

5 Regional Capacity for Studying the GLOF Risk

The four Himalayan countries that were the focus of the inventory project, Bhutan, India, Nepal and Pakistan, have a range of capacities in terms of the remote sensing applications needed for glacial lake mapping, and regular monitoring and risk assessment. They are also at different stages in terms of actual activities related to GLOF risk assessment.

Remote sensing capacity

Regional capacity

India has its own well established space programmes, viz. the National Remote Sensing Agency (NRSA), National Remote Sensing Centre (NRSC), Hyderabad; Indian Institute for Remote Sensing (IIRS), Dehradun; and the Indian Space Research Organisation (ISRO), Ahmedabad. The National Remote Sensing Centre (NRSC) at Hyderabad is one of the centres of the Indian Space Research Organisation (ISRO), under the Earth Observation Programme and Disaster Management Support Programme. NRSC is responsible for the acquisition, processing, and supply of aerial and satellite remote sensing data and continuously exploring the practical uses of remote sensing technology for multilevel (global to local) applications. It provides the necessary trained manpower through capacity building in remote sensing applications. NRSC is also providing single-window disaster management support services through the Decision Support Centre (<http://www.nrsc.gov.in>).

In Pakistan, the national space agency, the Space and Upper Atmosphere Research Commission (SUPARCO), established in 1961 as a Committee, was granted the status of a Commission in 1981. One of its many functions is to undertake research and conduct pilot studies based on applications of satellite remote sensing (SRS) data and geographic information system (GIS) technology to natural resources surveying, mapping, and environmental monitoring (<http://www.suparco.gov.pk>).

Bhutan and Nepal are not yet at such an advanced technological stage.

As yet, no specific assessment has been made of the capacity in China. But China has a well-established space programme as well as advanced capacity in remote sensing applications, GIS, and glacier research. Specifically, ICIMOD is collaborating with the Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI) of the Chinese Academy of Sciences (CAS), based in Lanzhou, in the development of a new inventory of glaciers and glacial lakes for the HKH region (see Chapter 6).

UN agencies using remote sensing for disaster management

There are a number of institutions within the United Nations system that employ remote sensing for disaster management that have services relevant to the Himalayan region.

The United Nations Office for Outer Space Affairs (UNOOSA), based in Vienna, is responsible for promoting international cooperation in the peaceful use of outer space. UNOOSA also maintains a 24-hour hotline as the United Nations focal point for satellite imagery requested during disasters, and manages the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) (<http://www.ossa.unvienna.org>).

UNOSAT (United Nations Operational Satellite Application Programme) is the United Nations Institute for Training and Research (UNITAR) Operational Satellite Applications Programme, implemented in cooperation with the European Organization for Nuclear Research (CERN). The programme, created in 2000, provides satellite solutions to relief and development organisations and comprises UN fieldworkers, satellite imagery experts, geographers, geologists, development

experts, database programmers, and Internet communication specialists. Their stated mission is "to deliver integrated satellite-based solutions for human security, peace and socio-economic development, in keeping with the mandate given to UNITAR by the UN General Assembly since 1963."

The International Charter on Space and Major Disasters is available to coordinate the use of space facilities in the event of natural and technological disasters (Rev. 3(25/4/2000).2) (<http://www.disastercharter.org>). This Charter can be activated during any major disaster, including GLOF events. UNOSAT can assist by providing satellite images, maps, and geographic information for relief operation and management (www.Unosat.org).

Organisations relevant for GLOF risk assessment

In the course of the inventory study, an attempt was made to identify institutions in the four countries that could undertake or were already involved in GLOF related activities. Some indication of organisations was obtained during a 'Regional Consultation Workshop on GLOF and Flash Flood Risk Assessment in the Hindu Kush-Himalayas' held from 30 July to 1 August in 2008 (ICIMOD internal report, 2008). However, it is difficult to assess the actual capabilities and activities of the various organisations and groups involved in mapping glacial lakes and assessing GLOF risk, not least because there is a continual refinement in the approaches as well as a stream of new imagery and methodologies coming on-line. The main organisations identified in the different countries, and the roles they play, are summarised below.

