



Flood risk from small mountain lakes

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Small lakes in mountain regions hold significant potential to wreak havoc as a result of sudden drainage. The risks can be managed within existing disaster reduction frameworks, but must be acknowledged and monitored.

A destructive debris-laden flood swept over the remote village of Til in the Limi Valley, Nepalese Himalaya on May 15, 2025 (Fig. 1), and destroyed local infrastructure. The damage included a recently built 15 kW hydro-power plant, roads, bridges, and about 0.25 km² of agricultural land also preconditioning other types of hazards including slope instability in the valley. We argue that there is a need for critical reflection on the occurrence and frequent mischaracterization of high-mountain flood events in the Himalaya and beyond. The debris-laden flood event illustrates risk factors that are often overlooked, points out deeply-rooted misconceptions in hazard perceptions and assessments, highlights long-term consequences, and outlines the implications for disaster risk reduction strategies.

Subsurface processes behind mountain floods

Sudden floods in high mountain areas are often linked to cloudbursts or Glacial Lake Outburst Floods (GLOFs). However, the flood in Til village was instead caused by the abrupt bursting of two thermokarst lakes formed in depressions within periglacial debris of a rock glacier. These bursts were likely caused by sudden opening/widening of the subsurface outflow channels located beneath a rock glacier. Since 2004, the Limi Valley has experienced at least seven flood events, including the 2025 Til event, highlighting a recurring pattern also observed in the neighboring Halji Valley¹. Importantly, all these events have occurred during the summer, between mid-May and mid-July. They were probably linked to the melting of ice within subsurface drainage systems that remain frozen during the winters.

We draw several critical insights from these flood events. First, the crucial role of subsurface processes that can lead to unexpected lake bursts, such as sudden opening of englacial conduits or subsurface outflow channels has been largely overlooked. We emphasize the need for careful monitoring of glacial and periglacial geomorphology and hydrology. Second, the recurrence of similar events during the summer season suggests that seasonal melting plays a significant role in destabilizing subsurface drainage systems. Third, the local topography, geology, and geomorphological settings strongly influence how and whether floods develop and transform from lake outbursts into debris-laden flows. The recurrence pattern of similar events in the region indicates a broader, regional vulnerability rather than isolated incidents, emphasizing the need for comprehensive hazard assessments over such glaciated regions. The complexity of these floods, involving interactions between subsurface drainage, seasonal changes and sediment entrainment, calls for integrated monitoring systems that can track hydrology, sediment transport, and geomorphic processes together.

Small is still dangerous

The Til village flood shows that even small lakes can trigger a range of immediate and long-term responses, highlighting that the size of the lake does not necessarily control the severity of the consequences. In particular, steep and sediment-rich valley sections can transform water flow into a destructive debris-laden flows, greatly increasing the hazard potential.

Additionally, lateral erosion and slope undercutting during such events can destabilize stream banks, making nearby slopes prone to landslides. Infrastructure and assets located tens of meters away and above the stream can still be affected during a flood event, as seen in the 2011 Halji GLOF¹, or in the aftermath, as witnessed in the 2023 South Lhonak GLOF². These indirect impacts are often overlooked in typical outburst flood hazard assessments, indicating a gap in current risk evaluation and mitigation strategies. Comprehensive flood hazard assessments should not only account for direct impacts but also for secondary effects like erosion and post-flood slope instability.

Risk reduction systems

Addressing the risks associated with outbursts of small lakes can build on and adopt disaster risk reduction practices developed for other types of comparably better-researched high mountain hazards, such as seasonal floods or debris flows³; development of whole new approaches or strategies is not necessarily required. The Limi valley urgently needs an early warning system, continuous glacial monitoring, and effective slope stabilization measures, combined with a community-inclusive adaptation strategy.

Crucially, early warning frameworks must incorporate monitoring of permafrost and glacier subsurface changes, as these often serve as vital precursors to flood events. However, small lakes are often not considered in outburst flood hazard assessments and the attention is predominantly paid to large lakes. We argue that even small lakes can represent substantial risks under specific topographic, geologic, and societal conditions, as documented by the 2025 Til village event.

Once the risk is acknowledged, many measures aimed at reducing outburst flood risks—particularly those related to preparedness, early warning, and community vulnerability—are naturally multi-hazard in scope. Consequently, outburst floods can be effectively managed within current disaster risk reduction frameworks by implementing integrated disaster risk management strategies. These typically involve structural measures aimed at reducing outburst flood or debris flow hazards, while vulnerability can be primarily addressed through non-structural approaches⁴.

Beyond Nepal

Outburst floods from small lakes are not isolated to Nepal. Disastrous consequences of small lake outbursts were recently reported from Peruvian Andes⁵ or Chinese Himalaya⁶. As most of the world's high mountain regions are witnessing an increase in both the number of glacial lakes and the number of people living downstream⁷, it is critical for sustainable development that potentially underestimated risks, such as outburst floods from small lakes are recognized, monitored and addressed.

