-term measures are scaled up to increase communities' adaptive capacity	GCF	71300	Local Consultants	1,586,160	1,239,030	1,239,030	780,030	737,568	**5,581,818**
	GCF	72100	Contractual Services-Companies	1,705,545	1,045,980	1,143,652	809,730	804,451	**5,509,358**
	GCF	71600	Travel	1,402,470	879,930	879,900	644,673	627,318	**4,434,291**
	GCF	72400	Communic & Audio Visual Equip	1,043,901	722,250	722,250	583,596	579,880	**3,651,877**
	GCF	74200	Audio Visual&Print Prod Costs	506,610	421,830	421,830	345,300	302,839	**1,998,409**
	GCF	74500	Miscellaneous Expenses	535,941	399,780	399,780	301,050	302,759	**1,939,310**
	GCF	72200	Equipment and Furniture*	1,130,400	533,817	533,817	208,803	148,500	**2,555,337**
			TOTAL Outcome 2	**7,911,027**	**5,242,617**	**5,340,259**	**3,673,182**	**3,503,315**	**25,670,400**
Project Management	GCF	71300	Local Consultants	50,000	50,000	50,000	50,000	50,000	**250,000**
	GCF	71200	International Consultants	60,000		90,000		150,000	**300,000**
	GCF	71400	Contractual Services -						

			Individ	800,000	800,000	850,000	850,000	850,000	**4,150,000**
	GCF	72100	Contractual Services-Companies	10,000	10,000	10,000	10,000	10,000	**50,000**
	GCF	71600	Travel	100,000	100,000	100,000	100,000	100,000	**500,000**
	GCF	73300	Rental & Maint of Info Tech Eq	11,000	10,000	10,000	10,000	10,000	**51,000**
			TOTAL Proj Mgt	**1,031,000**	**970,000**	**1,110,000**	**1,020,000**	**1,170,000**	**5,301,000**
			TOTAL	**10,504,366**	**7,461,097**	**7,698,739**	**5,737,254**	**5,558,544**	**36,960,000**

Cash Transfer Plan (GCF)		
Description	**Scheduled date**	**GCF Project Funds a/**
For Year 1 Activities	2017	10,504,366
For Year 2 Activities	2018	7,461,097
For Year 3 Activities	2019	7,698,739
For Year 4 Activities	2020	5,737,254
For Year 5 Activities	2021	5,558,544
Total		36,960,000