Bhutan

The risk of glacial lake outburst floods has been of major concern in Bhutan. The earliest known reference to dangerous glacial lakes in Bhutan relates to the scientific reconnaissance of Professor A. Gansser (1966). However, there was no documented evidence of GLOF events until the Luggye Tsho glacial lake outburst incident on 7 October 1994. This event, which caused extensive damage along the Punakha Wangdi valley, prompted investigation of glacial lakes and damage that might occur (National Report on Bhutan for World Conference on Disaster Reduction 2005). Institutions undertaking GLOF related activities in Bhutan at present include the following:

1. Department of Geology and Mines, Ministry of Economic Affairs
2. Hydro-Meteorological Services Division, Department of Energy, Ministry of Economic Affairs
3. Planning and Policy Division, Disaster Management Division, Department of Local Governance, Ministry of Home and Cultural Affairs
4. Ministry of Agriculture

The Department of Geology and Mines (DGM) of Bhutan is the government geo-scientific organisation entrusted with the responsibility for all geo-related activities in the kingdom. The Department is the leading organisation responsible for the monitoring of glaciers and glacial lakes in northern Bhutan and for mitigation of their possible outbursts. It prepared an inventory of glaciers and glacial lakes in the headwaters of major river basins in 1996 using 1:50,000 maps produced by the Survey of India that were based on air photographs of 1956 and 1958, and satellite images (DGM 1996). The DGM has carried out all the GLOF-related activities in Bhutan in cooperation with several international agencies, academic institutions in Japan and Austria, and UNDP and ICIMOD.

India

Institutions that could or are undertaking GLOF related activities in the Indian Himalayas include at least the following:

1. Wadia Institute of Himalayan Geology, Dehradun
2. GB Pant Institute of Himalayan Environment and Development, Almora
3. Birla Institute of Technology, Jaipur
4. National Institute of Disaster Management, New Delhi
5. Indian Institute of Tropical Meteorology, Pune
6. National Institute of Hydrology, Roorkee
7. Universities in India

Originally named the Institute of Himalayan Geology, the Wadia Institute of Himalayan Geology in Dehradun is an autonomous research organisation established in June 1968 under the Department of Science and Technology, Government of India. The Wadia Institute carries out basic research on Himalayan geology and related fields: geodynamic evolution, mountain building processes, geo-environment, and mineral resources. The Centre for Himalayan Glaciology at the Wadia Institute of Himalayan Geology was inaugurated on 4 July 2009. "The Glaciology Centre at the Wadia Institute of Himalayan Geology will act as a nodal centre for carrying out studies on glaciers in Uttarakhand, Jammu and Kashmir, Himachal Pradesh, and Sikkim, The Centre will concentrate on a broad spectrum of research in the field of glaciology. It will become an asset for the Wadia Institute of Himalayan Geology," (Tribune News Service, July 2009). The Wadia Institute collaborated as the national partner with ICIMOD on the inventory in Uttaranchal.

The GB Pant Institute of Himalayan Environment and Development (GBPIHED) is an autonomous institute of the Ministry of Environment and Forests, Government of India. GBPIHED has undertaken studies on different aspects of glacier response to climate change and its impact on Himalayan ecosystems since 1999. The Glacier Study Centre of the Institute, established in 2004, facilitates in-depth research on glacier response to climate change and its environmental and social impact in the Himalayan region. It has established field monitoring stations on several glaciers of the central and eastern Himalayas. Glacier and GLOF research has been a major activity of the Institute for over a decade.

The Birla Institute of Technology (BIT) – Jaipur Campus, India, established in 1995, is one of the leading institutions that began programmes in glaciology in concert with the Remote Sensing Division. The institute has conducted international collaborative research with the Centre for Ecology and Hydrology (CEH), Wallingford, UK, on the Gangotri glacier, and IRD (Institut de recherche pour le développement), France, on the Chhota Shigri glaciers. The Institute is in the process of preparing a glacial lake inventory in the Zaskar basin, Jammu & Kashmir. The work includes monitoring of two glacial lakes in the southern Zaskar basin formed by the recession of glaciers. Remotely sensed imagery, dating from 1989 and 2000, and GPS (global positioning system) observations from 2008, provide the basis for the survey.

The National Institute of Disaster Management (NIDM), Ministry of Home Affairs, is engaged in research and capacity building at national and international levels for managing disasters such as flash floods, drought, climate change, other extreme weather events, and their impact on agriculture, water resources, health, and related sectors.

