

**Policy Recommendations and Guidelines  
to streamline & incorporate Glacial Lake Outburst Flood  
issues for future policy formulation in Pakistan**



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Climate Change Division  
Pakistan Glacier Lake Outburst Floods Project**

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## Table of Contents

Glossary.....	III
Acronyms .....	V
Executive Summary.....	1
1. Introduction.....	3
1.1. Development of glacial lakes and lake-outburst floods .....	5
1.2. Obligations of Pakistan under international and regional agreements .....	8
2. Methodology.....	10
3. GLOF related National Policies.....	10
3.1. National Environment Policy 2005.....	10
3.2. National Climate Change Policy 2012 .....	11
3.3. National Disaster Risk Reduction Policy 2013.....	12
3.4. Pakistan Vision 2025 .....	13
4. Issues.....	13
5. Policy Recommendations.....	15
6. Guidelines.....	17
Annex-I Terms of Reference of the study.....	19
Annex-II GLOF related interventions at National level .....	20
Annex III Regional and International Experiences .....	21
References / Bibliography.....	24

## **Glossary**

### **Capacity**

A combination of all the strengths and resources available within a community, society or Organization that can reduce the level of risk, or the effects of a disaster. Capacity may include physical, institutional, social or economic means as well as skilled personnel or collective attributes such as leadership and management. Capacity may also be described as capability.

### **Capacity building**

Efforts aimed to develop human skills or societal infrastructure within a community or Organization needed to reduce the level of risk. In extended understanding, capacity building also includes development of institutional, financial, political and other resources, at different levels of the society.

### **Climate change**

The climate of a place or region is changed if over an extended period (typically decades or longer), there is a statistically significant change in measurements of either the mean temperature or variability of the climate for that region.

### **Community-based disaster risk management**

The process in which at-risk communities are actively engaged in the identification, analysis, treatment, monitoring and evaluation of disaster risks reducing their vulnerabilities and enhancing their capacities.

### **Disaster**

A serious disruption of the functioning of a community or society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources. It results from the combination of hazards, conditions of vulnerability and insufficient capacity to reduce the potential negative consequences of risk.

### **Disaster risk management**

The comprehensive approach to reduce the adverse impacts of a disaster. DRM encompasses all actions taken before, during, and after the disasters. It includes activities on mitigation, preparedness, emergency response, recovery, rehabilitation, and reconstruction.

### **Disaster risk reduction/disaster reduction**

The measures aimed to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development.

### **Glacier Lake outburst floods**

Sudden release of water stored either within a glacier or dammed by a glacier and associated with outburst of glacial lake. Glacial lake outburst floods are typically a result of cumulative developments and occur (i) only once (e.g., full breach failure of moraine-dammed lakes), (ii) for the first time (e.g., new formation and outburst of glacial lakes), and/or (iii) repeatedly (e.g., ice-dammed lakes with drainage cycles, or ice fall).

### **Hazard**

Potentially damaging physical event or phenomenon that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can be natural (geological, hydro meteorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or

combined in their origin and effects. Each hazard is characterized by its location, intensity, frequency and probability.

### **Indus River System**

Refers to “River System” by major rivers, namely; Indus, Jhelum, Chenab, Ravi and Sutlej including other major tributaries such as Swat and Kabul Rivers.

### **Land-Use planning**

Branch of physical and socio-economic planning that determines the means and assesses the values or limitations of various options in which land is to be utilized, with the corresponding effects on different segments of the population or interests of a community taken into account in resulting decisions. Land-use planning can help to mitigate disasters and reduce risks by discouraging high-density settlements and construction of key installations in hazard-prone areas, control of population density and expansion. Mitigation structural and non-structural measures are undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.

### **Natural hazards**

Natural processes or phenomena occurring on the earth that may constitute a damaging event. Natural hazards can be classified by origin namely: geological, hydro meteorological or biological. Hazardous events can vary in magnitude or intensity, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing.

### **Preparedness**

Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.

### **Prevention**

Activities to ensure complete avoidance of the adverse impact of hazards.

### **Public awareness**

The processes of informing the general population, increasing levels of consciousness about risks and how people can reduce their exposure to hazards. This is particularly important for public officials in fulfilling their responsibilities to save lives and property in the event of a disaster.

### **Recovery**

Decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk.

### **Relief / response**

Provision of assistance during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected, may be immediate, short-term, or of protracted duration

### **Risk**

The chance of losses (deaths, injuries, property, livelihoods, economic activity disruption or environmental damage) resulting from interactions between hazards and vulnerable social conditions. Risk is expressed as  $Risk = Hazards \times Vulnerability$ . Some experts also include the concept of exposure when referring to the physical aspects of vulnerability.

## **Acronyms**

AF	Adaptation Fund
AJ & K	Azad Jammu and Kashmir
CBDRM	Community Based Disaster Risk Management
CC	Climate Change
CCA	Climate Change Adaptation
CCD	Climate Change Division
DM	Disaster Management
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EA	Environment Agency
EU	European Union
GB	Gilgit-Baltistan
GBDMA	Gilgit-Baltistan Disaster Management Authority
CBO	Community Based Organization
GIS	Geographical Information System
GLOF	Glacial Lake Outburst Flood
GCP	GLOF Contingency Plan
GEW	GLOF Early Warning
GRR	GLOF Risk Reduction
HFA	Hyogo Framework for Action
HKH	Himalaya Karakoram Hindukush
IRS	Indus River System
KP	Khyber Pakhtunkhwa
LUP	Land Use Plan
MTDF	Medium Term Development Framework
NCCP	National Climate Change Policy of Pakistan 2012

NDMA	National Disaster Management Authority
PDMA	Provincial Disaster Management Authority
SDMA-AJK	State Disaster Management Authority - Azad Jammu and Kashmir
UN	United Nations
UNDP	United Nations Development Program
WMO	World Meteorological Organization

## **Executive Summary**

In Pakistan glaciers in northern areas act as a source of life by feeding more than 60% to the flows from Upper Indus Basin. Glaciers in Himalayas are receding faster than in any other part of the World and therefore the phenomenon of Glacial Lake Outburst Floods (GLOFs) would increase in future. The GLOFs can release millions of cubic meters of water and debris in some days or even hours which can cause catastrophic devastation and flooding up to hundreds of kilometers downstream, affecting distant communities (located dozens of kilometers from lakes) causing deaths, damaging their property, livelihood, destroying the bio-diversity and eco-system, affecting the tourism industry, bridges, road, hydropower plants and other infrastructure in the area. Due to remoteness of the area, many of GLOF events occurred in the past have not been documented. Major GLOFs that have been recorded for these areas were in years 1919, 1971, 1996, 2008, 2010 and 2013. Natural disasters like GLOFs are not mainstreamed into major policies and programmes of the Government. People residing at considerable distances downstream from unstable lakes are facing serious threats to their lives and property. This situation calls for in-depth study on GLOF hazards in Northern region and incorporation of GLOF for future policy formulation in the country so that the government may take serious action for prevention, mitigation, response to GLOFs and rehabilitation and reconstruction of the areas affected by GLOFs.

Pakistan is signatory to certain regional and international agreements including South Asian Association for Regional Cooperation (SAARC), Hyogo Framework for Action (HFA) for the period 2005-2015 etc. The HFA stresses to ensure that Disaster Risk Reduction (DRR) is a national and a local priority with a strong institutional basis for implementation; monitor disaster risks and enhance early warning; use knowledge for resilience from disasters; reduce underlying risk factors and strengthen disaster preparedness for effective response. To fulfill such commitments, Pakistan has the policy, regulatory framework, plan and institutional set up at the national, provincial and district levels for disaster management. The DRR may be taken as a priority in Government's programmes.

