Flash Flood Risk Management in the Hindu Kush Himalayan Region

Arun Bhakta Shrestha and Sagar Ratna Bajracharya, ICIMOD

Countries in the Hindu Kush Himalayan region generally lack policies, strategies, and plans dealing specifically with flash floods. Most of the existing policies relate to riverine floods or to disasters in general.

Introduction

The Hindu Kush Himalayas (HKH) is a mountain system of extremes with great influence over the Asian continent. The system stretches 3,500 km over eight countries, from Afghanistan in the west to Myanmar in the east. It is the world's largest and highest mountain system, with more than 30 peaks measuring over 7,600 m. It is also the youngest mountain system on Earth and still tectonically active. The HKH region is characterized by fragile bedrock, steep slopes, and a high rate of surface erosion. Its superlative dimensions give it enormous influence over the climate of Asia. The HKH mountains block the monsoon from the south as well as extremely cold air blowing from the north. Consequently, the southern slopes and valleys host some of the wettest, greenest mountain ecosystems in the world, particularly in the east, for example the subtropical uplands of Myanmar. In contrast, the northern mountains and Tibetan plateau are generally snowy, much colder, and in some areas dry and nearly devoid of vegetation.

The world's most populous mountain system, the Hindu Kush Himalayas are home to over 140 million people and affect the lives of hundreds of millions beyond. The inhabitants of the HKH are, by and large, poor and depend heavily on the land and natural resources for their livelihoods and wellbeing.

The HKH system is one of the Earth's great water reservoirs, providing freshwater for fields, industry, and drinking. Himalayan rivers generate electricity for countless homes, with many more hydroelectric dams planned. While the water flowing from this region sustains the lives and livelihoods of the millions of people residing in the HKH, it is also a source of considerable hazard. In addition to the geological conditions, intense seasonal precipitation in the central and eastern Himalayas during the summer monsoon (June–September) and in the western Himalayas during winter triggers a variety of natural hazards. Floods are one of the most common forms of natural disaster in this region, and flash floods are particularly devastating. The mortality rate from flash floods is much higher than from other water-induced disasters.

Despite their destructive nature and their immense impact on the socioeconomy of the region, flash floods have not received adequate attention from policy and decision makers. This is mainly because of poor understanding of the processes involved and measures needed to manage the problem. The current understanding of flash floods remains at the level of general concepts; most policy makers have yet to recognize that flash floods are distinctly different from normal riverine floods in term of causes, propagation, intensity, impacts, predictability, and management. Flash floods are generally not investigated as a separate class of event but are rather reported as part of the overall seasonal flood situation. As a result, the countries of the HKH region generally lack policies, strategies, and plans relating specifically to flash floods. Most of the existing policies relate to riverine floods or to disasters in general, and flash floods are dealt with using the same strategies as riverine floods.

Causes of Flash Floods in the HKH Region

High intensity rainfall events in the HKH are often localized and have important implications for flash floods. These intense rainfall events, sometimes called cloudbursts, can occur in remote areas as a

result of topographic variations and are generally unreported because of inaccessibility and isolation. An intense rainfall event may occur in the high reaches of a mountain stream in an unpopulated area yet may produce a flash flood affecting downstream communities. Prolonged monsoon rainfall can also cause flash floods, as occurred in central Nepal in 1993 and in Niujuangou gully, China in May 2010. Monsoon depressions are another climatic factor that causes flash flood, particularly in Pakistan. In the western Himalayas, accumulated snow can melt rapidly during spring, leading to flash floods.

The glaciers in the Hindu Kush Himalayas, particularly in the eastern Himalayas, are in a general state of retreat, probably because of climatic warming (Ageta and Kadota 1992; Kadota and Ageta 1992; Kadota et al. 1997). Himalayan glaciers in the Dudh Koshi are retreating at rates ranging from 10 to 60 m per annum, and many glaciers smaller than 0.2 km^2 have already disappeared (Bajracharya et al. 2007).