Nepal

Nepal has gained much needed experience and expertise in GLOF-related matters from various activities in the past. Human resources from all relevant disciplines, such as geology and geomorphology, remote sensing and GIS, geotechnical engineering, hydrology, meteorology, glaciology, socioeconomics, and environment are available within government organisations and universities. Institutions that have the expertise to undertake GLOF related activities, at least in part, include the following:

1. Department of Hydrology and Meteorology
2. Water and Energy Commission Secretariat
3. Department of Water Induced Disaster Prevention
4. Central Department of Geology, Tribhuvan University
5. Central Department of Hydrometeorology, Tribhuvan University
6. Central Department of Geography, Tribhuvan University
7. Department of Environmental Science and Engineering, Kathmandu University
8. Nepal Engineering College, Centre for Disaster Studies
9. Department of Geology, Tri-Chandra Campus

The Department of Hydrology and Meteorology (DHM), Ministry of Environment, Science and Technology, is the mandated government organisation with responsibility for snow hydrology and glaciology, in addition to monitoring river hydrology, climate, agro-meteorology, sediment, air quality, water quality, limnology, and wind and solar energy. DHM has conducted a multi-disciplinary study of Thulagi and Tsho Rolpa glacial lakes in collaboration with national and international agencies.

The Water and Energy Commission (WEC) established in 1975, was transformed into a permanent secretariat in 1981, with the objective of developing water and energy resources in an integrated and accelerated manner. It was the first government institution to investigate glacial lakes in Nepal (WECS 1987).

The Centre for Disaster Risk Studies (CDRS), Nepal Engineering College (NEC), is dedicated to applied research on disaster risk management. Some human resources are available in areas of climate change as well as flash floods, remote sensing, and GIS. The integrated study of natural disasters in Nepal embraces several planned research efforts related to floods, flash floods, climate change, and GLOFs.

The Central Department of Geology (CDG), Tribhuvan University (TU) participated in the study of the Thulagi and Tsho Rolpa glacial lakes. It employs professionals in the area of GLOFs and climate change observation.

Faculty members of the Department of Environmental Science and Engineering (DESE), Kathmandu University (KU), have been involved in the research projects on GLOF and climate change impacts on water resources; Gokyo lake water system; and solid waste and energy management in the Sagarmatha National Park. DESE has at least one professional in the area of GLOFs, glaciology, and remote sensing/GIS. The Himalayan Cryosphere, Climate and Disaster Research Centre (HiCCDRC) was established on 28 October 2009 at Kathmandu University in collaboration with the University of Colorado, Boulder, USA and is involved in the scientific investigation of glaciers and glacial lakes.

The Central Department of Geography of Tribhuvan University (TU) is also involved in research activities in the field of hazards, vulnerability, and risk assessment, including GLOFs, riverine floods, landslides, and climate change and risk reduction and adaptation strategies. There are several professionals in the area of glaciology and glacier mass balance and glacier hazards, including GLOFs.

Pakistan

ICIMOD is actively communicating with several institutions in Pakistan that are dealing with GLOF related activities, including the following:

1. Water Resources Research Institute, National Agricultural Research Centre (Islamabad)
2. Flood Forecasting Division, Pakistan Meteorological Department (Lahore)
3. Global Change Impact Studies Centre (Islamabad)
4. Focus Humanitarian Assistance (Islamabad)
5. Water and Power Development Authority (WAPDA, Lahore)

The Flood Forecasting Division has been entrusted with the responsibility of forecasting floods, flash floods, riverine floods, and all water induced disasters. In addition there are human resources in the areas of glaciology, GLOFs, climate change observation, remote sensing and GIS.

A task force on climate change and GLOFs has been formed recently to improve the exchange of information among the relevant organisations in Pakistan.

Ongoing regional programmes by ICIMOD and partners

There are many ongoing programmes in the region related to GLOFs. Some of the activities being coordinated by ICIMOD are described in the following.

Regional glacial lakes mapping and GLOF risk assessment

One of the most important regional programmes related to the theme of this study is the development of a new inventory of glacial lakes by ICIMOD in cooperation with regional partners for the entire Hindu Kush-Himalayan region. The expanded and revised inventory is being prepared to improve understanding of the characteristics of glacial lakes and the mechanism of GLOFs. The new inventory will take into account the following factors:

1. Use the same spatial reference datum (World Geographic System 1984 (WGS 84) for map projection)
2. Use the same data sources with similar data accuracy
3. Investigation for the same period as a reference year for glacial lake change analysis
4. No gaps or overlapping between different countries
5. Use the same lake classification, and one that can also be used to classify potentially dangerous lakes

In this project, efforts will be made to determine the status of glacial lakes, their changing patterns, expansion, and outburst mechanisms, and the impact on them of climate change. The capabilities of the national partner institutions will also be strengthened. Finally, inter-country cooperation will be augmented throughout the region by creation of a 'regional glacial lake information system.'

The new inventory is being prepared for the area from Afghanistan in the west to Myanmar in the east, and is being carried out by ICIMOD in conjunction with the Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI) of the Chinese Academy of Sciences (CAS) and supported by Sida, the Norwegian Ministry for Foreign Affairs, and the World Bank (see Chapter 6). The revised inventory for Nepal is a part of this. The results are being compiled during 2010 and will provide an up-to-date regional inventory for the entire region.