The present study on "Policy Recommendations and Guidelines to streamline & incorporate Glacial Lake Outburst Flood issues for future policy formulation in Pakistan" recommends that the future Disaster Risk Reduction Policies may focus more on the following measures to prevent and mitigate GLOFs; reducing its impacts by adaptation, rehabilitation and reconstruction measures: preparing/up-dating inventory of past GLOF incidences, and the damages caused; Mapping of potential areas threatened by GLOFs; Continuous monitoring of the glaciers and glacier lakes; Building capacity of stakeholders in monitoring of glacier lakes; Adopting immediate measures to control phenomenon that can lead to GLOFs; Relocation of threatened population; Establishment of GLOF Early Warning System; Sharing of information between different stakeholders; Preparation of national and provincial level GLOF Contingency Plans (GCP); Preparation of Standard Operating Procedures (SOPs) defining roles and responsibilities and chain of command for triggering action in the event of GLOF; Conducting Disaster Management Drills/ Mock trial of GLOF incidence preparedness; Preparation of local and provincial levels disaster management plans involving sustainable land use planning and integrated watershed management; Provision of finances to implement the plans; and capacity building of stakeholders.

Policies on Glacier Hazards may be developed at the national level and for provinces of Khyber Pakhtunkhwa and Gilgat-Baltistan and Azad Jammu and Kashmir. The GLOF may be incorporated in Vision 2025 by mentioning it in the Key performance indicators of its goals, particularly on Goal No.15 and 16 relating to water storage capacity and reducing food insecure population. Integrated national and provincial strategies to deal with GLOFs may be developed. Mandatory risk assessment of glacial lakes as part of planning process for hydropower plants may be conducted. As well as, there is a need for coordination of Disaster and GLOF related policies at the SAARC level and with other GLOF vulnerable countries like China etc. to comprehensively address future glacial lake hazards.

# **1. Introduction**

A study on, “Review and Analysis of Existing National Disaster Act and National Disaster Management Plan of Pakistan and formulate concrete policy recommendations and guidelines to streamline and incorporate Glacial Lake Outburst Flood issues for future policy formulation in the country” is being conducted under the Pakistan Glacier Lake Outburst Floods (GLOF) Project. The project is funded by the Adaptation Fund and the United Nations Development Programme and is being implemented by the Climate Change Division, Government of Pakistan in collaboration with provincial governments of Khyber Pakhtunkhwa and Gilgit-Baltistan.

Disasters had serious consequences for countries and their economies. Frequency and severity of disasters is increasing. Despite developments in science and technology, the costs of disasters had been increasing with mounting international concerns at the rising frequency and severity of natural hazards and disasters. In part due to factors related to climate change, there is increased impetus in many countries to put in place policy, legal, technical, financial and institutional measures that will reduce the destructive effects on the lives and livelihoods of individuals and communities. These concerns were intensively debated during the World Conference on Disaster Reduction, held in Kobe, Hyogo Prefecture, Japan; 18-22 January 2005. The Hyogo Framework for Action (HFA), adopted by the Conference, seeks the outcome of “The substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries”. In order to achieve the stated outcome by 2015, the HFA emphasizes a shift from reactive emergency relief (which nonetheless remains important) to pro-active Disaster Risk Reduction (DRR) in the pre-disaster stages by strengthening prevention, mitigation and preparedness. While better emergency response systems will save lives and properties, many of these losses can be avoided – or reduced – if appropriate policies and programmes are instituted to address the root causes and set in place mitigation, preparedness and response mechanisms that are effectively integrated into overall development planning.

The Northern parts of Pakistan cover Gilgit-Baltistan, Chitral District of Khyber Pakhtunkhwa Province and Azad Jammu and Kashmir. The area is a meeting place of three great mountain ranges the Himalayas, the Karakoram and Hindu-kush. Himalaya Karakoram Hindu-kush (HKH) region is called ‘Third Pole’ because of the largest area covered by glaciers and permafrost, beside two poles. The glaciers act as a source of life by feeding Asia’s major river systems: the Ganga, Indus, Brahmaputra, Salween, Mekong, Yangtze and Huang Ho. It also has some of the longest glacier outside the Arctic region. The Karakoram Mountains have some of the highest peaks in the world. The average heights of these mountains vary between 3000 to 4800 meters above the sea level. The area has the largest concentration of high mountains in the world with over 121 peaks. Overall five of the highest peaks in the world are here. Three of these include the following:

- ❖ K-2 at the height of 8,611 meters;
- ❖ Nanga Parbat is the second highest peak in the Himalayas at 8126 meters;
- ❖ Tirich Mir is the highest peak in Hindu-kush with a height of 7708 meters.

Their high-altitude topography influences atmospheric warming and circulation and the albedo (reflective power of the snow and ice) of the mountains plays a role in regulating both the regional and global climate. Warming in the Himalayas is higher than the global average. The region is susceptible to a whole range of hydro-metrological, tectonic and climate-induced disasters like Glacial Lake Outburst Floods (GLOFs), heavy landslides, Snow avalanches, rock-falls, debris and

mud flows, and flash floods. Thirty-five destructive out-burst floods have been recorded for the Karakoram Range during the past two hundred years (Hewitt, 1982). The area is a zone of high risk for human population because of the following reasons:

- unsustainable land use practices being adopted for intensive agriculture on mountain slopes using glacier-melt water;
- over-grazing of pastures;
- intensive deforestation of the dry temperate mountain forests to meet the demand of fuel-wood and timber;
- conversion of forest lands into non-forestry uses through encroachments, infrastructure development and human settlements, and
- Increasing un-planned infrastructure developments.

Glaciers in Pakistan cover about 15,040 sq. km which is 13% of mountain regions of the Upper Indus Basin. In a study, 5218 glaciers and 2420 lakes were identified and mapped out of which 52 lakes were classified as potential threat for GLOFs (Campbell, 2005). Some of the largest glaciers outside Polar region are present in the Karakoram range, namely Siachen, Hispar, Biafo, Baltoro and Batura (Ashraf, Roohi, Naz, & Mustafa, 2011). Melted water from these Glaciers contributes more than 60% to the flows from Upper Indus Basin. Major GLOFs that have been recorded for these areas were in years 1919, 1971, 1996, 2008, 2010 and 2013. Such incidences would increase in number, frequency and intensity in future due to climate change effects on glacier melting. According to a 1999 report of International Commission for Snow and Ice “Glaciers in Himalayas are receding faster than in any other part of the World and, if the present rate continue, the likelihood of them disappearing by the year 2035 is very high”.

Pakistan has a number of policies and strategies for the management of its environment. These include the National Environment Policy, the National Conservation Strategy, National Sanitation Policy, National Drinking Water Policy, National Energy Conservation Policy, National Renewable Energy Policy, National Disaster Management Policy, National Climate Change Policy etc. In addition, key documents such as Vision 2030, Vision 2025 and Medium Term Development Framework (MTDF) mention a commitment to conserve the environment and manage disasters. Some of these policies seem to have been developed in a piecemeal manner without a much integrated approach while others lack appropriate dissemination and awareness raising components. There is no national or provincial Land Use Policy in the country and development in hazard prone areas is un-planned. The importance of GLOFs has not been recognized in most of the policy documents.