Retreating glaciers often leave behind voids filled by meltwater called glacial lakes. Glacial lakes tend to burst because of internal instabilities in the natural moraine dams retaining the lakes (e.g., as a result of hydrostatic pressure, erosion from overtopping, or internal structural failure) or as a result of an external trigger such as a rock or ice avalanche, or even earthquake. Glacial lake outburst floods (GLOFs) can be catastrophic and are common in the HKH region. Floodwaters from this phenomenon contain a huge amount of sediment from glacial moraines, which can cause morphological changes in the river channel and devastating loss of life and property at great distances from the outburst source. The GLOF of Dig Tsho glacier lake on 4 August 1985 and the Zhangzanbo GLOF event of 1981, both in Nepal, caused great damage. The Zhangzanbo GLOF hampered trade between China and Nepal for a number of years.

Because of the young geology of the Himalayas and the instability of their slopes, the HKH region is prone to recurrent and often devastating landslides and debris flows. Such landslides and debris flows, released by torrential rain or seismic activity, may cause temporary dams across river courses impounding immense volumes of water. Subsequent overtopping or breaking through of the earth dam can result in a landslide dam outburst flood (LDOF), which, similar to a GLOF, is difficult to predict and may cause serious loss of life and damage to property. One remarkable LDOF event was the Larcha LDOF of 22 July 1996 in Nepal, which wiped out Larcha village killing 54 people.

The failure of artificial structures, such as embankments and hydropower dams, can also cause flash floods. Occasionally, the uncoordinated operation of hydraulic structures causes flash floods and loss of life and property. The major flood in the Jiadhal River basin in 2007, which devastated about 30 villages on the right bank in Dhemaji District, Assam, India, and the Koshi flood of 2008, which affected Nepal and India, are examples of flash floods caused by structural failure.

Socioeconomic Factors Contributing to Vulnerability

The Hindu Kush Himalayan region is one of the poorest regions in the world, containing about 40 per cent of the world's poor. Five of the eight counties in the region are categorized as least developed countries with 30 to 50 percent of the population living under the poverty line (Table 1). The region is the most densely populated in the world, with population density as high as 180 persons per square kilometre in some places. The population growth rate is also quite high. High population density results in scarcity of natural resources such as land and water, forcing people to live in areas vulnerable to natural disasters. On top of the physical and environmental factors, these social and economic conditions exacerbate the vulnerability of people in the region to different types of disaster including flash floods.

Policies, Strategies, and Institutional Framework

The countries of the Hindu Kush Himalayan region generally lack policies, strategies, and plans specifically dealing with flash floods. Most of the existing policies relate to riverine floods or to disasters in general. China has a somewhat better policy framework for flash floods; however, all of the countries in the region are yet to recognize and address mountain hazards as a separate issue from both upstream and downstream disaster risk perspectives, particularly in relation to flash flood risk reduction. This section gives a brief overview of the policy and institutional frameworks in place in each of the countries of the Hindu Kush Himalayan region.

Table 1: **Socioeconomic status of the countries in the Hindu Kush Himalayan region (2011)**

Country	Area within HKH region (km^2)	Population[a] (million)	GDP (current USD, billion)	Annual population growth rate (%)	Annual GDP growth rate (%)	Infant mortality rate (per 1,000 live births)	Access to improved water source (% of population)	Literacy rate (% of population)	Population below national poverty line (%)
Afghanistan	390,475	22	17.2	2.7	8.2	149	50	37.8	53
Bangladesh	13,295	1	100.0	1.2	6.1	48	81	47.9	50
Bhutan	38,400	0.74	1.7	1.7	8.4	56	96	52.8	23
China	2,420,266	32	7,298.1	0.5	9.1	18	91	95.9	13.4
India	461,139	46	1,848.0	1.4	6.9	63	92	74	29
Myanmar	317,629	11	–	0.8	13.7	66	83	92	32.7
Nepal	147,181	30.49	18.9	1.7	3.9	50	89	68.2	25.2
Pakistan	489,988	38	211.1	1.8	2.4	87	92	86.2	33

[a] Calculated based on 1997 data using average growth rate.
Source: World Bank 2011

Afghanistan

Afghanistan is just beginning to build its capacity for disaster management and is establishing institutions to deal with this issue. Among the existing institutions, the Ministry of Energy and Water is responsible for the development and management of water resources and could potentially take the lead in flash flood management. Community-based organizations and non-governmental organizations (NGOs) are not as prominent in Afghanistan as they are in some of the other countries in the region. The Afghanistan National Disaster Management Authority is the focal point for disaster management and has a coordinating role during emergency operations.

