

Understanding the Gyirong–Rasuwa disaster of 26 August 2026

A preliminary synthesis



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A caveat from the authors

This preliminary synthesis brings together the evidence and interpretations presented to date by scientists, government agencies, and independent observers concerning the 26 August 2026 Gyirong–Rasuwa disaster. All mechanisms discussed remain working hypotheses and require verification through field investigations, high-resolution comparison between pre- and post-event terrain, and reconciliation of seismic, satellite, meteorological, and streamflow-gauge records. Some interpretations cited in this report were shared by scientists via personal communication or on social media platforms and websites, and have not undergone peer review; these interpretations are therefore explicitly attributed to their respective authors. ICIMOD's role in this synthesis is to bring together and contextualise the available evidence to support the authorities in responding to the crisis. The mandates for warnings and responses rest with the Department of Hydrology and Meteorology (DHM) and the National Disaster Risk Reduction and Management Authority (NDRRMA) of the Government of Nepal.

Acknowledgement

We would like to acknowledge Etienne Berthier's (Researcher at the French National Centre for Scientific Research) contribution to this report. He conducted glacier mass balance analysis, referenced in this report, using Pléiades satellite data.

Executive summary

At around 8:37 am Nepal Standard Time (UTC+05:45) on 26 August 2026, an estimated 132 million cubic metres (Mm³) of rock and ice detached from the northern flank of the Langtang Lirung massif at an altitude of roughly 5,200 metres above mean sea level (masl), in the Langtang area of the Nepali Himalaya, and fell ~1,200 metres, almost vertically, into the Lhende Khola Valley. The mass was transformed into a debris-laden surge that swept through the Gyirong–Rasuwadaghi border corridor in approximately 7 minutes after the collapse. The surge – including a back-wave that ran roughly 3 kilometres upstream – continued to sweep the corridor over the next ~25–30 minutes, and continued down the Bhotekoshi into the Trishuli River, attenuating progressively through the Gandak. The collapse generated a seismic signal detected worldwide. SMS warnings were issued by the Department of Hydrology and Meteorology (DHM), Government of Nepal, at approximately 9:15 am, by which time the border corridor had already been struck.

This report seeks to provide a preliminary synthesis of the available evidence and interpretations from scientists, government agencies, and independent observers. It lists unresolved questions for future research and underlines the need for a multi-hazard risk assessment and regional collaboration in sharing hazard information.

The source of the event was a bedrock failure that sheared away part of a hanging glacier; this has been established through seismic, satellite, and drone evidence. The physical mechanism remains under investigation: geological preconditioning along pre-existing discontinuities, damage from the 2015 Gorkha earthquake, permafrost degradation, the progressive accumulation of ice and other mass on the source glacier, and entrainment of sediment left by the July 2023 and July 2025 floods

from the Purepu Glacier are all plausible and possibly compounding contributors; none can yet be identified as dominant. The event is best characterised as a cascading cryospheric geohazard rather than a glacial lake outburst flood (GLOF), as anticipated initially.

Its impacts were severe and transboundary. The National Disaster Risk Reduction and Management Authority (NDRRMA) has reported 1,451 deaths and 5,745 people missing in Nepal as of 21 September. Thirteen operational and under-construction hydropower projects were destroyed or damaged, accounting for the largest single share of assessed physical damage across all sectors, at approximately 44% (NPR 119,960 million out of NPR 274,480 million). The flood back-wave reached ~3 km upstream of Gyirong Port, causing many deaths and the complete destruction of Gyirong Port. The Chinese authorities have reported 43 deaths and 519 people missing in China. Two temporary lakes formed downstream breached on 28 August and 31 August, respectively, but did not result in a secondary disaster. This was the second catastrophic flood (after the 8 July 2025 Purepu GLOF) to hit the corridor in little over a year.

There are two implications of this disaster that have a bearing on international engagement and cooperation. First, the event was of cascading nature with transboundary impacts, and the warning system and analytical methods that retrospectively identified pre-event slope deformation could be applied in advance to enable regional screening of analogous source zones. Second, early warning for hazards of this scale requires arrangements, such as seismic event detection, upstream monitoring, cross-border notification protocols, and impact-based, people-centred dissemination, that no single-hazard or rainfall-based system can provide.

Key facts at a glance

This is as of 11 September 2026.
All values are preliminary.

Event:

26 August 2026, 8:37 am, rock-ice avalanche and cascading debris flood.

Source:

Northern face of Langtang Lirung massif, inside Nepal; release elevation ~5,200 masl; near-vertical fall of ~1,200 metres (m).

Estimated volume:

~132 Mm³, comprising ~115 Mm³ of rock and ~17 Mm³ of glacier ice [requires validation against high-resolution digital elevation models (DEMs)].

Seismic signal:

Ms 5.2 (United States Geological Survey); Mw 5.2–5.7 (GFZ Helmholtz Centre for Geosciences); attributed to the mass movement.

Warning chronology:

8:37: seismic onset; ~8:44–8:50: surge at the border corridor; 9:15–09:16: The DHM sent SMS alerts to ~679,000 residents in districts downstream.

Human toll:

1,451 deaths, 5,745 missing (Source: NDRRMA; as of 21 September, still evolving).

Hydropower affected:

13 operational and under-construction projects destroyed or damaged; approximately one-tenth of Nepal's installed capacity affected.

Temporary lakes:

Two lakes were formed immediately downstream. They breached on 28 August and 31 August, respectively, without secondary disaster.

Precedent:

July 2023 and July 2025 supraglacial-lake floods (from the Purepu Glacier in Tibet) through the same corridor.

1. What is known with reasonable confidence

At around 8:37 am on 26 August 2026, an estimated 132 Mm³ of rock and ice, equivalent to approximately 53,000 Olympic-size swimming pools, detached from the northern flank of the Langtang Lirung massif at an altitude of ~5,200 masl in the Nepali Himalaya. This enormous mass descended almost vertically for ~1,200 m into the Lhende Khola Valley. The impact and rapid movement may have melted much of the ice and entrained water, sediment, and debris, including material deposited by the floods of July 2023 and July 2025. The resulting debris flow travelled through the Gyirong–Rasuwadaghi corridor and continued down the Bhotekoshi River into the Trishuli River.

Available meteorological records indicate no heavy rainfall in the area or a preceding rise in river levels. The possible influence of unusually warm conditions remains under investigation. The collapse generated seismic waves detected worldwide: the United States Geological Survey (USGS) classified the surface wave magnitude (Ms) 5.2 event as a landslide, while the GFZ Helmholtz Centre for Geosciences (GFZ) in Germany attributed the seismic moment magnitude (Mw) 5.2–5.7 signal to mass movement. At Galchhi, a municipality in Dhading District, the Trishuli reportedly rose by up to 9 m within 30 minutes. The DHM, Government of Nepal, issued SMS warnings at approximately 9:15–9:16 am, by which time the flood had already affected the border corridor.