The country has diverse climatic variations from tropical to temperate with rainfall as little as less than 1” to over 150” a year. The mountains affect water availability in the region not only directly through melt that feeds the rivers, but also via precipitation, particularly seasonal monsoons. The northern region of Pakistan contributes 70% fresh water flows in rivers in Pakistan. Flow in the rivers depend on the monsoon and combined availability of heat to melt the snow and of water stored in the form of snow and ice, as well as on the lithology that influences the water loss within the ground. Main sources of water include: (i) rainfall i.e. summer monsoon, winter rains; and (ii) its rivers fed largely by glaciers and snow melt from the Hindukush Karakoram Himalaya Mountains ranges. Distribution of Water in Main Rivers of Pakistan is described in the following table:

Table: Distribution of Water in Main Rivers of Pakistan

	% of IRS inflows	% Seasonal Distribution		Dominant Source in Summer	Dominant Source in Winter
		Summer (Apr-Sep)	Winter (Oct-Mar)		
Indus	44	86	14	Snow/Glacial melt	Winter Rainfall + Base flow
Chenab	19	83	17	Snow/Glacial melt + Monsoon	
Jhelum	16	78	22	Mainly Snow melt + Monsoon	
Kabul	16	82	18	Snow/Glacial melt	
Others	15				

The Himalayan ecosystem sustains some 1.5 billion people who live directly in the floodplains of its many rivers e.g. Brahmaputra, Ganges, Indus, and Meghna River. Population density is scanty and uneven except in the main cities. More than 30% of the population of northern areas in Pakistan is poor. Poor people are more vulnerable to the effects of disasters; live in hazard prone areas and even in the bed of the Rivers and Nallahs prone to flood hazards. Furthermore, poverty leads to extra pressure on natural resources which further cause an increase in natural hazards to meet the basic necessities of the poor people. The northern areas of Pakistan have a traditional social set-up which is based on self-help basis and serves well for all types of collective work in the villages such as channel and road repairs during damages by GLOF, flash floods, landslides and other disasters.

Trapping of hydro-power sources of this region is among the cheapest sources of energy. The recoverable potential of hydroelectric power in the region has been estimated to be nearly 40,000 Mega-Watts, whereas less than 20% of the total potential has so far been exploited. Therefore a number of micro and mini Hydel power plants can be installed which will not only produce low cost Hydel power but can be utilized for development of Agriculture and other sectors of economy which would be helpful in uplift of far-flung, isolated and remote areas of the country. Before development of hydropower sources in the area, survey of potential future risk assessment of glacier lakes to GLOF to protect the hydropower source may safeguard it from losses in the future.

### 1.1. Development of glacial lakes and lake-outburst floods

The accelerated glacial melting causes glacial retreat, leading to accumulation of increasing amounts of water behind moraine or ice 'dams' creating glacial lakes, the additional water is used for river flow, ecosystem management, production of crops, and livelihood of the people. These lakes can pose significant threats to downstream towns, physical infrastructure like roads, bridges, tracking routes, power schemes, and valuable food producing land. Sometimes, water from the glaciers, flow to the agricultural fields through the channels. Such channels are mostly constructed by the villagers on self-help basis. To a major extent HKH glaciers determine the socio-economic activity in this part of the Indian sub-continent.

Large amounts of material from a landslide or debris from retreating glaciers can temporarily block a river (forming a dam), preventing outflow of the water and leading to development of a temporary reservoir or lake behind the dam. Eventually the unstable dam may break, either as a result of pressure from the volume of water, or when the water rise high enough to flow over the top of the dam and destabilize it. Occasionally secondary landslides falling into the reservoir will lead to a combination of pressure and overtopping with a sudden catastrophic failure of the dam. The resultant outburst of water can have effects far downstream. Such outburst events are generally random and cannot be predicted with precision, although when a landslide blocks a river the likelihood of an outburst at some time is clear.

The GLOFs are one of the most frequent and damaging processes that originate from glaciated areas Worldwide (Anaconda & Norton, 2014). The GLOFs can release millions of cubic meters of water and debris in some days or even hours which can cause catastrophic devastation and flooding up to hundreds of kilometers downstream, affecting distant communities (located dozens of kilometers from lakes). In Pakistan the GLOFs mostly occur in northern areas which are the most remote areas of Pakistan so most of the GLOFs that occur in such areas are not documented by any organization or person, and the data about GLOFs conditioning and triggering factors are very limited. Ten main GLOF events have been noted in Pakistan, however, the number of actual GLOF events could be more. The exact number of deaths and the value of damage caused by GLOFs are not known, however, frequency of GLOFs is increasing. As the pressure on investment in infrastructure projects and density of population within the valleys in northern areas is increasing; there are now more people and high value structures at risk from an increasing number of dangerous glacial lakes.

The glaciers melting are expected to increase flooding of Indus and its tributaries and GLOFs for the next few decades which will be followed by decreased river flows as the glaciers recede. Himalayan glaciers are known to be receding at the rate of 10 meters to 23 meters per year. It is expected that the inter-annual and intra-annual variability of river flows will increase and there will be more frequent and intense occurrences of floods including GLOFs due to the following: (i) increased variability of monsoon and winter rains and (ii) the loss of natural reservoirs caused by glacier melting as a result of climate change. Mostly wood-collectors, shepherds and village watchmen warn the local communities by blowing a fire on the mountain tops, using mobile phones and other communication networks during the occurrence of GLOFs. Villagers experience loud thunder before GLOF happening. The immediate response to GLOFs is to save life; free livestock from the cattle sheds, and pick up children, elderly, disabled and precious domestic things to safe places. The receding trends of glacier masses threaten water supplies, livelihoods and the economy of the region. The **impacts** of GLOF on some of the main sectors include the following:

#### **Soil, Water, Agriculture and Livestock**

- Gully erosion and destruction of irrigation channels
- Drying up of natural springs
- Reduced productivity of crops including fodder and orchards
- Damage to general crops and orchards
- Physiological stress and reduction in number of livestock causing reduced productivity of milk and meat

## **Forestry and rangeland**

- Decreased productivity
- Change in species composition
- High load of silt and clay in glacier-melt water sometimes choke soil water capillaries and damages root system of forest plants
- Reduction of Forests and Forest Area due to GLOFs

## **Energy, Social Sector, Bio-diversity and industry**

- Reduced hydel energy
- Loss of livelihood, life and property
- Reduced availability of water for drinking and meeting other daily needs
- Population displacement and human rights issues
- Risks to health
- Rural Urban Migration
- Stress on Political Sector
- Disruption in transport facilities due to damages to bridges and roads network
- Shifting and shrinking biodiversity resources of the area and
- Tourism and any other industry in the area

There occurred a series of GLOF events in upper Hunza valley, central Karakoram Range, within short time periods during 2008 that had a devastating effect on the nearby communities (Roohi, Ashraf, Mustafa, & Mustafa, 2008). Reshun village in Booni, Northern Area was destroyed due to GLOFs in July 2013. On January 4, 2010, a landslide occurred on Hunza river of Northern Pakistan. The initial disaster buried the village of Attabad. It also blocked the Hunza River, creating a 11-kilometer long lake that inundated several villages and submerged more than 20 kilometers of the Karakoram Highway as depicted in accompanying maps. Besides displacing some 2500 people as it flooded their homes, cropland and forest/orchards the lake cut off everyone between Attabad and the submerged bridge—an estimated 3,000 people. Besides damaging the crop and property, the worst fear was that the rising water level might breach the Dam and flood villages downstream and its impact may reach as far as Tarbela Dam, therefore, an artificial spill way had to be created to avoid a disaster of enormous proportion. The people residing at considerable distances downstream from the unstable lakes are facing a serious threat to their lives and property. This situation calls for in-depth study on GLOF hazard in the Northern region and incorporation of GLOF for future policy formulation in the country so that the government may take serious action for the prevention, mitigation, response to GLOFs and rehabilitation and reconstruction of the areas affected by GLOFs. The Government of Nepal now does mandatory risk assessment of glacial lakes as part of planning process for hydropower plants.