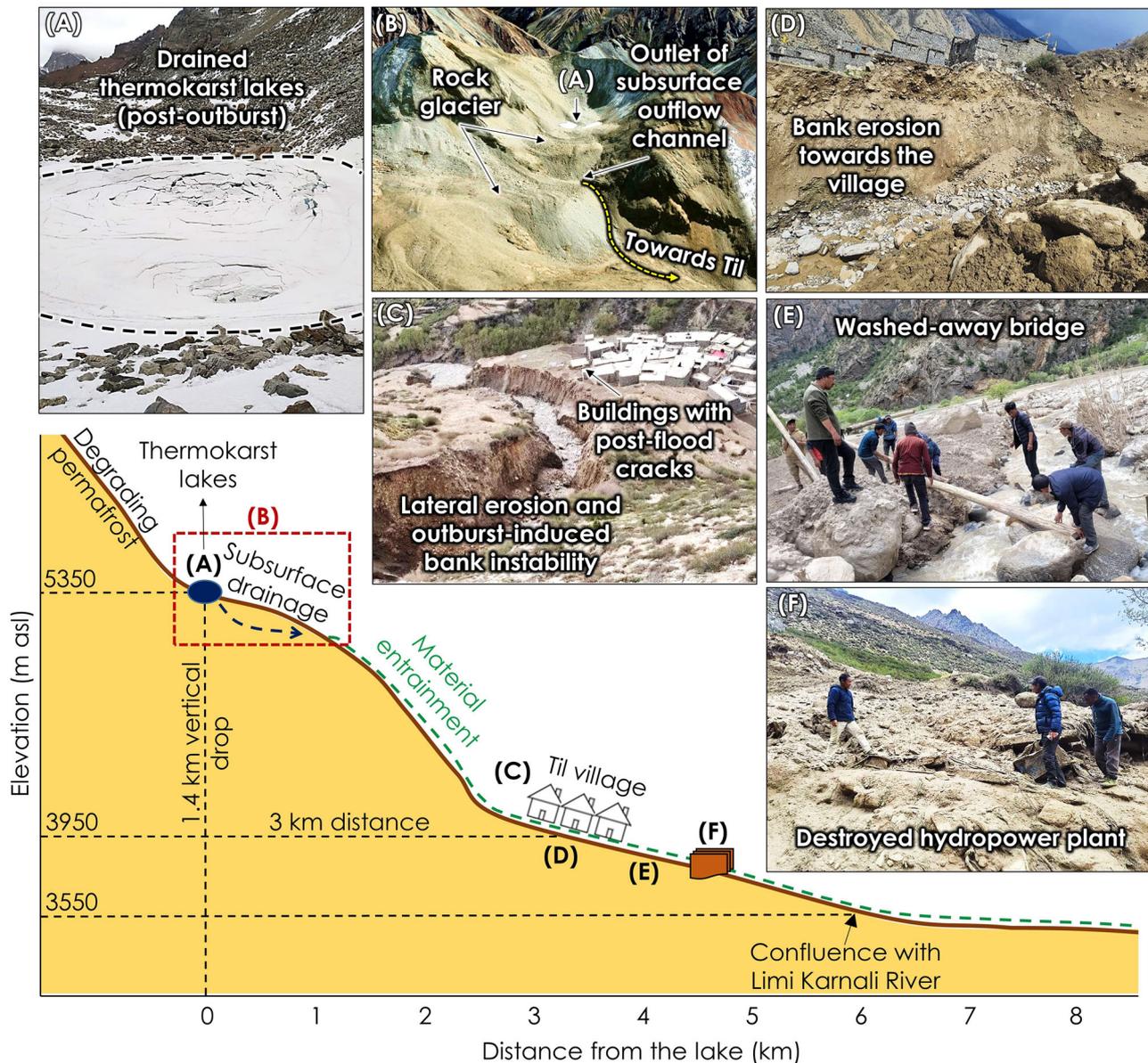


Fig. 1 | Setting of the Til village with its surroundings, the debris-laden flood cascade processes and its impacts. A thermokarst lakes that drained through subsurface channels causing downstream flooding; B outlet of the subsurface outflow channel located at the base of the rock glacier, background © 2025 CNES/Airbus/Maxar Technologies; C, D flood induced lateral/bank erosion along the

channel; buildings close to the channel developed cracks post-event due to slope instability; E washed away bridge that connected Til village with other side of the downstream valley; F destroyed 15 kV hydropower plant located downstream of Til village.

Informed decision-making demands policies and scientific interventions that prioritize not only areas of high population density and bigger glacier lakes, but also regions that harbour small lakes with highly vulnerable downstream communities and infrastructure with low adaptive capacity.

Data availability

No data were used or generated for this article.

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Author contributions

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Competing interests

The authors declare no competing interests.

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