As of 21 September 2026, the reported death toll was 1,451, with 5,745 people still missing. Thirteen operational and under-construction hydropower projects along the Bhotekoshi–Trishuli river corridor were destroyed or damaged. The disaster damaged or disconnected electrical power equivalent to approximately one-tenth of Nepal's installed capacity.

The same corridor had been struck in July 2025, when a supraglacial lake on the Purepu Glacier in Tibet drained rapidly, causing a flood in the Lhende–Bhotekoshi system and destroying the Friendship Bridge.

2. Four early assumptions and a confirmation

When videos of the disaster first emerged, a number of explanations were put forward by varied sources: it was assumed that it was yet another GLOF, or that an earthquake had triggered an avalanche, leading to the flood (a minor tremor of 2.6 on the Richter scale was recorded near Rasuwagadhi at 8.20 am, less than 20 minutes before the event by the Department of Mines and Geology (DMG), which may require further investigation). A third suggestion was that a landslide the previous day had dammed the river and formed a temporary lake, only to be struck a day later by a huge mass of rock and ice that fell, causing a violent breach. Yet another version of events was that part of a glacier on the northern face of the Langtang Lirung massif had collapsed,

and had unleashed the flood. It sounded plausible, given the glacier collapse in the recent past, and for a while, this and the earthquake theory were the main explanations.

Once the seismic data and satellite images were studied more closely, it became clearer that it wasn't the tremor that had caused the collapse of a part of the glacier, but the other way around – that the collapse had caused the tremor. By the night of 26 August, it became clear that a massive rock-ice avalanche had occurred on the northern face of the Langtang Lirung massif, causing the Gyirong-Rasuwa disaster (Figure 1).

FIGURE 1

AN AERIAL VIEW OF THE SOURCE AREA ON THE NORTHERN FACE OF LANGTANG LIRUNG BEFORE (LEFT) AND AFTER THE ROCK-ICE AVALANCHE (RIGHT)



Source: Kristian Svennevig and Guoxiong Zheng on LinkedIn.

3. Bedrock failure that took part of a glacier with it

As has been discussed, the flood was triggered by a large rock–ice avalanche originating on the northern face of the Langtang Lirung massif. It was a bedrock failure that sheared away part of a hanging glacier (Figure 1). The massive block of ice and rock fell from an elevation of ~5,200 masl down a steep slope of nearly 50 degrees to the bottom of the valley, a near-vertical fall of about ~1,200 m and a total fall of ~2,200 m, and then rose ~450 m on the opposite slope (Figures 2 and 3).

This triggered a catastrophic debris flow that propagated through the Lhende Khola–Bhotekoshi–Trishuli river system, causing extensive damage in both China and Nepal (Figure 2). A secondary

landslide followed approximately three hours later, roughly 18 kilometres (km) upstream of the Rasuwagadhi border point. Two lakes were formed, one just below the avalanche on the glaciated valley floor in the depression created by its impact. The second lake formed at the confluence of Chhochan Khola (stream) and Chhyusumdo Khola (Lhende Khola) at 2,800 masl, due to a secondary landslide on the left bank of Chhyusumdo Khola (Lhende Khola). The landslide dam lake overflowed and drained on 28 August, and the first lake in the avalanche-impacted area drained via subsurface flow on 31 August, without causing any secondary disaster (Figure 4).

FIGURE 2

A BROAD VIEW OF THE RASUWAGADHI REGION ALONG THE NEPAL–CHINA BORDER, WITH KEY LOCATIONS MARKED, INCLUDING TIMURE, SYABRUBESI, AND RASUWAGADHI



Note: Elevation contours are noted at approximately 5,100, 3,700, and 2,900 masl.

Source: Google Earth. Image credit: Sravan Shrestha, ICIMOD.

FIGURE 3

A POST-EVENT SENTINEL-2 IMAGE (LEFT) AND A PRE-EVENT DIGITAL ELEVATION MODEL (RIGHT) USED TO ANALYSE THE UPPER PART OF THE AVALANCHE'S RUN-OUT PROFILE (BERTHIER, 2026).