In Pakistan Natural disasters like GLOFs are not mainstreamed into major policies and programmes of the Government. Even till today the country lacks Standard Operating Procedures (SOPs) for organizing emergency response to such large-scale disasters. Some of the work implemented with regard to GLOFs at national level is described in Annex-II. Regional and international experiences

gained for preventing, mitigating disasters like GLOF, response mechanisms and post-disaster interventions are presented at Annex-III.

## **1.2. Obligations of Pakistan under international and regional agreements**

The Guidelines on Sustainable Flood Prevention were produced by the United Nations. The character of the United Nations Guidelines is strategic rather than technical; they aim to recommend measures and best practices to prevent, control and reduce the adverse effect of flood events on human health and safety, on valuable goods and property, and on the aquatic and terrestrial environment. The Guidelines are intended to assist the Parties to the Convention on the Protection and Use of Trans-boundary watercourses and International Lakes and other UN countries in developing and implementing sustainable measures and good management practices for flood prevention and protection that take account of economic, environmental and social considerations.

World Conference on Disaster Reduction (18 - 22 Jan 2005, Japan) adopted Hyogo Framework for Action (HFA) for the period 2005-2015 (UNISDR, 2011). The HFA recognized "Disaster Risk Management" as an important element for achieving internationally agreed goals. Pakistan, along with 168 other nations, is a signatory to the HFA. The UN General Assembly Resolution RES-59-212 (March 2005) on "International Cooperation on Humanitarian Assistance in the Field of Natural Disasters, from Relief to Development" called upon all States to implement the HFA, and requested the international community to continue assisting developing countries in their efforts to adopt appropriate measures to mitigate the effects of natural disasters, and to integrate Disaster Risk Reduction (DRR) strategies into development planning.

The key elements of the Disaster Risk Management (DRM) framework are reflected in the HFA 2005-2015: Building the Resilience of Nations and Communities to Disasters which elaborates the five priorities for action adopted by the World Conference on Disaster Reduction to achieve its strategic goals by 2015. The HFA priorities for action which are all closely linked to the broader context of sustainable development are as follows:

1. Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.
2. Identify, assess and monitor disaster risks and enhance early warning.
3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels.
4. Reduce the underlying risk factors.
5. Strengthen disaster preparedness for effective response at all levels.

### **Fulfilling Pakistan's commitments under HFA**

To fulfill such commitments, National Intervention planned in National Disaster Management Plan includes the following:

- (i) Establish the institutional and legal system for disaster management and prepare disaster management plans at various levels;
- (ii) Establish a national hazard and vulnerability assessment and establish a multi-hazard early warning system;

- (iii) Promotion of training, education and awareness in relation to disaster management and strengthen awareness program on disaster risk reduction at local level;
- (iv) Infrastructure development for disaster risk reduction and mainstreaming disaster risk reduction into development; and
- (v) Establish a national emergency response system and capacity development for post-disaster recovery.

In order to build institutions that are better prepared for, resilient to and able to cope with hazards, it is useful to enrich the concept and practice of DRR used in the HFA which focuses on pre-disaster stages (prevention, mitigation and preparedness) by placing them within the broader concept and practice of DRM which combines (through a management perspective) prevention, mitigation and preparedness with response.

Against the first priority of HFA, the Government of Pakistan (GoP) has taken Disaster Risk Reduction as a national, provincial and district levels priority. Institutional structure has been established, Policy, Act and plans have been prepared and certain projects and programmes for on-the-ground implementation of planned interventions have been initiated. Pakistan 2025 one nation – one vision is one of the main policy documents of the government. The document describes that the government will focus on improving post-disaster early recovery support mechanism and water related disaster resilience is among the key targets of the government. While keeping the catastrophe's like earthquake, flood, internally displaced persons and militancy in mind, the vision encompasses a demand driven transparent, efficient and accountable system, improved corporate governance and macroeconomic stability (Planning-Commission). The National Disaster Management Authority (NDMA) is providing report to the HFA on their prescribed format after every two years.

### **South Asian Association for Regional Cooperation and Natural Disasters**

During Thirteenth Summit meeting of the South Asian Association for Regional Cooperation (SAARC) in Dhaka, Bangladesh on 12 - 13 November 2005, the Heads of State or Government underscored the urgency to put in place a permanent regional response mechanism dedicated to disaster preparedness, emergency relief and rehabilitation to ensure immediate response. They directed the concerned national authorities to coordinate their activities in such areas of disaster management as early warning, exchange of information, training and sharing of experiences and best practices in emergency relief efforts. "SAARC Agreement on Rapid Response to Natural Disasters" was finalized and agreed by the Inter-governmental meeting held in Male on 25-26 May 2011. The objective of the agreement is to provide effective regional mechanism for rapid response to disasters to achieve substantial reduction of disaster losses in lives and in the social, economic and environmental assets of the Parties (SAARC Member countries) and to jointly respond to disaster emergencies through concerted national efforts and intensified regional cooperation.

Recurring disasters pose a great development challenge for all SAARC countries. In that context, a SAARC Comprehensive Framework on Disaster Management and Disaster Prevention was articulated. The SAARC Centre for Disaster Management and Preparedness (New Delhi), SAARC Coastal Zone Management Centre (Male) and SAARC Meteorological Research Centre (Dhaka) are implementing the Framework in the context of regional cooperation within the mandate of the respective Regional Centers. The framework's Priorities for Action 2006-2015 focuses on the following policy level issues: Members States and regional organizations will integrate disaster risk reduction considerations into their sustainable development policy, planning and programming at all

levels. Mainstreaming disaster risk reduction into the development policies and practices of the government at all levels and development of policies and programmes that recognizes all risks to the communities, and mitigation strategies that are based on a risk management assessment would be the key outcomes of this collaboration.

The **methodology** adopted for conducting the study on “Formulation of concrete policy recommendations and guidelines to streamline & incorporate Glacial Lake Outburst Flood issues for future policy formulation in the country” is described below:

## **2. Methodology**

The methodology comprised of: (i) review of relevant documents, reports, modules, brochures, GIS based information, web searching etc; and (ii) Conducting meetings with stakeholders. The work started with kick off meeting with the National Project Manager of GLOF Project, Climate Change Division, Government of Pakistan. A plan of action for the scheduled task was developed and shared with the GLOF Project. Key concepts and terminologies related to disaster risk management were noted down. Background information on existing national DRM institutional structures, mandates, policies, laws, and DRM-related projects were reviewed.

A desk review of the glaciers and GLOFs as discussed in the national policies was conducted by collecting secondary data from internet, literature was review. Meetings were held with Muhammad Tahir Orakzai, Director General, Provincial Disaster Management Authority (PDMA), Shah Nasir Khan, Head of Disaster Risk Management and Climate Change Adaptation Strategic Management Unit; Rashid-ud-Din, Assistant Director, GBDMA; Imtiaz Ahmed, Assistant Director, GBDMA. Relevant data was retrieved from the PDMA-Khyber Pakhtunkhwa and GBDMA. Reflection of basic theme of International commitments including Hyogo Framework of Action in National policies was also noted down. National Policies that has described different GLOF related issues; policy related GLOF issues; missing planning links particularly related to GLOF and other glacier related disasters, concrete policy recommendations and guidelines to streamline & incorporate GLOF issues for future policy formulation in the country were identified through the studied literature and information received from stakeholders keeping in mind the environmental conditions of different agro-ecological zones; land capability classification and socio-economic conditions of the people of Pakistan.

