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FOR MOUNTAINS AND PEOPLE

# Managing Flash Flood Risk in the Himalayas

INFORMATION SHEET #1/10

Although flash floods are by their nature difficult to predict and control, it is possible to reduce the risk to lives and property through different measures. This information sheets summarises the major causes of flash floods in the Hindu Kush-Himalayan region, and the different approaches that can be used to reduce the potential impacts. There are three key messages:

- Due to local characteristics and the sudden nature of their occurrence, flash floods are best managed by local authorities and communities.
- Non-structural measures are more effective in the management of flash flood risk, but a combination of non-structural and small-scale structural measures can produce the best results.
- Flash floods should be addressed while implementing national and regional flood management policies, and integrated water resources management and disaster risk management plans.

## What are flash floods?

Flash floods are one of the most common forms of natural disaster in the Hindu Kush-Himalayan (HKH) region. They consist of a sudden and very strong surge of water, usually along a riverbed or dry gully, that can carry rocks, soil, and other debris. Whereas 'normal' riverine floods can to some extent be predicted, offering opportunities for preparation and avoidance, flash floods are sudden, usually unexpected, and allow little time to react. Individual flash floods may last from several minutes to several days and may happen anywhere, but are more common in mountain catchments. Although flash floods generally affect smaller areas and populations than riverine floods, their unexpected and intense nature means that they pose a significant risk to people and infrastructure, leading to death and destruction. The HKH region is particularly vulnerable to this type of flood as a result of the steep slopes, high rate of surface erosion, and intense seasonal precipitation, particularly during the summer monsoon in the central and eastern Himalayas and in winter in the western Himalayas. Changing watershed and environmental conditions (including climate) are increasing this vulnerability.

## Causes of flash floods

Flash floods can be caused by a variety of factors. The main direct causes in the Hindu Kush-Himalayan (HKH) region are intense rainfall events, landslide dam outbursts, glacial lake outbursts, rapid melting of snow and ice, sudden release of water stored in glaciers, and failure of artificial structures such as dams and levees.

**Intense rainfall:** Intense rainfall in the region is generally caused by cloudbursts, stationary monsoon troughs, or monsoon depressions. When the rain falls in an area with limited surface and sub-surface drainage, it can cause a local flash flood; when it is channelled down a steep slope through a narrow opening, it can cause massive destruction.

**Landslide dam outburst flood:** Landslides and debris flows are common in the Himalayan region as a result of the weak geological formations, tectonic activity, rugged topography, and intense monsoon rainfall. Sometimes large amounts of material from a landslide or debris flow can temporarily block a river, preventing outflow of the water and leading to development of a temporary reservoir or lake above the landslide dam. Eventually the unstable dam may break, either as a result of pressure from the volume of water, or when the water rises high enough to flow over the top of the dam and destabilise 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 Yigong flood in Tibet, China on 10 June 2000 is a typical example of a large landslide dam outburst flood with a transboundary impact.

**Glacial lake outburst flood (GLOF):** Glacial lakes form when a glacier retreats leaving the debris mass at the end of the glacier – the end moraine – exposed. The moraine wall can act as a natural dam, trapping the meltwater from the glacier and leading to the formation of a lake. The moraine dams are composed of unconsolidated boulders, gravel, sand, and silt. As with landslide dams, they can eventually break catastrophically, leading to a glacial lake outburst flood. The glaciers in the Hindu Kush-Himalayan region are in a general state of retreat; and the number of glacial lakes, and the threat of an outburst, are likely to increase. Thirty-five GLOFs have been recorded in the region since 1935.

## Flash flood in Chitral, Pakistan

At 5pm on Friday 4 May 2007, there was panic in Chitral when everybody in five villages ran to save their lives and those of their dear ones. Thunderstorms had started at 4pm and continued for an hour followed by a half-hour hailstorm, causing flash flooding more intense than ever before experienced in the history of the area. Within half an hour, 42 families were homeless and looking for food, clothes, and shelter. The flood moved at such a tremendous speed that it moved huge boulders, tore out trees, destroyed buildings, and obliterated bridges. When the water receded, the green agricultural lands were full of boulders and standing crops were ruined. All signs of human settlement had been washed away. The wealth accumulated by the community from generation to generation – houses, agricultural land, orchards, livestock, irrigation channels, roads, water and electricity supply lines– everything except their lives was gone. The damage was estimated at over US $0.5 million

**People trying to relocate after another flash flood in Chitral in July 2007**

## Yigong landslide dam outburst flood

Following a sudden temperature increase, a huge amount of snow and ice melted, resulting in a massive, complex landslide on 9 April 2000, that blocked the Yigong River, a tributary of the Yarlung Zangbo River in the upper part of the Zhamulongmba watershed. The dam blocked the outlet of the Yigong lake, and the lake level rose by about one metre per day. On 10 June 2000 the landslide dam burst creating a huge flash flood with a peak 36 times greater than normal flood. Although a large amount of property and infrastructure was damaged Chinese territory, there were no injuries or deaths. However, the destruction on the Indian side of the border was unprecedented. Thirty people died, more than 50,000 people in five districts of Arunachal Pradesh were made homeless, and the infrastructure suffered extensive damage. The total economic loss was estimated at more than 22 million US dollars.