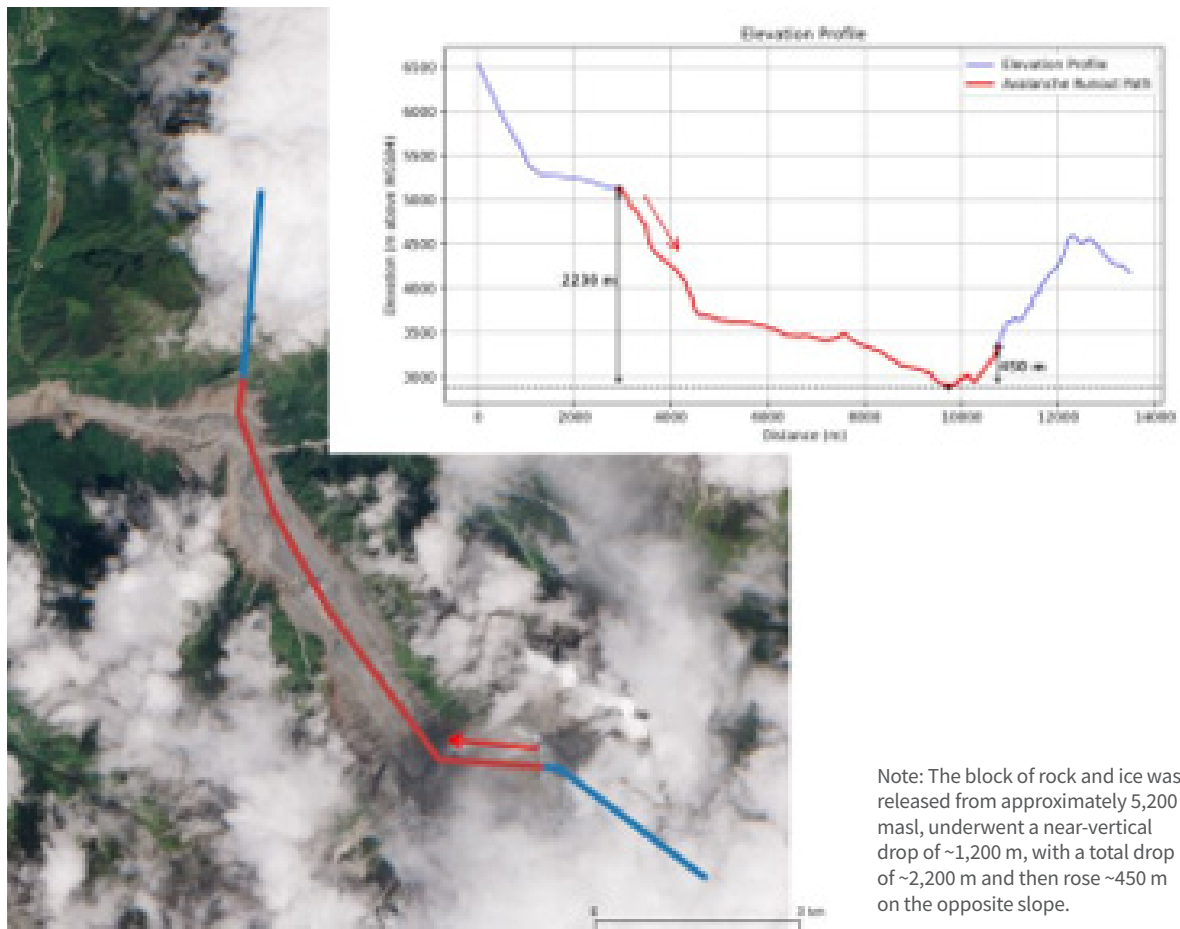
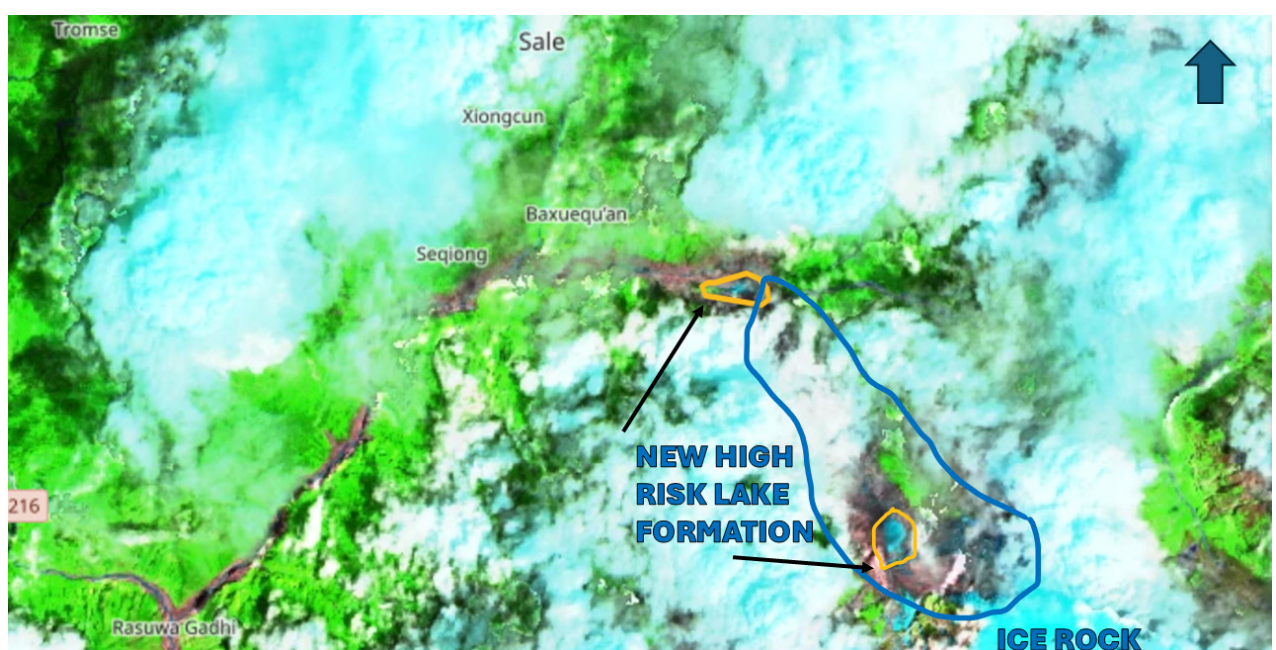


FIGURE 4

A SENTINEL-2 L2A IMAGE OF 27 AUGUST 2026 SHOWING THE LOCATIONS OF THE TWO TEMPORARY LAKES FORMED BECAUSE OF THE ROCK-ICE AVALANCHE



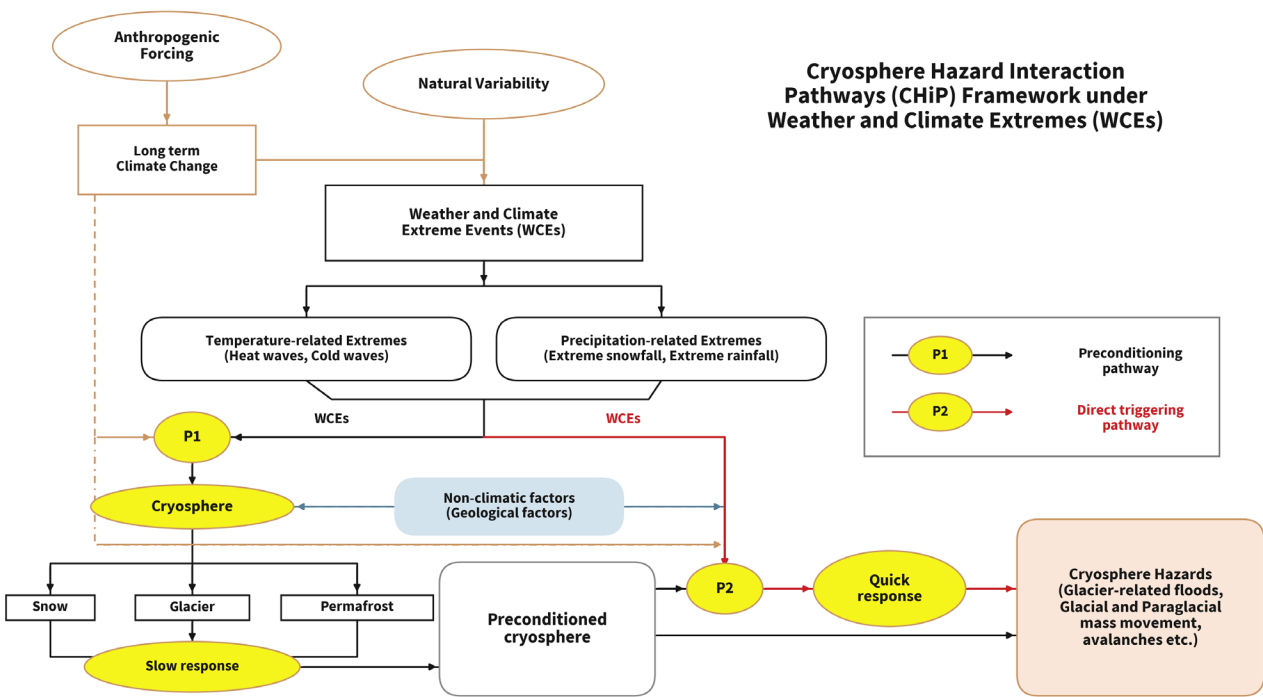
Note: The upper lake is also visible in Figure 1. Image credit: Sravan Shrestha, ICIMOD

4. Possible physical mechanisms

The Hindu Kush Himalaya (HKH) has emerged as a hotspot of cryosphere hazards due to climate change. While long-term warming governs the evolution of glaciers, snow, and permafrost, weather and climate extremes (WCEs) often control the timing and magnitude of hazards. Several recent disasters have been examined in the context of extreme events, but the existing preconditioning-triggering concepts have not been studied in detail. Here, we used the Cryosphere Hazard Interaction

Pathways (CHiP) framework (Azam et al., 2026) to investigate the Gyirong-Rasuwa disaster (Figure 5). The framework links WCEs to cryosphere hazards via a preconditioning pathway (P1) and a direct triggering pathway (P2). While increasing temperatures and heatwaves over the recent decade are evident, no extreme rainfall event was reported in this area prior to this disaster. We therefore focused mainly on the preconditioning pathway in this synthesis report.