Policy on natural resource management in Afghanistan is indirectly related to flash flood management as it favours preservation of the environment which helps ensure flash flood hazard reduction. River basin and watershed management are included in the policy framework of the water sector, and the Environment Act is in the process of being finalized. The Department of Disaster Preparedness has prepared a draft National Disaster Management Strategy focused on the structure of the Department of Disaster Preparedness; type of disasters that might happen in Afghanistan; various stakeholders available to work jointly; the need for an early warning system and awareness programme; emergency response operations; reporting; planning/programming; capacity building; the identification of problems; and the establishment of a revolving fund to cope with issues related to emergencies caused by flash floods, earthquakes, and other natural disasters.

Bangladesh

Bangladesh has a long history of managing floods, with plans for flood control measures dating back to the 1950s. A master plan for water development was drawn up in 1964. Severe floods of 1987 and 1988 prompted the Flood Action Plan and introduced the concept of 'controlled flood', instead of full flood control. The Government of Bangladesh formulated the National Water Policy in 1995 and the National Water Management Plan in 2003. Within this policy framework, there are some set policies related to flash floods. Flash flood prone areas have been delineated in the national strategy, and programmes for mitigation measures are being implemented. In 1997, the Government issued a Standing Order on Disasters documenting instructions and orders for disaster activities and management. It initially only covered cyclones but was revised in 1999 to cover all types of disasters, including flash floods. This is an important policy document encompassing many aspects of disaster management such as arrangements for local focal points, supervision, rescue, and evacuation. Bangladesh's strategy focuses on collaboration with upstream countries in the exchange of data and joint assessments.

Bhutan

In Bhutan, the Department of Disaster Management under the Ministry of Home and Cultural Affairs is responsible for disaster management activities. Considering the susceptibility of the country to various types of flash floods, the Department of Disaster Management, in collaboration with the Department

of Geology and Mines and the Department of Hydro-Met Services, is raising awareness among downstream communities about flash floods. The Department of Energy is the lead organization for addressing GLOF hazards and is working on an early warning system, while mitigation aspects are led by the Department of Geology and Mines. The National Disaster Bill for Bhutan, which is coordinated by the Department of Disaster Management, is in the process of finalization.

In addition, Bhutan is in the process of setting up disaster management committees in all of its Dzongkhags (districts). All Dzongkhags will be mandated to have emergency, prevention, and mitigation plans included in their annual and five year plans. The emergency plan will specify who will do what during a disaster and how. The prevention and mitigation plans will focus on what is to be done to prevent and mitigate disasters. The Department of Local Governance is in the process of formulating a disaster management strategy for the whole country.

China

China is the only country in the HKH region that deals with flash floods separately from other floods and disasters. China has an institutional set up and policies specifically targeted at flash flood risk management. The flash flood hazard prevention team is led by the State Flood Control and Drought Relief Headquarters. Representatives from the Ministry of Water Resources, Ministry of Land and Resources, China Weather Bureau, Ministry of Construction, and the State Environmental Protection Administration of China are members of the team.

China has a number of policies indirectly related to flash flood management and is preparing policies with a particular focus on flash floods. Existing policy ensures the consideration of flash flood hazards during construction planning. China also has a mechanism to allocate funds for flash flood prevention. China's flash flood prevention strategies are based on three principles: the principle of "harmonious coexistence between people and nature"; the principle of "reliance on prevention and a combination of prevention and control" and "reliance on non-structural measures and a combination of structural and non-structural measures"; and the principle of "making full use of existing resources and avoiding repetitive construction". China has short-term (by 2010) and long-term (by 2020) plans for flash flood management. The short-term plan, which focuses on non-structural measures such as monitoring, telecommunication, forecasting, and warning and combines them with structural ones, is being set up as a preliminarily measure in key regions. The long-term plan is a comprehensive flash flood hazard prevention and reduction system combining non-structural and structural measures and will be implemented in all flash flood prone areas.