## **3. GLOF related National Policies**

The issue of GLOF as discussed in the “National Environment Policy 2005”, “Pakistan Vision 2025”, “National Climate Change Policy 2013” is as follows:

### **3.1. National Environment Policy 2005**

The National Environment Policy 2005 is silent in dealing with GLOF issues. However it discussed disaster as an overarching framework for addressing the environmental issues facing Pakistan. It highlighted the commitment of the government to ensure disaster risk reduction and adequate preparedness for natural disasters, for which the government may: (a) develop and implement a natural disaster management strategy; and (b) establish disaster management institutions at the federal and provincial levels (Ministry-of-Environment, 2005). The Climate Change Division,

Government of Pakistan implements, coordinates and monitors the implementation of the National Environment Policy 2005.

### **3.2. National Climate Change Policy 2012**

The Climate Change Division (CCD), Government of Pakistan implements, coordinates and monitors the implementation of the National Climate Change Policy 2012. The policy has incorporated GLOF issues. During illustrating Pakistan's Vulnerability to Climate Change Threats the policy highlights that important climate change threats to Pakistan are:

1. Considerable increase in the frequency and intensity of extreme weather events;
2. Projected recession of the HKH glaciers due to global warming and threatening water inflows into the Indus River System (IRS);

In its Section four on Climate Change Adaptation (CCA) it describes that only by devising and implementing appropriate adaptation measures it will be possible to ensure water, food and energy security for the country as well as to minimize the impact of natural disasters on human life, health and property.

Discussing Water resources it illustrates that these are inextricably linked with climate; this is why the projected climate change has such serious implications for Pakistan's water resources. Freshwater resources in Pakistan are based on snow and glacier-melt and monsoon rains, both highly sensitive to Climate Change (CC). Country specific climate change projections strongly suggest the following future trends in Pakistan: decrease in glacier volume and snow cover leading to alterations in the seasonal flow pattern of the IRS; increased annual flows for a few decades followed by decline in flows in subsequent years; increase in the formation and outburst of glacial lakes; higher frequency and intensity of extreme climate events coupled with irregular monsoon rains causing frequent floods and droughts; and greater demand on water due to higher evapotranspiration rates at elevated temperatures.

To address the impact of climate change on water resources and to enhance water security, the Government of Pakistan, in collaboration with relevant entities shall take the legislative framework and enhanced capacity among the other measures. These are described as follows:

#### **Legislative Framework**

- a. Enact and enforce laws and regulations required for efficient water resource management and a groundwater regulatory framework;
- b. Protect the HKH glaciers, considered as the world's water tower, by declaring them as 'protected areas' through agreements among countries sharing the Himalayan region.

#### **Enhancing Capacity**

- a. Develop and extend water efficient technologies and techniques for sea water utilization, water recycling and avoiding wasteful use of domestic and drinking water;
- b. Ensure measurement and monitoring of irrigation water delivery at various points of the supply system for effective planning and management;
- c. Enhance national capacities in remote sensing and GIS techniques for monitoring temporal changes in glaciers and snow cover.

While illustrating mountain Areas as other Vulnerable Ecosystems, it presents “Increase in temperature, resulting in rapid glacier melting and GLOFs and change in cropping patterns” as one of the most likely climate change risks to the mountain areas of Pakistan. The policy describes that the Government shall also take the following measures to safeguard against likely climate change impacts on mountain areas and to safeguard their ecosystems and ensure the livelihoods of people living there:

- ❖ Promote and encourage the use of glacier grafting techniques in high altitude areas;
- ❖ Undertake a comprehensive study to find and address the impact of “Black Carbon Soot” and “Atmospheric Brown Cloud” on Pakistan’s glaciers and their connection to climate change.

The National Climate Change Policy (NCCP) “Set up appropriate mechanisms to monitor the development of glacial lakes and develop evacuation strategies in case of GLOFs for vulnerable areas” as one of the policy measures for disaster preparedness.

While presenting Capacity Building and Institutional Strengthening measures for Carbon sequestration and Forestry, the policy illustrates, to address the deficiencies in climate change related requirements, human resources and institutions, the Government of Pakistan shall also take the following measures:

### **Capacity Enhancement**

- ❖ Expand and upgrade meteorological services and monitoring stations in various parts of the country, particularly in the northern mountainous areas, glacial regions feeding IRS and over the Arabian Sea adjoining Pakistan’s coastline, to the level recommended by the World Meteorological Organization (WMO);
- ❖ Promote the use of GIS/RS based studies to assess and quantify past temporal trends and monitor future changes in snow cover, glacial volume, glacial lake formation and burst, deforestation, land degradation (salinity, water logging), soil erosion, inundation of Indus deltaic region and other coastal areas;
- ❖ Undertake scientific studies to preserve glaciers and explore grafting techniques;

In the Policy’s Section on International and Regional Cooperation it illustrates that the Government of Pakistan shall consider “Working with countries like Nepal, Bhutan, Kyrgyzstan and other mountainous countries to take initiatives on mountain ecosystems, particularly glaciers and their contribution to sustainable development and livelihoods, and to highlight the region’s vulnerability to climate change” as one of the policy measure to achieve the international and regional cooperation (Ministry-of-Climate-Change, 2012).

### **3.3. National Disaster Risk Reduction Policy 2013**

The NDMA implements, coordinates and monitors the implementation of the National Disaster Risk Reduction Policy 2013. In the policy document, during describing the context of the preamble, it has been illustrated that due to geo-physical conditions, climatic extremes, and high degrees of exposure and vulnerability, Pakistan is a disaster-prone country. A range of hydro-meteorological, geo-physical and biological hazards including avalanches, cyclones and storms, droughts, floods, GLOF, earthquakes, landslides, tsunamis and epidemic pose risks to Pakistani society.

Chapter 3 of National Disaster Risk Reduction Policy 2013 highlights policy interventions. While illustrating Damage and loss data-base and climate change-focused research, the policy highlights that data from damage and loss assessments provide insights into patterns of vulnerability, hazard occurrence, magnitude and severity. The creation of an integrated multi-hazard damage loss data-base is therefore a prerequisite for systematic vulnerability and risk monitoring. Against this objective a multi-hazard damage and loss data-base, uniting data that is currently scattered across various organizations, needs to be created. While damage-loss data-bases help to identify trends based on past events, research into the impact of climate change on glaciers and ice caps in the North need to be carried out to inform scenarios for DRR planning that consider further changes to existing patterns of hydro-meteorological hazards (NDMA, 2013).

### **3.4. Pakistan Vision 2025**

The Pakistan Vision 2025 has described 25 goals. For each goal targets and key performance indicators would be developed. There is no mention of any glacier related option or flood or disaster control in the goals of Vision 2025.

In the Section on “Food and water security real concerns for governments worldwide” presented under Physical & Environmental Trends of New Global Context, it has been described that storage capacity of rainwater is limited to a 30-day supply, well short of the recommended 1000 days for countries of a comparable climate. The supply demand gap is continuing to increase – compounded by the effects of climate change on snowmelt, reducing flows into the Indus River, the primary fresh-water source for the country.