FIGURE 5 THE CRYOSPHERE HAZARD INTERACTION PATHWAYS (CHiP) FRAMEWORK UNDER WCEs, SHOWING INTERACTIONS AMONG LONG-TERM CLIMATE CHANGE, WCEs, AND CHANGING CRYOSPHERE HAZARDS VIA INDIRECT/PRECONDITIONING (P1) AND DIRECT (P2) PATHWAYS. THE LONG-TERM IMPACTS OF CLIMATE CHANGE AND NON-CLIMATIC FACTORS (GEOLOGICAL FACTORS) ARE ALSO SHOWN BY THE DOTTED ORANGE AND BLUE ARROWS, RESPECTIVELY.



Source: Azam et al. (2026).

4.1 Preconditioning

While the source of the Gyirong–Rasuwa disaster has been identified through seismic signals and before-and-after satellite and drone imagery, the physical mechanisms of the bedrock failure and the source of the water that fed the flood remain under discussion. Based on quick assessments by scientists and specialists outside Nepal and by ICIMOD, we discuss here several possible explanations for the bedrock failure, including non-climatic geologic preconditioning and climate-induced cryospheric changes.

THE 2015 EARTHQUAKE PRECONDITIONING

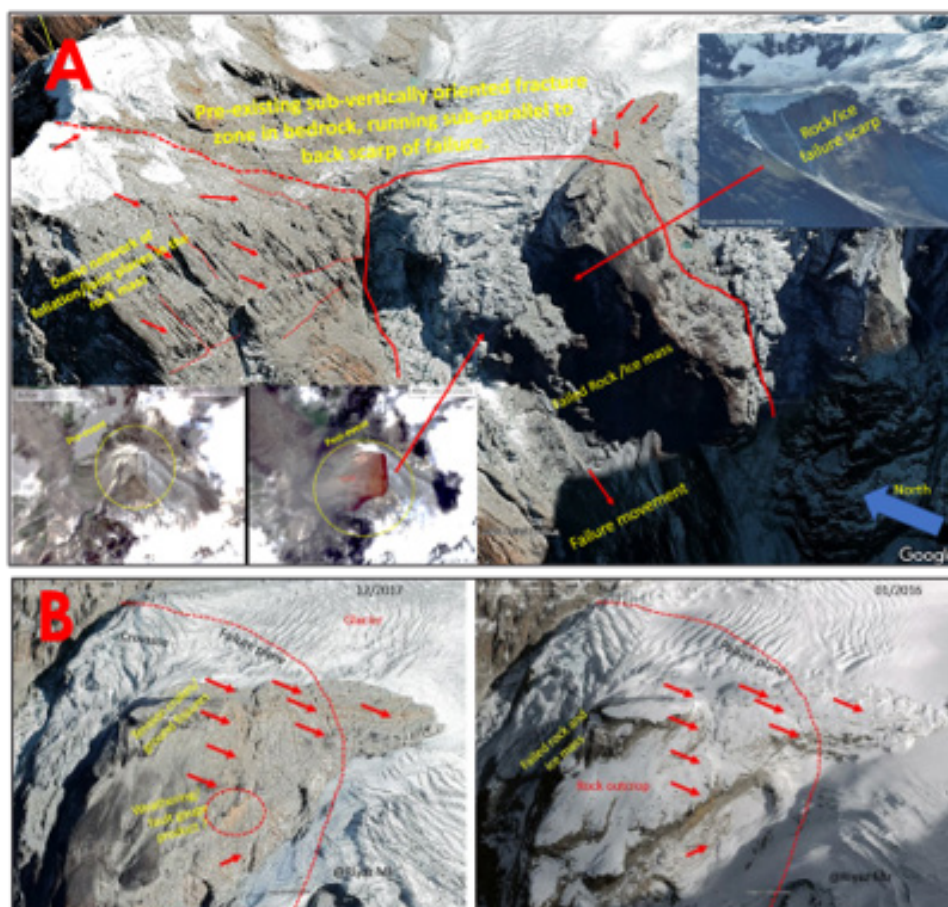
Langtang Lirung is the same mountain whose southern flank failed catastrophically during the 2015 Gorkha earthquake, burying Langtang village. Strong shaking can open fractures that remain stable for years before failing, and the 2021 Melamchi flood and debris flow disaster is widely

discussed as a possible delayed consequence of the 2015 earthquake. Whether damage from the 2015 earthquake contributed to the 2026 bedrock failure remains unresolved; it is presented here as one of several possibilities still under discussion.

POSSIBLE GEOLOGICAL PRECONDITIONING OF THE BEDROCK FAILURE

Rasuwa sits close to the Main Central Thrust (MCT) in fractured High Himalayan gneiss and schist, with more than 5,500 metres of relief between Langtang Lirung (7,234 masl) and the Trishuli Valley. The investigation by India's National Disaster Management Authority (NDMA) into the 2021 Chamoli disaster found the same structural setting, with wedge failures along joint and foliation planes in Central Crystalline rocks near the MCT and a similar series of events: a rock–ice avalanche, leading to the formation of a debris-dammed lake and debris flows.

FIGURE 6 FIELD AND SATELLITE EVIDENCE OF THE 26 AUGUST 2026 ROCK-ICE AVALANCHE, SHOWING



(A) major fractures, foliation and joints, the failed rock-ice mass, and south-westerly movement. The inset images show pre-event and post-event conditions and persistent pre-existing weak zones along the glacier–bedrock interface. A comparison of images

(B) from December 2017 and January 2026 reveals that several of these features were already present before the 2026 collapse

Source: Riyaz Mir, National Institute of Hydrology Roorkee, India.

The bedrock failure underlying the 26 August 2026 Gyirong–Rasuwa disaster may reflect long-term structural preconditioning in deglaciated terrain rather than a purely glaciological event (a glacier collapse), although this remains to be confirmed. Post-event imagery (Figure 6A) reveals a steep source zone in which exposed bedrock and glacial ice exhibit planar failure along pre-existing fractures, foliation, and joints, discontinuities that could form kinematically favourable failure surfaces. Notably, a linear groove-like depression visible in images from both December 2017 and January 2026 (Figure 6B) suggests this was a pre-existing weak zone, not a feature created by the August 2026 collapse itself. If confirmed, meltwater infiltration along such discontinuities, combined with freeze-thaw action and permafrost degradation over the years under a warming scenario, could have progressively weakened the rock mass until a critical failure threshold was reached, offering a plausible, though still unverified, geological explanation for the disaster.