India

In India, flood management is organized at the central, state, and local levels. The central level provides guidance to the states, which implement flood management at the field level. The main central-level agencies are the Ministry of Home Affairs and the Ministry of Water Resources. In addition to the relevant ministries, commissions, and technical support agencies, the central government has created river boards for the major rivers such as the Ganges and Brahmaputra. A National Committee on Disaster Management was recently established under the Prime Minister to review disaster situations in the country.

The first flood policy of India was prepared in 1954. Since then, India's flood policy has been modified repeatedly. The most comprehensive flood policy was completed in 1980. The National Water Policy was released in 1987 and revised in 2002, and a draft revised policy of 2012 is under discussion after being posted on a website for public opinion. These policy documents stress the importance of non-structural measures in mitigating flood risk. The National Water Policy emphasizes an integrated basin approach to flood management and public participation in flood management. The traditional strategy of flood management in India was through structural measures. This trend is changing, and the following four strategies have been adopted for flood management: modification of floods; modification of susceptibilities to flood damage; modification of loss burden; and bearing the loss. India plans to implement these strategies through various activities. Emphasis will be placed on flood plain management, i.e., on regulating land use in flood plains to minimize the damage caused by floods while deriving maximum benefits from them. Floodproofing measures will also be implemented to mitigate distress and provide immediate relief to populations in flood prone areas. Floodproofing is essentially a combination of structural changes and emergency

action that does not involve evacuation. India plans to set up flood forecasting and early warning systems as part of its non-structural measures to manage flash floods. India also plans to take action towards disaster preparedness and response planning, flood relief and rehabilitation, and flood insurance.

Myanmar

Myanmar organizes flood management mainly at the central level with the involvement of the Department of Meteorology and Hydrology, Irrigation Department, Relief and Resettlement Department, and the Myanmar Red Cross Society. These institutions are responsible for flood forecasting and warning, constructing structural mitigation measures, conducting disaster management training courses, and erecting signs for hazard control. A National Disaster Preparedness Central Committee has been formed under the chair of the Prime Minister as the apex body for disaster management.

Myanmar has not prepared a policy framework for flood, or flash flood, management. Land use policies and various national and local policies indirectly address flash flood issues. Myanmar's strategies related to flash flood management are gradually evolving towards reducing losses in the event of a hazard. The primary aim is to reduce the risk of death and injury to the population, and the secondary aim is to reduce damage to public infrastructure and consequent economic loss.

Nepal

In Nepal, water-induced disasters are accorded high priority. Flash flood management is led by the Central Natural Disaster Relief Committee, which is chaired by the Minister for Home Affairs; members include two other ministers, the secretaries of most ministries, various director generals, and representatives from the armed forces, police, scouts, and Nepal Red Cross Society. At the local level, there are regional, district, and local natural disaster relief committees. The Department of Water Induced Disaster Prevention is responsible for implementing flood mitigation programmes. The Department of Hydrology and Meteorology is responsible for monitoring glacial lakes and issuing weather forecasts and flood forecasts. A number of NGOs are actively involved in flood risk management including community-based flood risk management.

The promulgation of the Natural Calamity (Relief) Act in 1982 was a milestone in systematic disaster management in Nepal. This act provides a framework for disaster mitigation in the country and has been amended twice. However, it only describes the duties and responsibilities of the Ministry of Home Affairs. It is now accepted that the duties and responsibilities of other disaster management agencies should be more defined. The Tenth Plan (2002–2007) underlines the need to develop means for improved prevention, mitigation, and reduction of natural disasters. In terms of water, the National Water Plan is currently under finalization and will operationalize the Water Resource Strategy adopted in 2002.