## Assessing the risk

The risk of flash flood must be assessed (if possible) before a risk management strategy can be developed. Risk assessment consists of characterising the area; determining the likelihood and likely intensity of a flood (the hazard level); assessing the extent of damage (physical and social) that could result (the vulnerability); and using this information to assess the overall risk – a combination of hazard level and vulnerability. The assessment can be used to prioritise, plan, and implement management measures (especially if a full economic assessment is made), and also indicates the kind of management needed (e.g., non-structural or structural, community-based or technology-based, and so forth).

## Managing the risk

Most flash flood events take place in remote, isolated catchments where the central government's reach is limited or non-existent. When flash floods strike, external help may take several days to reach affected communities, during which time they are left to cope on their own. Technological advances and institutional arrangements for disaster risk management are gradually improving in the Hindu Kush-Himalayan region, but this process takes time. In areas where flash floods can be expected, it is essential to build the capacity of communities to manage the risks from disaster by themselves. Individual households usually have strategies in place, but the effectiveness of these individual efforts can be enhanced manyfold if they are coordinated.

### Community risk management committee

A forum like a community flash flood risk management committee (CFFRMC) is a good mechanism for uniting the efforts of community members and local authorities.


**Tsho Rolpa glacial lake showing the loose moraine dam which can burst, sending a flood of water downstream**

The use of local and indigenous knowledge can be an important part of community-based flash flood risk management; it is essential that gender aspects are taken into account and the effects on all members of a community considered during planning.

### Structural and non-structural measures

It is difficult to predict the exact location, magnitude, and extent of most flash floods, thus it is rarely useful to carry out large-scale structural measures like building of embankments, dams, and levees. But there are many non-structural measures that can help to reduce the impact of floods, ranging from land use planning, construction codes, and soil management and acquisition policies, through insurance, awareness raising, public information, and emergency systems, to post-catastrophe recovery plans. Such non-structural measures are generally sustainable and less expensive. Small-scale structural measures like check dams, small-scale levees using local materials, and sand bag embankments can also be useful. The best solution is usually a combination of small-scale structural and non-structural measures.

**Structural and non-structural measures for flash flood risk management**

| | | | |
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| Structural measures | | | Catchment-wide interventions (agriculture and forestry actions and water control work) |
| | | | River training |
| | | | Other flood control measures (passive control, water retention basins and river corridor enhancement, rehabilitation and restoration) |
| Non-structural measures | Risk acceptance | Tolerence strategies | Tolerance |
| | | | Emergency response system |
| | | | Insurance |
| | Risk reduction | Prevention strategies | Delimitation of flood areas and securing flood plains |
| | | | Implementation of flood areas regulations |
| | | | Application of financial measures |
| | | Mitigation Strategies | Reduction of discharge through natural retention |
| | | | Emergency action based on monitoring, warning, and response systems (MWRS) |
| | | | Public information and education |

Source: Colombo et al. (2002)

## Who is responsible?

Minimising the risk to life and property is the foremost goal of risk management. To be successful, risk management must involve a wide range of individuals and institutions.

### Roles of different groups in flash flood risk management

| Central administration | River basin organisers | Provincial administration | Local adminstation | Household |
|---|---|---|---|---|
| • Develop national strategy<br>• Create legal framework<br>• Create financial mechanisms | • Long-term planning taking into account basin-wide conditions, development, and climate change scenarios<br>• Create hazard/risk maps<br>• Forecasting and dissemination of warnings | • Planning at provincial level<br>• Implementing mitigation measures<br>• Linkage between national and local (basin and catchment) levels | • Formation of community-based flash flood management organisation<br>• Coordination with community-based organisations<br>• Post-flash flood preparedness<br>• Local level early warning system | • Securing household from flooding<br>• Organising life at home<br>• Preparing family for evacuation |
| **Professionals/scientists** | **Natl meteorological & hydrological services** | **Regional organisations** | **Private sector** | **Crisis management services** |
| • Support central administration in planning and strategy building<br>• Prepare guidelines and practical solutions<br>• Advice to government and academia<br>• Capacity building at policy level | • Create early warning and dissemination system<br>• Research | • Knowledge transfer<br>• Capacity building<br>• Transboundary dialogue<br>• Cooperation facilitation | • Prepare action plan for damage minimisation<br>• Ensure safety of equipment and structures<br>• Insurance<br>• Implementation of financial mechanisms | • Coordinate warning systems<br>• Identify vulnerable groups and their needs<br>• Planning response mechanisms<br>• Post-flash flood activities |
| **Spatial planners** | **Academia** | **NGOs** | **Media** | |
| • Create spatial planning<br>• Land zoning<br>• Support regulation | • Flood education<br>• Research support<br>• Advice to government | • Awareness raising<br>• Capacity building<br>• Pressurise higher level<br>• Post-event support | • Awareness raising<br>• Exert pressure<br>• Early warning<br>• Post-event support and information dessemination | |

Source: Adapted from APFM (2007)

## Further reading


APFM (2007) *Guidance on flash flood management: Recent experiences from Central and Eastern Europe*. Geneva: Associated Program on Flood Management (APFM)

Colombo, AG; Hevas, J; Arllam, ALV (2002) *Guidelines on flash floods prevention and mitigation*. Ipsra (Italy): NEIDES

Shrestha, AB; Shah, SH; Karim, R (2008) *Resource manual on flash flood risk management, Module 1: Community-based management*. Kathmandu: ICIMOD

Shrestha, AB (2008) *Resource manual on flash flood risk management, Module 2: Non-structural measures*. Kathmandu: ICIMOD


**Debris from a flash flood covers fields and buildings in Chitral, Pakistan**


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