PERMAFROST DEGRADATION

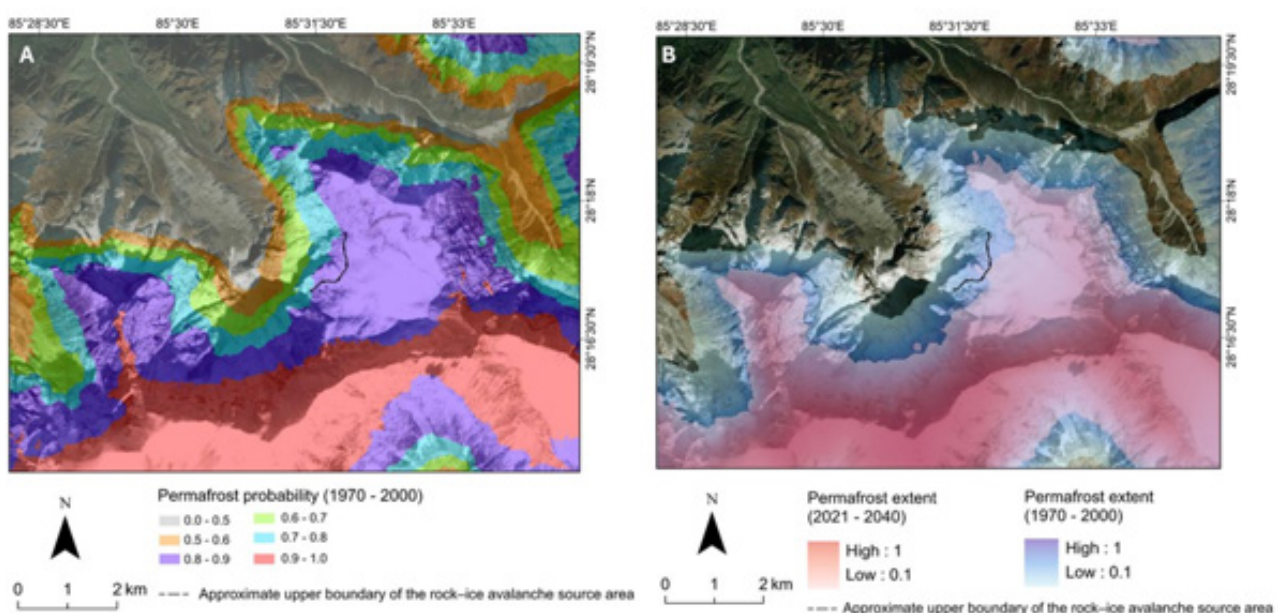
Beyond the fractured, foliated bedrock (Figure 6), another quieter process may have been at work deep within the slope: the degradation of permafrost.

Like snow and glaciers, permafrost is also affected by increasing temperatures. ICIMOD's 2023 report, *Water, ice, society, and ecosystems in the Hindu Kush Himalaya*, noted degrading permafrost across the HKH and anticipated larger and more frequent rock–ice avalanches as the ice in rock joints thaws (Jackson et al., 2023). The source area was mapped at ICIMOD using a rock glacier-based permafrost probability model (Figure 7A), built from the signatures of nearby intact and relict rock glaciers (Baral & Haq, 2020); it fell squarely within a zone in which permafrost was discontinuous or conditions were marginally favourable. The modelled probability indicates a likelihood of permafrost present at, or near the failure site, although its presence at the exact failure surface cannot be confirmed without direct ground observations. The source area was also mapped using a temperature grid-based permafrost extent model (Figure 7B) (Gruber, 2012).

If that were the case, the implications are significant. Warm, ice-filled fractures are known to be sensitive to even small thermal shifts. A few degrees can be enough to loosen the ice's grip on rock joints, echoing the freeze–thaw and ice-wedging mechanisms suspected of causing the bedrock's slow weakening. Under sustained warming, such fractures may have thawed gradually over years (Magnin & Josnin, 2021), a trend consistent with the modelled contraction of permafrost extent in

FIGURE 7

ROCK GLACIER-BASED PERMAFROST PROBABILITY DISTRIBUTION FOR THE SOURCE AREA OF THE GYIRONG–RASUWA DISASTER



Rock glacier-based permafrost probability distribution for the source area of the Gyirong–Rasuwa disaster (A).

A spatial comparison indicates reduced extent of permafrost in the source area of the rock–ice avalanche under the warmer climatic conditions (B).

Sources: Prashant Baral, ICIMOD

the source area under warmer climate scenarios (Figure 7B), quietly reducing the rock mass' internal interlocking long before the final collapse.

Still, this remains a hypothesis, not a conclusion. No direct evidence has yet confirmed that permafrost had degraded at the actual failure plane, or that it played a decisive role in triggering the avalanche. However, the mapping does offer a plausible piece of the puzzle, one that points to the source area as a priority site for future field and geophysical investigations.