Recently, Nepal prepared the Water-Induced Disaster Management Policy, which covers five areas: emergency protection; information dissemination for effective relief, rescue, and protection; awareness raising; warehouses for rescue and relief supplies; and a rehabilitation fund. In 1996, Nepal prepared a National Report and Action Plan for Disaster Management. The Action Plan contains a Disaster Preparedness Plan and Risk Assessment for Disaster Management. The National Water Plan sets out detailed activities to be carried out to implement the Water Resource Strategy and envisions the establishment of disaster prevention, warning/preparedness, and mitigation measures in at least 20 priority districts by 2010 and across the whole country by 2027. In the meantime, documents related to disaster mitigation are gradually being developed.

No separate policy has been formulated for managing GLOF risk. However, some national policies contain strategies and programmes to reduce the risk of GLOF. These include the Sustainable Agenda for Nepal, 2003; Water Resource Strategy, 2002 and National Water Plan, 2005; Disaster Risk Reduction Strategy, 2009; and Climate Change Policy, 2011. Many of these policies have adopted integrated water resource management and river basin management approaches with emphasis on community-based risk management. The National Adaptation Programme of Action (NAPA) to Climate Change 2010 and the Climate Change Policy, 2011 specifically mention GLOF. Monitoring of potential GLOF lakes, implementation of structural measures, establishment of early warning systems, forecasting and preparedness in downstream communities, and support for vulnerable communities are some of the recommended programme activities contained in the NAPA and Climate Change Policy, 2011.

Pakistan

In Pakistan, the National Crisis Management Cell under the Ministry of Interior is responsible for monitoring natural hazards and coordinating emergency response services with the Provincial Management Cells. The Emergency Management Cell under the Cabinet Division is responsible for relief operations during emergencies. The Civil Defence Department and Pakistan Army play an important role in relief operations. The other federal agencies that deal with flash floods are the Pakistan Meteorological Department, Federal Flood Commission, and Dam Safety Council. Besides government institutions, there are a few NGOs involved in flash flood management. One prominent NGO in this regard is Focus Humanitarian Assistance (FOCUS), Pakistan.

Pakistan lacks policies directly related to flash floods. The National Calamities (Prevention and Relief) Act 1958, Emergency Services Ordinance 2002, and Local Government Ordinance 2001 are some of the policy documents indirectly related to floods and flash floods. The Federal Flood Commission makes polices in light of the decisions made at pre- and post-flood meetings at the national and regional levels. These policies are reviewed according to the shortcomings identified during the flood season and are implemented at the grassroots level as strategies and action plans to reduce vulnerability to flash floods. Strategies related to flash flood management are gradually evolving in Pakistan. The main strategies are to strengthen flood forecasting, to strengthen the technical capacity of institutions involved in flood forecasting, and to improve rescue and relief activities. Emphasis is placed on improving the communication system for the proper dissemination of forecasts.

Flash Flood Mitigation Measures

Major emphasis has been placed on structural and non-structural measures for flash flood hazard mitigation in the HKH region. Like China, India has relied heavily on structural measures for flood control in the past. China, however, is gradually accepting that absolute immunity from flood damage is unattainable. An integrated approach encompassing flood plain zoning and flood plain management is gaining ground. Bangladesh also has an extensive network of structures aimed at reducing inundation-related hazards from floods. A combination of hard and soft measures to reduce the damage caused by floods is postulated. Similarly, Bhutan is trying to protect its forests as a way of protecting downstream areas from floods.

Afghanistan and Bhutan have no operational flood forecasting system. Nepal is currently conducting a test of flood forecasting models and intends to provide flood forecasting in the near future. China operates a forecasting system which includes weather, stream, debris flow, and landslide forecasting. The accuracy of forecasts is improving in China, although flash flood forecasting in small drainage areas is still difficult. India and Bangladesh have an extensive flood-forecasting network, but forecasting is mostly for riverine floods, not flash floods. Pakistan has a network of weather radar used for flood forecasting and has been successful in flood forecasting and minimizing human casualties in recent years.