The Pakistan Vision 2025 has presented seven priority areas for action or pillars. These pillars have been identified as the key drivers of growth, which will transform Pakistan into a vibrant and prosperous nation by 2025. While describing “Pillar IV: Energy, Water & Food Security”, it has been highlighted that Pakistan’s rising water demands are met by the Indus River System, supplying 180 billion cubic meters of water. The river system is sustained by glaciers in the Hindukush-Karakoram ranges, believed to be receding under influence of climate change and global warming. Seventy-five percent of annual Indus river system supplies occur during three monsoon months and all access availability goes to the sea due to inadequate storage capacity. The country has very low technical and financial capacity to adapt to and mitigate the effects of climate change. Global warming has caused acceleration in melting glaciers, shifts in biodiversity, changes in crop and vegetation distribution, vulnerability of mountain, desert, marine and coastal ecosystems.

## **4. Issues**

- ❖ One of the main policy documents, “Pakistan Vision 2025” does not contain any goal directly related to glaciers, glacier hazards or GLOFs.
- ❖ There is no GLOF Contingency Plan (GCP) in the country or at provincial or valley level.
- ❖ The national and provincial policies does not focus on the following important measures to reduce losses from GLOF:
  1. Adopting appropriate measures to prevent communities from settling in active GLOF plains;

2. Reducing deforestation;
  3. Increasing afforestation;
  4. Controlled grazing of fragile pastures;
  5. Preservation of indigenous knowledge related to GLOFs; and
  6. Preparation of disaster management plans at the local levels involving sustainable land use planning and management.
- ❖ The national and provincial policies are not focusing on glaciers, glacier hazards including GLOFs, protecting bio-diversity resources from GLOFs and inclusion of GLOFs in the educational curriculum of schools and colleges.
  - ❖ The melting of glaciers due to global warming will result in increased water flows for a few decades which need to be harnessed through constructing more dams in the catchment areas. It would be followed by reduced river flows as the glaciers get depleted that will need again higher reservoir capacity to reduce flow of water into the sea during flood periods
  - ❖ Continued efforts are required in reaching communities (particularly those in remote locations with limited infrastructure and communications systems) and ensuring that they are aware of occurrence of expected future GLOFs and its severity, and act in a timely manner when GLOF Early Warnings (GEW) are issued.
  - ❖ Water flowing from GLOFs causes soil erosion, siltation in Dams and reduction in soil productivity of the area.
  - ❖ There may be considerable environmental, health and financial consequences if floods affect water distribution and sewage systems and other physical infrastructure of the area like roads, bridges used for the transportation of communities and livestock from disaster prone areas. Increased water and soil pollution is among the environmental consequences.
  - ❖ Increased incidences of high altitude GLOFs generated by surging tributary glaciers sometimes block main un-glaciated valleys, this further affects the tourism industry in the area.
  - ❖ In Pakistan there is (i) no GLOF emergency management manual in Urdu or any of the local language except one developed by the Pakistan GLOF Project;(ii) no web based GLOF information management system; and (iii) no Decision Support System for disasters; and (iv) GLOF Risk Reduction (GRR) not included in the curricula at school, college or university levels; and (v) no enforcement of building regulations to reduce GLOF risks. To fulfill its commitments under HFA, several countries have developed emergency management manuals for main disasters in their local languages; web based information management system for main disasters, Decision Support System for disasters and introduced Disaster Risk Reduction in the curricula at school, college; university levels; and enforced building regulations/codes.
  - ❖ There is no insurance scheme at government level to protect life, livelihood (Agriculture, livestock etc.) and property from GLOF for GLOF prone areas.

- ❖ The GLOF Risk Reduction (GRR) is an area that cuts across sectors and different levels of administration. Coordination and information sharing between the many concerned individuals and departments addressing DRR therefore remains a challenge.
- ❖ The GLOF has been indicated specifically in the disaster management policy and plan of Pakistan. However, the enforcement of the measures suggested for prevention, mitigation, preparedness, rehabilitation and reconstruction for GLOF events and specific budgetary provision for these measures is still lagging in Pakistan.
- ❖ Glacial lake hazards would require greater coordination on data collection, monitoring and enforcement of policies and other legal frameworks at the national level as well as at the regional and international levels.

## **5. Policy Recommendations**

### **5.1. The future policies may be focused more on the following measures to prevent GLOFs and reduce its impacts:**

- 5.1.1. Preparing/ up-dating inventory of past GLOF incidences. and the damages caused;
- 5.1.2. Mapping of potential areas threatened by GLOFs; distances of glacier lakes from settlements, agricultural lands, infrastructural facilities likely to be impacted by GLOF incidence in future;
- 5.1.3. Continuous monitoring of the glaciers and glacier lakes in northern Pakistan; keeping a strict watch on temporal changes in HKH glaciers through Remote Sensing and GIS techniques and on-the-spot physical measurements and monitoring the corresponding impact on Indus River System flows; Capacity of organizations like Geological Survey of Pakistan, PDMA-Khyber Pakhtunkhwa and GBDMA to conduct such monitoring may be enhanced;
- 5.1.4. Immediate measures may be adopted to remove/ control cracks in rocks/mountains, potential land slide areas and other actions that can lead to GLOFs; Residents of potential houses at risk may be provided with alternate houses and asked to leave the risky sites;
- 5.1.5. Sharing of information between different stakeholders in the public, academia and private sector working on such issues for review, advice and guidance;
- 5.1.6. Preparation of national and provincial levels GLOF Contingency Plans (GCPs) on urgent basis since GLOFs are considered mountain tsunamis in the making; The plan should cover the crisis management before, during and after the GLOF event; An emergency plan that may be the part of the contingency plan should be in place to manage and operate against the harmful impacts of water pollution on ecosystems during GLOFs;
- 5.1.7. Annually review and up-date the plan so that it is in operational status.

- 5.1.8. Prepare Standard Operating Procedures (SOPs) defining roles and responsibilities and chain of command for triggering action in the event of GLOF which may be given legal cover; notified and distributed widely for knowledge of all stakeholders; The SOPs may also contain contact details such as telephone, fax, e-mail etc.
- 5.1.9. Conduct GLOF Early Warnings (GEW), Disaster Management Drills/ Mock trial of GLOF incidence preparedness in each GLOF prone settlements alternatively, once in a year;
- 5.1.10. Preparation of local (Village or Valley) and provincial levels disaster management plans involving sustainable land use planning and management;
- 5.1.11. Regular and timely provision of finances to implement the plans;
- 5.1.12. Facilitation and capacity building of Community Based Organizations (CBOs) to deal with GLOFs;
- 5.1.13. Conducting Research and Demonstrations on mitigation and adaptation measures for glacial melt and reducing disaster risks resulting from GLOFs;
- 5.1.14. Hazardous substances, if stocked should be shifted outside the flood risk area or stored well above flood levels;
- 5.1.15. Establishing, maintaining and training local effective organization(s)/ CBOs for GLOFs emergency operation by the the NDMA, Gilgit-Baltistan Disaster Management Authority (GBDMA), PDMA-Khyber Pakhtunkhwa and State Disaster Management Authority - Azad Jammu and Kashmir (SDMA-AJK);
- 5.1.16. Organizing experienced feedback after a flood event and producing a report including recommendations for improvements;
- 5.1.17. Considering Human rights of persons displaced due to GLOFs.