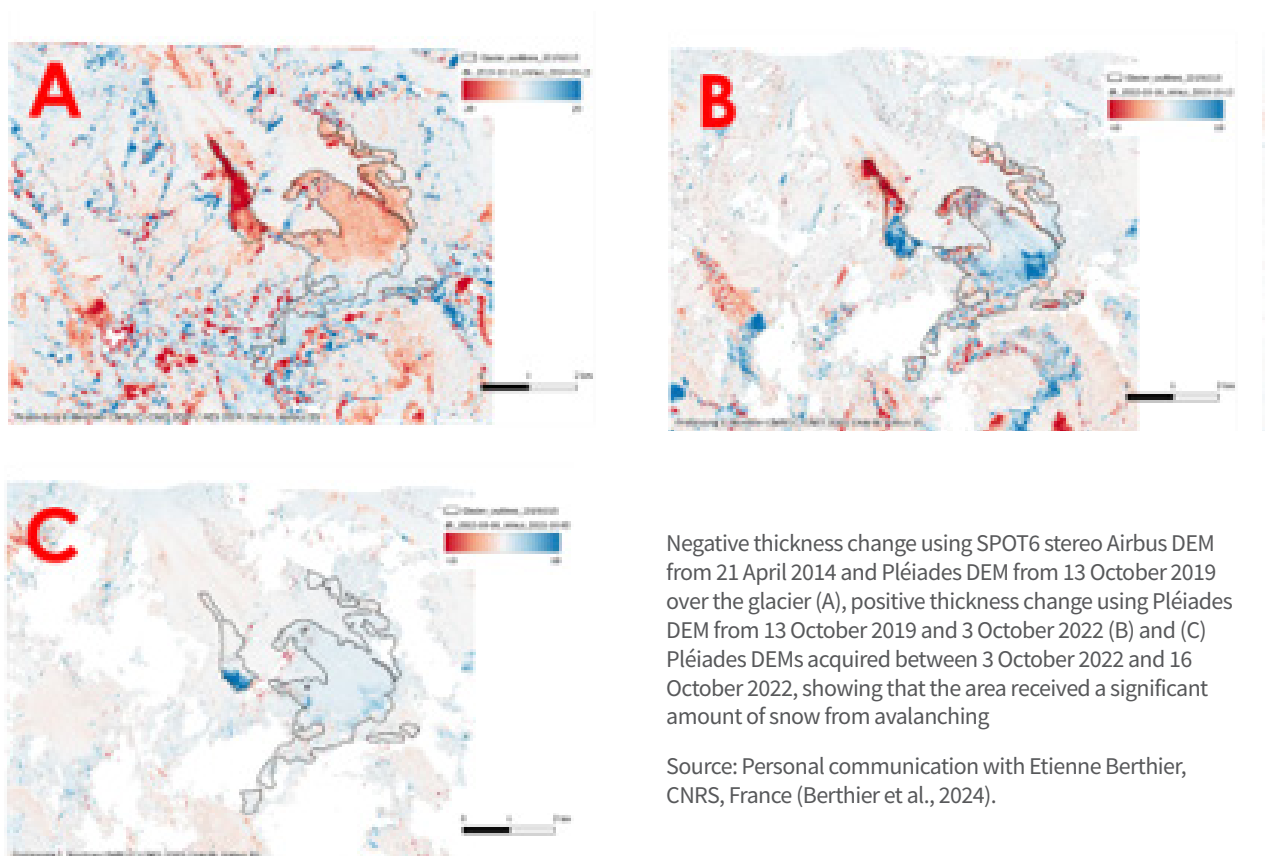
PROGRESSIVE OVERLOADING

Even as one awaits a much-needed post-event digital elevation model (DEM), the behaviour of the rock-ice avalanche area in the years preceding the collapse has been documented using four pre-event DEMs: a SPOT6 stereo Airbus DEM from 21 April 2014 and three Pléiades (CNES) DEMs of the area from 13 October 2019, 3 October 2022, and 16 October 2022.

Between April 2014 and October 2019, the mean rate of change in this glacier's elevation was -0.80 m per year. However, from October 2019 to October 2022, the same glacier surface thickened by 0.30 m per year, likely due to periodic snow avalanches from its surrounding sidewalls, a process that may have progressively added mass and load to an already unstable slope. Without these snow avalanches, the glacier might instead have been losing thickness, like other glaciers in the Himalaya or the nearby Yala Glacier (see the section on glacier wastage). The likelihood of snow avalanches is clearly visible in the thickness change map derived from Pléiades DEMs acquired between 3 October and 16 October 2022, only 13 days apart (personal communication with Etienne Berthier, CNRS, France) (Figure 8). Together, these observations reveal how dynamic the lower glacier zone was in the years before failure, with numerous instabilities evident along the side moraines, consistent with a slope being incrementally overloaded ahead of collapse.

FIGURE 8

MAPS SHOWING CHANGES IN GLACIER THICKNESS, DERIVED FROM SPOT6 STEREO AND THREE PLÉIADES DEMS OF THE AREA.



Negative thickness change using SPOT6 stereo Airbus DEM from 21 April 2014 and Pléiades DEM from 13 October 2019 over the glacier (A), positive thickness change using Pléiades DEM from 13 October 2019 and 3 October 2022 (B) and (C) Pléiades DEMs acquired between 3 October 2022 and 16 October 2022, showing that the area received a significant amount of snow from avalanching

Source: Personal communication with Etienne Berthier, CNRS, France (Berthier et al., 2024).

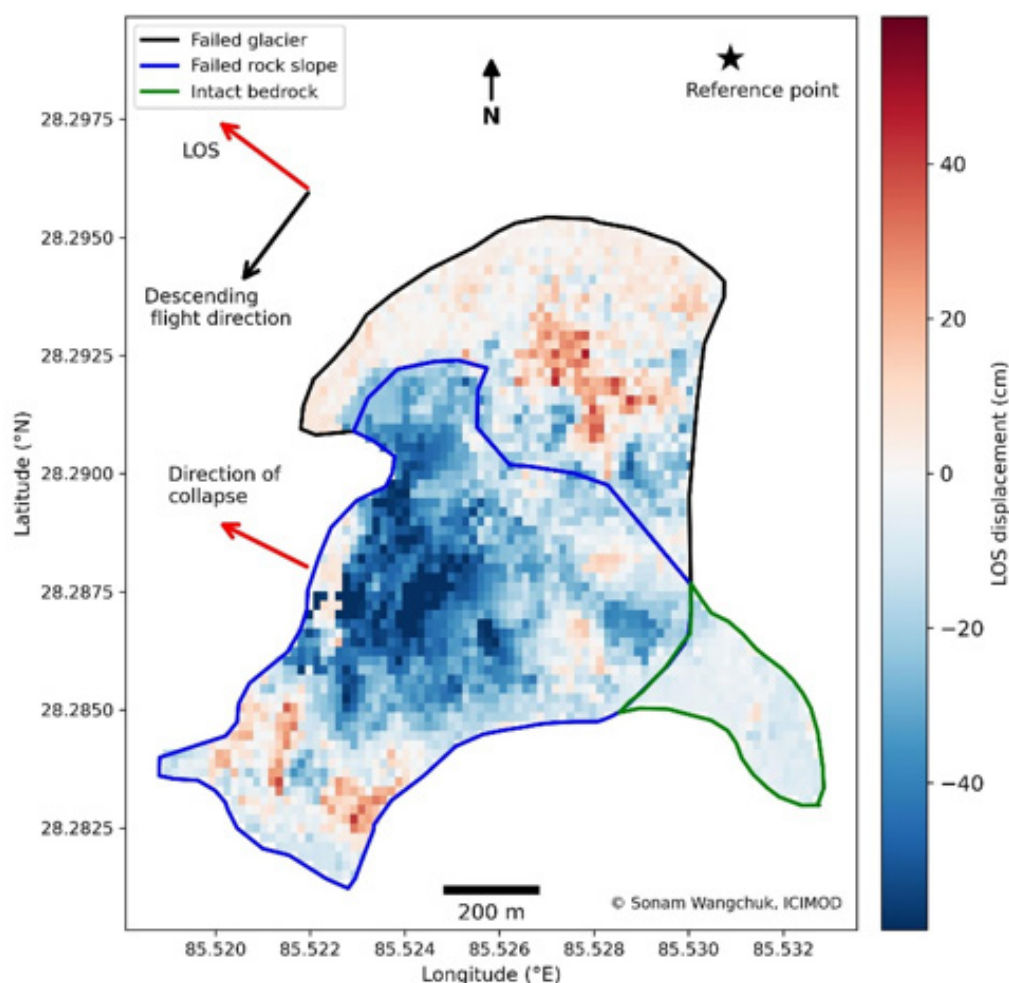
DEFORMATION

Pre-event line-of-sight (LOS) displacement recorded by Sentinel-1 InSAR between 7 July and 24 August 2026 (a 48-day period) revealed deformation patterns of up to 40 cm across the failed area, suggesting destabilisation of the rock-ice system prior to failure (Figure 9). Similarly, pre-event LOS displacement of up to ~30 cm was observed using NISAR InSAR over 26 July–19 August 2026 (a 24-day period) across the same area, as reported by Quinn Brencher on LinkedIn (not shown here).