Mitigation efforts in the HKH rely mainly on the development of detection and response warning systems, which have undergone tremendous transformations in recent times as a result of technological innovations. Real time observations combined with hydrometeorological models allow for increasingly accurate and timely forecasts and warning, increasing the lead time for evacuation. ICIMOD is undertaking a few initiatives in this field, such as the HKH Hydrological Cycle Observing System (HYCOS) and Satellite Rainfall Estimation (SRE). In addition, ICIMOD has developed a Resource Manual on Flash Flood Risk Management, which contains materials needed to help people working in risk prone areas to understand the problem and manage the risks associated with flash floods. The first and second modules (Shrestha et al. 2008; Shrestha 2008) focus on community-based management and non-structural measures for managing flash flood risk. The third module (Shrestha et al. 2012) focuses on structural measures for flash flood risk management. The main objective of this resource manual is to build the capacity of people working in district-level government and non-governmental organizations for flash flood risk management; it is also expected to be of use to district-level disaster mitigation and relief workers as well as professionals from community-based and non-governmental organizations including hydrologists, meteorologists, and civil engineers.

The countries of the HKH region differ in the extent of their flash flood early warning infrastructure. Many of the countries in the region have no early warning system in place. It is increasingly acknowledged that the management of flash floods, including

early warning systems, is best handled by local communities, as outlined in the case studies on the Jiadhal River basin in Assam, India and Chitral in Pakistan in Part 2 of this publication. China, India, Myanmar, and Bangladesh have flash flood early warning systems in operation in some watersheds. Nepal has a GLOF early warning system based on a meteor burst communication system downstream from Tsho Rolpa glacial lake.

Conclusions

- The current understanding of flash floods in the HKH remains at the level of general concepts and processes, but systematic learning and reflection from past events are lacking.
- The capacity to manage flash floods in terms of prevention, preparedness, response, and recovery is lacking in most countries of the HKH.
- With the exception of China, none of the countries in the HKH give particular focus to flash floods; instead these events are dealt with as part of overall disaster management or riverine flood management.
- The countries in the HKH differ greatly with respect to flash flood management mechanisms, policies, and implementation. For instance, some countries follow a top-down and centralized approach to flash flood management, while others enlist local community participation in the design and implementation of flash flood management systems. This diversity poses difficulties in the development of cross-border and integrated flash flood management; however, it offers great opportunities for regional learning and exchange. For example, China has an advanced setup for total flash flood disaster management, which other countries could learn from.

Recommendations for Strengthening Flash Flood Risk Management in the Hindu Kush Himalayan Region

- Develop policies specific to flash flood risk management in the countries of the HKH region.
- Raise awareness and knowledge about flash floods at all levels among communities, practitioners, and policy makers to enhance preparedness.
- Improve the institutional setup for flash flood risk management and ensure that it deals with flash floods as separate from other types of floods and disasters, but still addresses the need for an integrated disaster management approach. This also requires the strengthening of other bodies responsible for disaster management, including those responsible for flash floods.
- Empower communities to play a central role in flash flood management including preparedness, adaptation, and mitigation. Promote the concept of community-based disaster management and the use of indigenous and local knowledge.
- Adopt a watershed management approach with community involvement and integrated water resource management.
- Develop a standard methodology and format for documenting flash flood events and for subsequent reflection on the causes, effects, and lessons that can be derived from such events.
- Strengthen the national network of hydrological and meteorological observation, weather radar, and the processing of modern satellite-derived products for the acquisition of real-time data to forecast flash floods and provide warning.
- Promote effective early warning systems with the involvement of upstream and downstream communities to save lives and reduce the risk of flash floods in vulnerable areas of the HKH region.
- Strengthen communication and coordination among relevant institutions and as part of national disaster risk management strategies. National stakeholders should be encouraged to establish formal and informal platforms to facilitate cross-sectoral dialogue to improve flash flood management.
- Conduct flash flood modelling and hazard mapping to identify hazard prone areas and develop land use guidelines and building codes, and implement these with the strong involvement of local stakeholders.
- Develop transboundary collaboration, both international and national, for the management of flash floods including information exchange, joint implementation of mitigation projects, and establishment of flash flood early warning systems.