Source : www.thehindu.com Date : 2023-10-25

# MITIGATING TRAGEDIES IN THE HIMALAYAN REGION

Relevant for: Environment | Topic: Disaster and disaster management



October 25, 2023 12:35 am | Updated 08:13 am IST



A portion of the NH-10 was washed away by the flash floods on October 3. | Photo Credit: The Hindu

The recent glacial lake outburst flood (GLOF) in Sikkim wreaked havoc along the Teesta river, bringing into focus the magnifying risk of climate change-induced GLOF across the Indian Himalayan Region. A study published in *Nature*this year indicates that 90 million people across 30 countries live in 1,089 basins containing glacial lakes. Of these, one-sixth live within 50 km of a glacial lake and 1 km of potential GLOF runout channels.

In mountains, hazards often occur in a cascading fashion — heavy rainfall triggers a landslide, which may in turn cause a glacial lake outburst and more landslides downstream, and create conditions for flash floods. Predicting this chain of events is difficult. Institutional awareness of these risks is increasing, but the challenge is to evolve a system to mitigate risks from such hazards, and provide early warnings.

The magnitude of the tragedy that occurred on October 3 at the South Lhonak glacial lake in Sikkim is still unfolding. In September, the National Disaster Management Authority (NDMA) had led a multi-agency preparatory mission to the high-altitude South Lhonak and Shako Cho glacial lakes and installed solar-powered automated cameras and monitoring equipment, which transmitted weather data 250 times a day. While the equipment at South Lhonak ceased transmission four days later and could not be revived, equipment at Shako Cho continues to transmit data. The expedition was successful in identifying locations to install sensors for an end-to-end early warning system during the next mission and in identifying possible mitigation measures for both lakes such as small check dams.

While the exact combination of causes of the event is yet to be ascertained, monitoring equipment had reported higher-than-normal temperatures of zero to 5°C in the four days that data was received — exceptionally warm for Himalayan glaciers. Scientists are gravitating towards the view that the key trigger in the process chain of the disaster was the collapse of a huge mass of rock/moraine from the north-western bank of the lake. Assessed to be more than a quarter million cubic metres in volume, it displaced a significant volume of melt water, widening the river mouth at the eastern end, resulting in flash floods.

The Himalayan Region is susceptible to a range of hydro-meteorological, tectonic, climate and human-induced mountain hazards. Each of them requires an extensive set of monitoring, mitigation, and early warning strategies. The process chain of glacial melting is adequately

mapped. However, the multitude of glaciers and temporal variations in glacial recession makes monitoring and estimation of the risk more difficult.

The enormity of the challenge is seen in the National Remote Sensing Centre's (NRSC) Glacial Lake Atlas of 2023. Three major river basins, of the Indus, Ganga, and Brahmaputra, are host to 28,000 glacial lakes greater than 0.25 hectares in area, in five countries. Of these, 27% are in India, in six States and Union Territories. This region has witnessed catastrophic GLOF events in the past few decades.

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Many geo-technical solutions for mitigation of GLOFs have been tried globally, including excavating channels for regulated discharge, drainage using pipes and pumps, spillway construction, and setting up small catchment dams to cut the speed of outflow. But in practice, conditions above 5,000 metres above mean sea level create formidable challenges such as inaccessibility, impossibilities in transporting and retaining excavation equipment, strong winds, difficulties in sourcing power and connectivity, and vandalism. These measures are arduous and labour-intensive, yet need to be implemented across high-risk lakes.

The most significant risk of such a disaster is to downstream hill communities and authorities who get a very short lead time to respond. They stand to suffer serious damage to life, property, and livelihood. Such events bring permanent changes in morphology, topography and stream hydrology. Interviews show that people downstream are mostly unaware of the risks posed by sudden glacier-melt and cascading hazards. Risks from glacial melting, slope shifting, landslides, intense precipitation, and heatwaves, among other hydro-meteorological and geo-physical hazards, are rising. While meeting the development needs of hill communities, disaster and climate resilience principles need to be assimilated into government policy and practice as well as private investment.

This requires an integrated, multi-disciplinary effort across institutions. NRSC's atlases have provided high-resolution data via remote sensing, which allows for monitoring spatial change. The Central Water Commission is conducting hydro-dynamic assessments of high-risk lakes, mapping water flow, height and routing simulations using digital elevation models. The NDMA's national guidelines (2020) provide States with a technical overview of the hazard and risk-zonation and suggest strategies for monitoring, risk-reduction and mitigation.

A comprehensive GLOF risk mitigation plan is in the final stages of approval and will include installation of monitoring and end-to-end early warning systems at high-risk glacial lakes. In this endeavour, all governments and scientific institutions need to come together to integrate resources and capacities in disaster risk reduction. While appropriate synergies have been created, increased focus on prevention and mitigation will reduce loss and damage and bring stability into the lives of hill communities.

***Safi Ahsan Rizvi is an Indian Police Service officer and Advisor (Mitigation), National Disaster Management Authority***

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