Pre-event mapping of the source glacier's surface velocity by Abinash Silwal (GISP, on LinkedIn) showed it moving at approximately 29 metres per year during 2014–2024, the fifth-fastest among 148 ice bodies in the area, though with no acceleration trend observed during 2014–2024, and a flow direction of roughly 306°. Taken together, these findings indicate a slope that was actively deforming before failure, carrying a fast-moving but not visibly accelerating glacier, a pattern more consistent with a bedrock failure in which the ice played a passive role rather than driving the collapse. These preliminary analyses argue against the possibility of a typical glacier collapse.

FIGURE 9

SENTINEL-1 INSAR LINE-OF-SIGHT (LOS) DISPLACEMENT PRECEDING THE ROCK-ICE AVALANCHE BETWEEN 7 JULY AND 24 AUGUST 2026



Note: The location of the reference point used for the InSAR displacement measurements is indicated by the star. The black arrows indicate the approximate flight direction of the descending Sentinel-1 acquisition and the inferred collapse direction, while the red arrows represent the approximate LOS and collapse direction.

Source: Sonam Wangchuk, ICIMOD.

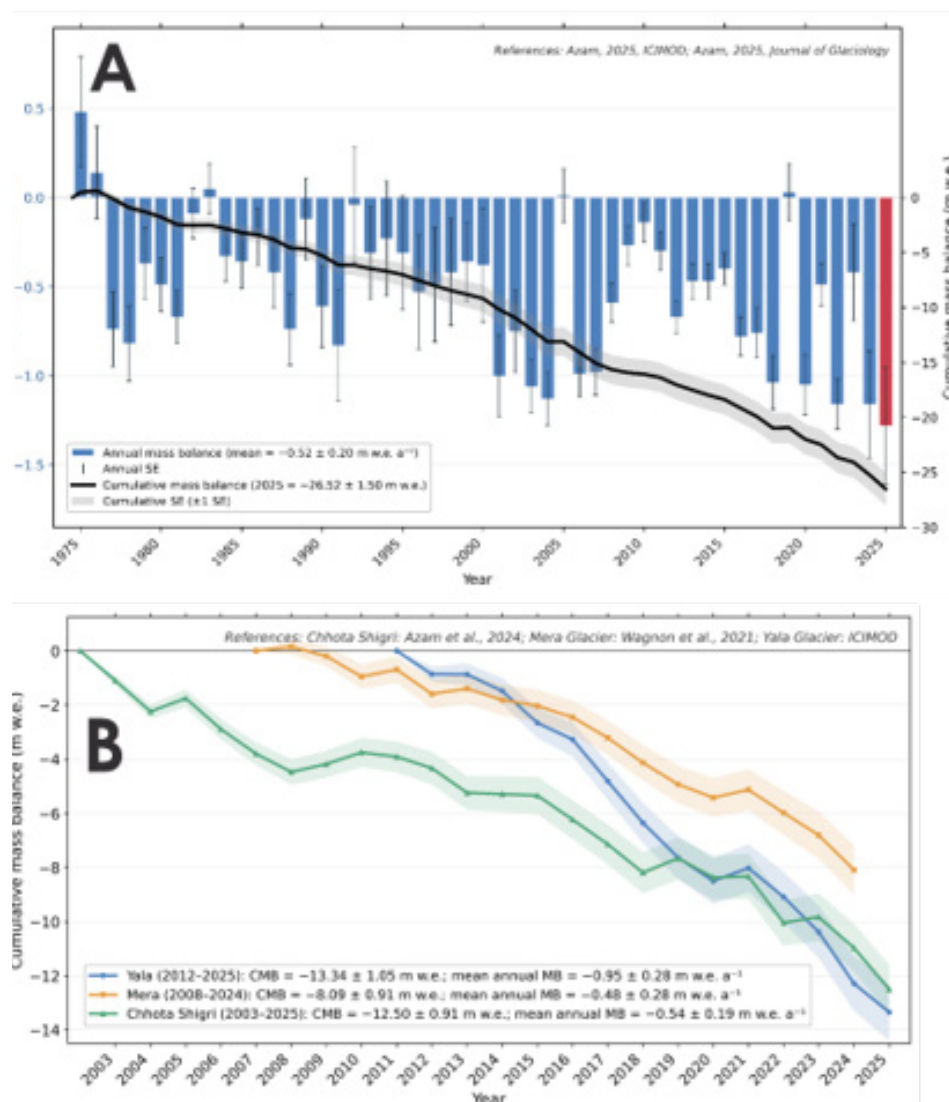
GLACIER WASTAGE

Climate change is driving widespread glacier retreat, leaving behind loose sediment and boulders on newly exposed slopes. Debuttressing (the destabilisation of steep rock faces) is a recognised process that contributes to slope instability in glacierized terrains. While there is no direct evidence linking rapid glacier melt in the region to the Gyirong–Rasuwa disaster, it reflects a broader pattern: retreating glaciers expose more bare rock and sediment, surfaces that absorb more heat from the sun, and may, over time, contribute to the thermal and mechanical destabilisation of surrounding slopes.

Yet our understanding of these changes rests on surprisingly limited direct observation. Of the more than 63,000 glaciers across the HKH (Maharjan & Sherpa, 2026), only 38 have been monitored for glacier-wide mass balance, and of these, just 21 have ongoing field measurements with direct mass-balance data (Azam, 2026a). But even with limited data, what these records show is striking: the rate of regional mass wastage has nearly doubled since 2000, with the most recent mass-balance year, 2024–2025, breaking all previous records (Figure 10A).

FIGURE 10

MEAN ANNUAL MASS BALANCE OF ALL MONITORED HIMALAYAN GLACIERS AND CUMULATIVE MASS LOSS ACROSS THE HIMALAYA, 1975–2025 (A); CUMULATIVE MASS LOSS ON THE YALA, CHHOTA SHIGRI, AND MERA GLACIERS OVER THEIR RESPECTIVE MONITORING PERIODS (B)



Sources: Mass balances estimated and compiled by Mohd. Farooq Azam, ICIMOD (Azam 2026b); Chhota Shigri Glacier Azam et al. (2024); Mera Glacier Wagnon et al. 2021, Yala Glacier, ICIMOD.

Closer to the disaster site, ICIMOD has monitored the Yala Glacier, located roughly 11 km southeast of the Langtang Lirung massif on its southern side, since 2011. Figure 10B presents Yala's cumulative mass loss over this period, set alongside two benchmark glaciers: Chhota Shigri in the Chandra Basin (representative of the western Himalaya) and Mera Glacier in the Khumbu region (representative of the central Himalaya). Yala Glacier stands out among the three, having lost ice at a markedly faster rate than either of the other two benchmark glaciers.