**5.2.National policy on Glacier hazards may be developed.**

**5.3.Provincial policies on Glacier hazards including GLOF may also be developed for Gilgit-Baltistan; Khyber Pakhtunkhwa provinces and Azad Jammu and Kashmir to increase awareness, early warning, and risk prevention, mitigation, and improve response mechanism.**

**5.4.Key performance indicators of the following goals of Pakistan Vision 2025 may also include glaciers, glacier hazards or GLOFs related indicators:**

- 5.4.1. Goal No. 15: Water: increase storage capacity to 90 days, improve efficiency of usage in agriculture by 20%, and ensure access to clean drinking water for all Pakistanis
- 5.4.2. Goal No. 16: Reduce food insecure population from 60% to 30%

**5.5. Integrated national and provincial strategies to deal with GLOFs and related matters such as social and economic development, water resources, infrastructure development and so on, may be developed.**

**5.6. Further the local communities may be empowered to participate in planning different measures to prevent, mitigate and respond to GLOF, conservation and natural resource development and management, and ensure that their feedback on policies can reach decision-makers and influence future policy-making.**

**5.7. Mandatory risk assessment of glacial lakes as part of planning process for hydropower plants planned and maintained downstream may be conducted.**

**5.8. Integration of glacial lake hazards would require greater co-ordination on Disaster/GLOF related policies at the regional level (SAARC and other GLOF vulnerable countries like China etc.).**

## **6. Guidelines**

- ❖ The Pakistan GLOF project may provide assistance in preparation of drafts of national and provincial policies, for Gilgit-Baltistan and Khyber Pakhtunkhwa provinces, on glacier hazards and legislative framework to support these policies.
- ❖ Awareness raising workshops for highlighting GLOF issues and policy and planning recommendations may be organized for the policy makers at the national and provincial levels in Gilgit-Baltistan and Khyber Pakhtunkhwa provinces.
- ❖ Awareness raising and training workshops for local CBOs to build their capacity so that their feedback on policies can reach decision-makers and influence future policy-making.
- ❖ Decision support system for glacier lakes and expected GLOF and other glacier hazards may be introduced by placing the available related statistics, data, spatial and indigenous information on the website and giving the access of necessary information to the policy and decision makers and giving access of early warning information to the local community.
- ❖ To elaborate the following goals of Pakistan Vision 2025 into key performance indicators related to glaciers or GLOFs, the Pakistan Vision 2025 Secretariat, Planning Commission, Ministry of Planning, Development and Reforms may be sent a request by the Climate Change Division, Government of Pakistan:

Goal #	Goal	Goal's key performance indicator that may be relevant to glacier or GLOFs
15	Water: increase	- Type and number of measures adopted to protect GLOFs to

	storage capacity to 90 days , improve efficiency of usage in agriculture by 20%, and ensure access to clean drinking water for all Pakistanis	<p>keep intact storage capacity of glacier lakes.</p> <ul style="list-style-type: none"> <li>- Number of new glacier lakes developed for water storage.</li> <li>- Number of glacial lakes whose water was used for growing forest trees or agricultural crops and type of efficient water use measures adopted.</li> <li>- Number of glacial lakes whose water was used for drinking purposes.</li> </ul>
16	Reduce food insecure population from 60% to 30%	<ul style="list-style-type: none"> <li>- Type and number of Climate Change Mitigation and Adaptation measures to reduce GLOFs and increase crop production and yield in areas surrounding glaciers.</li> </ul>

**Terms of Reference of the study**

“Review and Analysis of Existing National Disaster ACT and National Disaster Management Plan of Pakistan and formulate concrete policy recommendations and guidelines to streamline and incorporate Glacial Lake Outburst Flood (GLOF) issues for future policy formulation in the country”

The duties and responsibilities of the Consultant are as follows:

- 1) Through coordination with NPM, UNDP and the Climate Change Division; develop a plan of action for the scheduled task.
- 2) Conduct a desk review of the existing National Disaster ACT and National Disaster Management Plan for Pakistan.
- 3) Conduct a detailed analysis of the both of the policy documents and abstract the missing policy links related to GLOF and other glacier related disasters.
- 4) Develop and submit two separate drafts of policy recommendations to be considered for future policies and Plans regarding disaster management incorporating the GLOF and other Glacier related challenges in the country; one on National Disaster ACT and the other for National Disaster Management Plan of Pakistan.
- 5) Obtain the feedback and input of the key stakeholders and audiences through project management and incorporate the received feedback in the draft report.
- 6) Submit both hard and soft copies of the both separate final reports.

### GLOF related interventions at National level

- A. The National Disaster Management Authority conducted the following studies: (i) “Risk assessment of Glacial Lake Outburst Flooding (GLOF) in Gilgit district of Gilgit-Baltistan” and (ii) “Dam Break study of Hunza River-Attabad”. The study was conducted by NESPAK. The study was carried out to answer the following questions:
1. What is the location & composition of landslide?
  2. What is the capacity of Glacier Lake that has been formed?
  3. When the Glacier Lake would overtop the landslide mass?
  4. What would be the peak flood discharge at various locations along Hunza River downstream of landslide?
  5. What would be the depth and velocity of water at various locations?
  6. How much is the warning time for various villages/Gilgit city in case of GLOF?
  7. What are the areas that would be affected in case of dam failure?
  8. Up to which location on the river the dam-break flood wave would be highly destructive?
  9. What are the major and immediate steps/ decisions required at this stage?
- B. The Pakistan GLOF Project (2011 – 2015) has implemented a lot of on-the-ground interventions that would be helpful in preventing GLOFs and reducing its impacts on the life and livelihood of the local communities. The project supported Pakistan Meteorological Department in improving its early warning system and studied different aspects of the GLOF like “Impact of GLOFs on Biodiversity & Ecosystem in Bindo Gol Valley, District Chitral, Khyber Pakhtunkhwa”, “Literature Review On GLOF Issues: Work Done in Pakistan”; “GLOF Risk Reduction Guidelines for Chitral District, KP Province, Pakistan” etc.
- C. The National Agricultural Research Centre also conducted studies on glaciers and GLOFs. Water Resources Research Institute, National Agriculture Research Center Islamabad prepared preparatory Assessment Report on “Community Based Survey for Assessment of GLOFs in Hunza River Basin” with the collaboration of the UNDP. Different NGOs including Aga Khan Rural Support Programme and Sarhad Rural Support Programme have implemented certain interventions that are helpful in preventing disasters like GLOF.

### Regional and International Experiences

Regional and international organizations like International Centre for Integrated Mountain Development (ICIMOD), United Nations Development Programme conducted certain studies and implemented projects on glaciers and GLOFs. Some of the work of such organizations is as follows:

- Asia-Pacific Network for Global Change Research and the ICIMOD prepared a report on “Inventory of Glaciers and Glacial Lakes and the Identification of Potential GLOFs Affected by Global Warming in the Mountains of India, Pakistan and China/Tibet Autonomous Region”.
- European Commission on Humanitarian Aid and UNDP published a report on “GLOF Risk Reduction through Community-Based Approaches”.
- Asian and Pacific Training Center and Communication Technology for Development prepared a report on “Formation of Glacial Lakes in the Hindu Kush-Himalaya and GLOF Risk Assessment”.

