

7 Conclusions and Recommendations

During the preparation of this report, an effort was made to accumulate information that would contribute to an understanding of potentially dangerous glacial lakes and how they are forming. This was extended to develop an approach for determining the degree of vulnerability to lake outburst across the Hindu Kush-Himalayan region, with emphasis on Bhutan, India, Nepal, and Pakistan. The most pertinent conclusions and recommendations are listed below.

The application of remote sensing is the most effective first phase approach in GLOF risk reduction and preparedness. It facilitates rapid and complete coverage of large and extremely remote mountainous areas, thus allowing potentially dangerous localities to be pinpointed for closer inspection. This is important because the total area of such localities will be a small percentage of the entire region under initial survey. In this manner, time and expenses are conserved. Nevertheless, reliance on in-situ field inspection is unlikely to be replaced, at least in those cases where individual lake stability needs to be assessed.

Compilation of a standardised glacial lake inventory of the entire HKH region is essential in view of the realisation that the potential for serious losses to glacial lake outburst appears to be growing steadily. Such an inventory must be up-dated periodically. This has become highly practical in recent years with progressively inexpensive access to remotely sensed imagery and more sophisticated methods for its analysis.

Potentially dangerous glacial lakes must be provisionally identified and prioritised for further investigation. Methods to be used for prioritisation have been detailed in the body of this report. Potentially dangerous lakes must be monitored on a continuing basis. High resolution time series satellite images will provide the means of achieving this economically. Continued assessment of the glaciers, end and lateral moraines, lake limits, and outflow characteristics, together with the terrain surrounding the prioritised lakes, will be necessary.

It is emphasised that ranking of glacial lakes that are assumed to present a high degree of instability is problematic. Thus, a list of the largest and most rapidly expanding lakes that are also situated above areas of intensive human utilisation is necessarily a first step. A more complete assessment and eventual ranking will require intensive fieldwork, including the application of sophisticated geophysical techniques. It will also require establishment of the vulnerability of human assets in the downstream area.

Over-flight observations of the prioritised lakes and their immediate downstream areas should be maintained on a regular basis. Detailed field investigation of a selection of glacial lakes, especially in Nepal and Bhutan, and upstream sections in neighbouring China where lake outbursts have the potential for crossing international borders, need special attention. Comparable work, in partnership with the relevant agencies in India, should involve similar efforts, for example, in the Sutlej basin of Himachal Pradesh. Above all there is an urgent need for region-wide collaboration in the development of standardised approaches and, eventually, of uniform policies aimed at early warning and hazard mitigation.

South-South collaboration should be encouraged for sharing know-how and experiences for GLOF risk management. As an example, consideration should be given to invite to the Himalayas Andean professionals who have successfully tackled problems of GLOF risk mitigation in the Peruvian Andes.

Continuation of the mapping of terrain characteristics downstream of potentially dangerous lakes should be maintained. Greater efforts are required to ensure close rapport with local people. More attention must be given to the question of achieving active collaboration, for example, so that inadvertent or mischievous damage to any early warning system that may be installed is avoided.

Consideration should be given for the employment of a reliable local person or persons, to make two inspections each year of the condition of the prioritised lakes in their vicinity. Special attention should be paid to lake outlets and levels. For example in the case of Nepal, local Sherpas from Dingboche, or another village close to Imja Lake, should be recruited and asked to file a report following each inspection. (As an example, Icelandic farmers were encouraged (voluntarily) in the 1930s to monitor that country's numerous glaciers. This led to creation of an excellent national glacier inventory that continues to be up-dated annually to this day.)

The availability of current information and communication technology (ICT) suitable for rural application of early warning systems should be evaluated. This will enhance possibilities for installation of the most up-to-date systems to ensure near-instant warning of danger to a large population. There are examples of comparatively simple and highly effective CDMA (Code Division Multiple Access) and SMS (Short Message Service) communication systems in place for early warning against tsunamis; the applicability of these should be assessed.

It is recommended that a complete bibliography on glacial lake research world-wide should be developed. This could then form the data base for compilation of a specific repository of all available publications and internal reports within the ICIMOD library system. This would provide an invaluable asset for country partner institutions that are collaborating with ICIMOD.

There is a significant number of publications arising from a series of investigations to determine the degree of danger from the potential break of the landslide dam holding up Lake Sarez in the Tajikistan High Pamir. While this is not a glacial lake (it was dammed following an earthquake-induced massive landslide in 1911) the related field experience, and problems with over-dramatised news media reporting render it highly relevant to the issue at hand (e.g., ISDR, United Nations 2000; Science, 18th December 2009: Richard Stone).

It would be highly valuable to work with government authorities for the development of national policy guidelines to deal with the problem of potential glacial lake outbursts and GLOF risk management. This should include the establishment of principles for risk assessment. Regional collaboration among or between the governments in the events of transboundary disaster, such as GLOF risk assessment and mitigation, is essential. There is a need to accelerate inter-governmental collaborative researches on glacial hazards and GLOF risk management as well as development of a mechanism of inter-governmental collaboration for sharing data and information. A regional convention of inter-governmental expert groups should identify and make recommendations on details of collaboration and the role of national governments, and draw action plans for GLOF risk management.