Other ICIMOD activities

ICIMOD is also implementing a project on 'Hazard assessment and mitigation study of potential glacial lake outburst floods (GLOFs) in Nepal' in collaboration with national partner institutes, supported by the World Bank. The objectives are 1) to develop recommendations for adaptation and mitigation against GLOF hazards in Nepal; and 2) to assist Nepal in the development of an overall strategy to address the risk from GLOFs in the future. The project aims to assess hazards from critical (potentially dangerous) lakes in Nepal and to investigate vulnerable downstream areas. The intent is also to strengthen partnerships among key stakeholders for development of a risk reduction strategy. Three lakes were selected as project sites: Imja, Thulagi, and Tsho Rolpa. ICIMOD is collaborating with DHM; WECS; Central Department of Hydrology and Meteorology/Tribhuvan University (CDHM/TU); Ministry of Water Resources, Government of Nepal (MoWR); Department of Mines and Geology, Government of Nepal (DMG); Central Department of Geology/Tribhuvan University (CDG/TU); Geographic Information System and Integrated Development Centre (GISIDC); Kathmandu University (KU); Nepal Electricity Authority; private hydropower companies; and various NGOs. International institutions such as WWF-Nepal, WB, UNDP, and Department for International Development, UK (DFID) are also sharing resources and knowledge.

Since 2008, ICIMOD has implemented a three-year project funded by Sida on 'Too much water, too little water - Local adaptation strategies to climate induced water stress and hazards in the greater Himalayan region'. One aim is to strengthen capacity within ICIMOD and among national partners for undertaking regular monitoring of glaciers, snow and ice fields, and pro-glacial lakes. This will help provide decision makers in the region (and beyond) with timely and adequate data and information on the status of these features.

ICIMOD, together with the Centre for International Climate and Environmental Research, Oslo (CICERO), and UNEP-GRID Arendal, has been undertaking a feasibility study for a 'Himalayan climate change impact and adaptation assessment' (HICIA) with a focus on GLOF and flash flood risk assessment, as well as assessment of other impacts.

A regional project entitled 'Flash flood risk reduction – Strengthening capacity in the Hindu Kush-Himalaya' is also being undertaken by ICIMOD working with regional partners with funding from the United States Agency for International Development, Office for Foreign Disaster Assistance (USAID/OFDA). During the previous two phases of the project, emphasis was placed on a baseline assessment of flash flood risk management in the region, strengthening the capacity of key stakeholders, and awareness raising. The main objective of the present phase (2010-2012) is to contribute to reducing the vulnerability of mountain communities to flash floods in the region through capacity building of key stakeholders. Glacial lake outburst floods are causative factors in propagating flash floods downstream, thus this type of project is also contributing to GLOF-related risk reduction. Geographically, the project will focus on China, India, Nepal, and Pakistan.

Since 2001, ICIMOD has collaborated with the regional partner countries Bangladesh, Bhutan, China, India, Nepal, and Pakistan on a long-term project 'Regional cooperation in flood forecasting and information exchange in the HKH region' supported by funding from the United States Agency for International Development, Office for Foreign Disaster Assistance (USAID/OFDA). Linked to this, application of satellite rainfall estimation (SRE) in the Hindu Kush-Himalayan region is a regional project implemented by ICIMOD and its partner countries. The aim of the project is to strengthen regional cooperation in data and information exchange and to build the capacity of partner institutions in satellite rainfall estimation and its use with the end goal of minimising the loss of lives and property by reducing natural vulnerability in the HKH region, in particular in the Indus, Ganges, and Brahmaputra basins (Shrestha et al. 2008). Although, the project is not directly a GLOF project, it has a causative relationship with GLOF phenomena.

ICIMOD and the Ministry of Foreign Affairs, Government of Finland, signed an agreement in December 2009 for a three-year collaborative project to establish a regional flood information system. The project will be implemented by ICIMOD in close collaboration with the World Meteorological Organization (WMO) and the six ICIMOD regional partner countries. The long-term goal is to minimise loss of lives and livelihoods by providing timely warning of floods and thus reducing flood vulnerability in the Hindu Kush-Himalayan region, in particular in the Ganges-Brahmaputra-Meghna and Indus river basins. The regional flood information system developed under this project will help improve flood forecasting and disaster preparedness, improve regional cooperation in flood risk reduction, strengthen upstream-downstream linkages, and contribute to reducing loss of lives and livelihoods.