International experiences regarding responsibilities of local communities in flood-prone areas; Flood Action plans; Insurance schemes for GLOF prone areas; Land Use, Zoning and Risk Assessment (Planning and Development Control) are described below:

- ❖ There is a responsibility on the individual who may be at risk from the consequences of flood events to take, if possible, his/her own precautions. However, appropriate information and forecasting systems would need to be put in place by the competent authority. This current thinking in relation to flood management measures is illustrated by the following international examples:
  - i. In England, the Environment Agency (EA) is currently in the process of changing its flood defence policy from one of building flood defences to that of managing flood risk. Existing flood defence policy emphasized the development of flood warning systems and construction of urban and coastal flood defences. The EA’s first priority will now lie with targeting investment at reducing risk to people and infrastructure identified in river basin plans. This will be closely followed by reducing flood impacts where they occur. Flood warning systems will continue to be developed, with a greater focus on accuracy and reliability.
  - ii. The Netherlands, following a series of serious flooding incidents in the early to mid-1990s; has introduced a number of policies and strategies including:
    - Space for the River’ – a policy of permitting the river to utilize its natural winter floodplain area, and restricting development within such areas to river-dependent uses.
    - Repair, maintenance and possibly setback of embankments along the designated floodplain areas.
  - iii. In Germany, Federal Leander has developed a manual for, and promotes the development of, Flood Action Plans. These plans set out measures required to minimize the risk of flood damage, reduce high water levels, strengthen the awareness of flooding and improve flood information. The plans are centered on a policy whereby floodplain management and sustainable planning and development have priority over flood protection works.
  - iv. A federal law passed in Switzerland in 1991 stated that ‘protection of human lives and substantial economic values should be achieved in the first order by means of maintenance of river courses, second by land use management and in third order, if the above mentioned means are not sufficient, by structural protection measures’.

- v. The Russian Federation has a framework flood-protection programme (in stages up to 2015) that emphasizes, inter alia, improvements to forecasting and warning systems.

❖ **Introducing Insurance of GLOF Prone Areas:**

In addition to public and individual measures, insurance can be an important factor in increasing the awareness and reducing the financial risk for individuals, businesses and even whole societies where natural hazards, such as GLOF, are concerned. A range of approaches to flood insurance has been adopted by different countries. They range from obligatory to completely voluntary coverage and from all-risk policies to flood only policies. There are advantages and disadvantages in all these concepts and none can be declared the best. In a study of different national approaches to flood insurance within the EU Dr.

Jens Mehlhorn of Switzerland made the following points:

1. Effective and sustainable flood cover is technically possible, but requires partnership between the state, the insurance industry and the individual, with each bearing certain responsibilities in relation to risk reduction.
2. A large risk community (through, for example, compulsory insurance for all, or flood insurance incorporated as a standard part of property insurance with some risk differentiation) is preferable to a small community in terms of economic viability of the insurance scheme.
3. Risk assessment (i.e. flood hazard information) is important for a sustainable insurance scheme.

The final point reinforces the requirement for flood hazard mapping by insurance companies when designing a premium structure. Flood risk zoning information is required by re-insurers so that they can calculate the expected losses that the insurance industry might face as a result of an extreme event threatening a company's existence. Insurance companies can make an important contribution towards loss reduction by raising the willingness of home and business owners to defend their property against flood damage. The motivation for the insured to take measures aimed at loss reduction would be reflected in adequately structured premiums.

❖ **Inappropriate planning and development in a river basin:**

This may be a significant factor in adding to the flood risk. The more intensively and the less suitably a river basin is used, the greater the potential for damage when the flood occurs. Water management policy and spatial planning efforts in the long run must concentrate on attaining a balance between economic development and urbanization on the one hand and the need to allocate more space to water for flow retardation and water retention on the other hand. Water must become a guiding principle in spatial planning. Specific key points relating to preventive land use are:

- Immediate GLOF plains should be identified and designated by law as priority sites for flood retention or to restore mobility to waterways.
- Building development in the immediate areas at risk of GLOFs, landslides or dam failures should be stopped if unacceptable risks to human lives or material damage exist.
- All installations, works, construction work and hazardous or hazard-prone activities and uses in designated areas should be subject to administrative permits or authorizations. Restrictions and prohibitions should be based on risk assessments. Moreover,

incorporation of an activity may not impede the retention, storage or drainage of water in the river basin area and should be guided by the underlying principle that water-related problems may not be passed downstream or from one part of the river basin to another.

- Vulnerability diagnoses should be generalized to existing industrial and commercial companies, real estate development managers, drinking water production or water treatment facilities, farms, etc. located in flood-prone areas. This is in order to assess the consequences of high-water incidences and to propose measures enabling their reduction, to produce flood emergency plans and to develop preparedness to the risk by training exercises.
- The most sensitive establishments, such as buildings, facilities and installations whose operation is fundamental to civil safety, defence or maintaining public order, or whose failure presents a high risk to humans or presenting the same risks due to their socio-economic importance, must be implemented on the nearest no-risk prone areas. Only activities that are inextricably tied to the water management system or cannot be implemented elsewhere for reasons of important societal interest should be permitted.
- Existing constructions at risk of flooding should be made flood-compatible for all water-related problems. In some cases construction and reactive measures, with economic justification, can contribute more to damage reduction than other natural water retention measures and technical flood protection. In potential flood plains, the forward planning and approval stages of further construction work should take account of new and creative construction methods that incorporate the need to maintain space for water and address water-related problems.
- It is necessary to identify and reduce the vulnerability of existing infrastructures and all networks located in flood-prone areas (water supplies, energy systems, transportation and communication networks, public facilities, etc), and particularly transport network which may suffer massive interruptions or hinder the evacuation and the arrival of emergency services.

It might be noted in the context of the above that the United Kingdom has a well-developed policy in relation to planning and development that encourages development outside of flood risk areas, but is not prohibitive if no other appropriate site can be found.

## **References / Bibliography**

- Anaconda, P. I., & Norton, A. M. (2014). Glacier Lake Outburst Flood (GLOF) Hazard Assessment and GLOF Risk Management in the Chilean Patagonia. *7th Australasian Natural Hazards Management Conference, Wellington* (p. 3). School of Geography Environment and Earth Sciences, Victoria University of Wellington, PO Box 600, Wellington, New Zealand, pablo.iribarren@vuw.ac.nz.
- Ashraf, A., Roohi, R., Naz, R., & Mustafa, N. (2011). Identification of Glacial Flood Hazards in Karakoram Range Using Remote Sensing Technique and risk analysis. *A scientific journal of COMSATS – SCIENCE VISION Vol.16 and Vol. 17 (January 2010 to December 2011)*, 71-80.
- Campbell, J. G. (2005). *Inventory of Glaciers and Glacial Lakes and the Identification of Potential Glacial Lake Outburst Floods (GLOFs) Affected by Global Warming in the Mountains of India, Pakistan and China/Tibet Autonomous Region*. Kathmandu: Final Report of Asia-Pacific Network for Global Change Research Project 2004-03-CMY-Campbell, International Centre for Integrated Mountain Development (ICIMOD) and Asia-Pacific Network for Global Change Research (APN).
- Hewitt, K. (1982). Natural dams and outburst floods of the Karakoram Himalaya, in proceedings of the Exeter symposium on Hydrological aspects of Alpine and High Mountain areas. *Proceedings IAHS, 138, July*, 259-269.
- Ministry-of-Climate-Change. (2012). *National Climate Change Policy*. Islamabad: Ministry of Climate Change, Government of Pakistan.
- Ministry-of-Environment. (2005). *National Environment Policy*. Islamabad: Ministry of Environment, Government of Pakistan.
- NDMA. (2013). *National Disaster Risk Reduction Policy*. Islamabad: National Disaster Management Authority, Ministry of Climate Change, Government of Pakistan.
- Planning-Commission. (n.d.). *Pakistan 2025, One Nation - One Vision*. Islamabad: Planning Commission, Government of Pakistan.
- Roohi, R., Ashraf, A., Mustafa, N., & Mustafa, T. (2008). *Preparatory Assessment Report on Community Based Survey for Assessment of glacial Lake Outburst Flood Hazards (GLOFs) in Hunza River Basin*. Islamabad: WRII-NARC and UNDP, Pakistan.
- UNISDR. (2011). *HFA Progress in Asia-Pacific, Regional Synthesis Report 2009-2011*. United Nations International Strategy for Disaster Reduction.