THE 2025 RASUWA FLOOD AS AMPLIFIER

Beyond conditions at the source discussed in this section, the pathway the flood travelled through may itself have had a bearing on the scale of the disaster. The July 2023 and the July 2025 Rasuwa flood events left the Lhende and Upper Bhotekoshi river channels lined with loose sediment, with widened and raised beds, stripped of vegetation, and only partially rebuilt in terms of infrastructure. Debris flows are known to grow by entraining loose material along their path; the February 2021 Chamoli disaster, for instance, picked up leftover debris from a 2016 avalanche and widened its channel six-fold as a result (Westoby et al., 2023). A channel already primed in this way could plausibly have amplified the immediate collapse into a larger, faster-moving surge. This remains a hypothesis for the post-event sediment budget to test.

4.2 The mass movement and the massive flood that was generated

While scientists still await clear, high-resolution post-event imagery, rough early estimates put the detached mass at somewhere between 100 million and 200 million cubic metres. A more refined assessment (Hendrickx, 2026) puts the total at 132 Mm³, comprising 115 Mm³ of gneiss rock and 17 Mm³ of glacial ice (13% by volume) (Figure 11). This is roughly four times the scale of the 2021 Chamoli rock-ice avalanche (~27 Mm³) in India and about twelve times that of the 2025

Blatten event in Switzerland, underscoring just how massive the Gyirong-Rasuwa disaster is. It will be worth checking these initial figures against more accurate results once the latest DEM data have been fully analysed.

According to this preliminary calculation by Marc Hendrickx and Associates Pty Ltd (Hendrickx, 2026), the 132 Mm³ of material descended ~1,200 metres nearly vertically down the steep slope, releasing 3.84×10^{15} Joules (3.84 PJ) of gravitational potential energy. The failure appears to be governed by a broadly translational/wedge-style mechanism, possibly controlled by pre-existing structural defects in the rock (Figures 6 and 11).

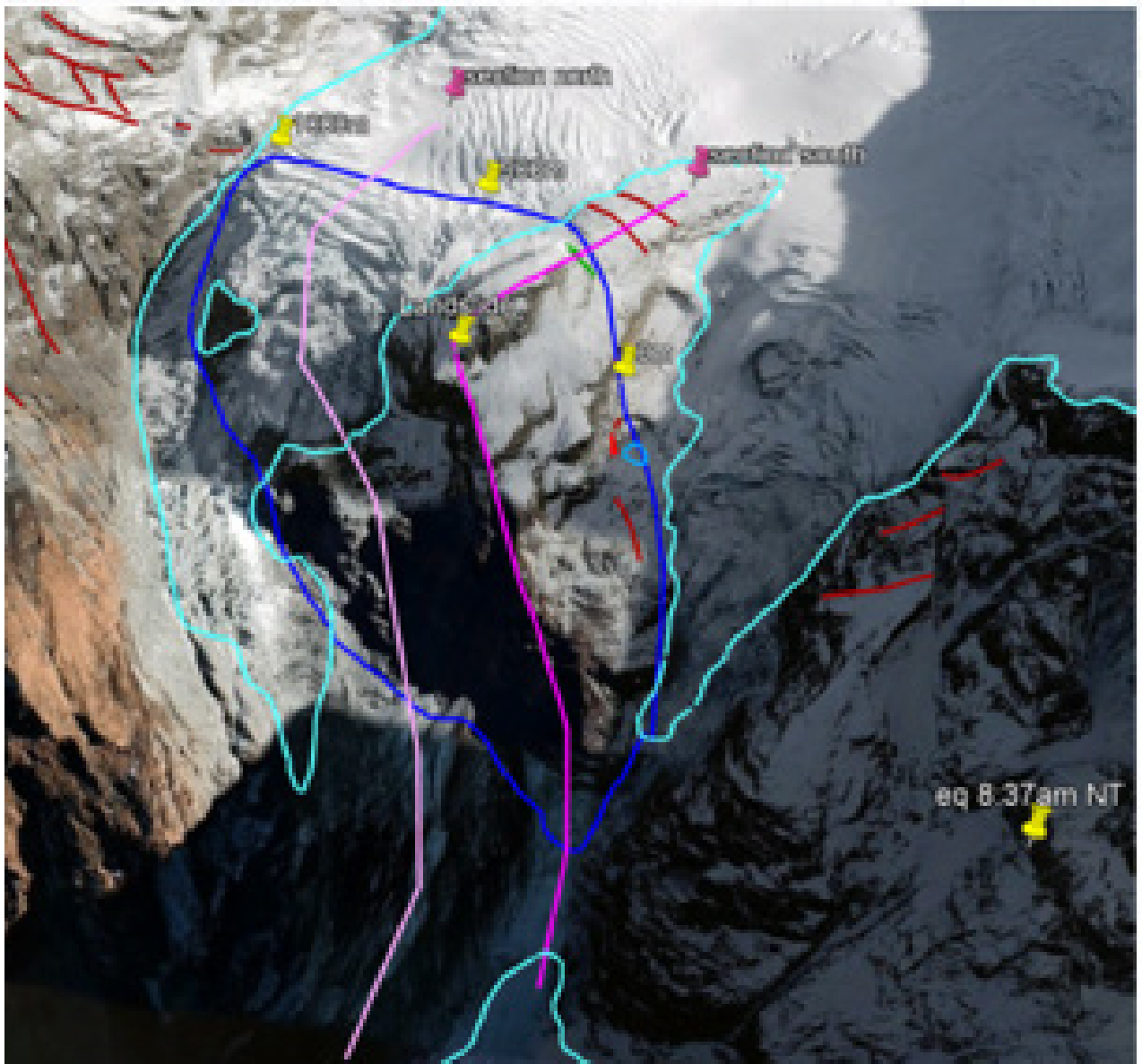
This collapse was the source of the Ms 5.2 seismic signal recorded at the time. Assuming that 0.1% of the total energy was radiated as seismic waves (roughly 3.98×10^{12} J), the remaining 99.9% would have been released almost instantly as frictional heat and mechanical rock crushing – enough, by this estimate, to flash-melt approximately 11.5 billion kilogrammes (kg) of ice, or about 73% of the total estimated ice mass, into liquid water (Hendrickx, 2026).

Carried forward by its own momentum, the mass then surged roughly 450 m up the opposite valley wall – a slope of about 45° – before sliding back down (Figure 3). This return swing would have generated a further $3.39\text{--}6.78 \times 10^{14}$ Joules of frictional energy, sufficient to melt another 1.02–2.03 billion kg of ice. By the time the debris settled on the valley floor, an estimated 86% of the original ice mass had converted to liquid water (Hendrickx, 2026).

These estimates align closely with the energy-balance calculations from the 2021 Chamoli disaster, in which researchers found that a similar rock-to-ice ratio (roughly 80:20), combined with a comparable height of 3,700 masl from which the mass fell, could generate a similar catastrophic flood (Shugar et al., 2021).

FIGURE 11

CROSS-SECTIONS AND ESTIMATED VOLUME OF THE ROCK-ICE AVALANCHE



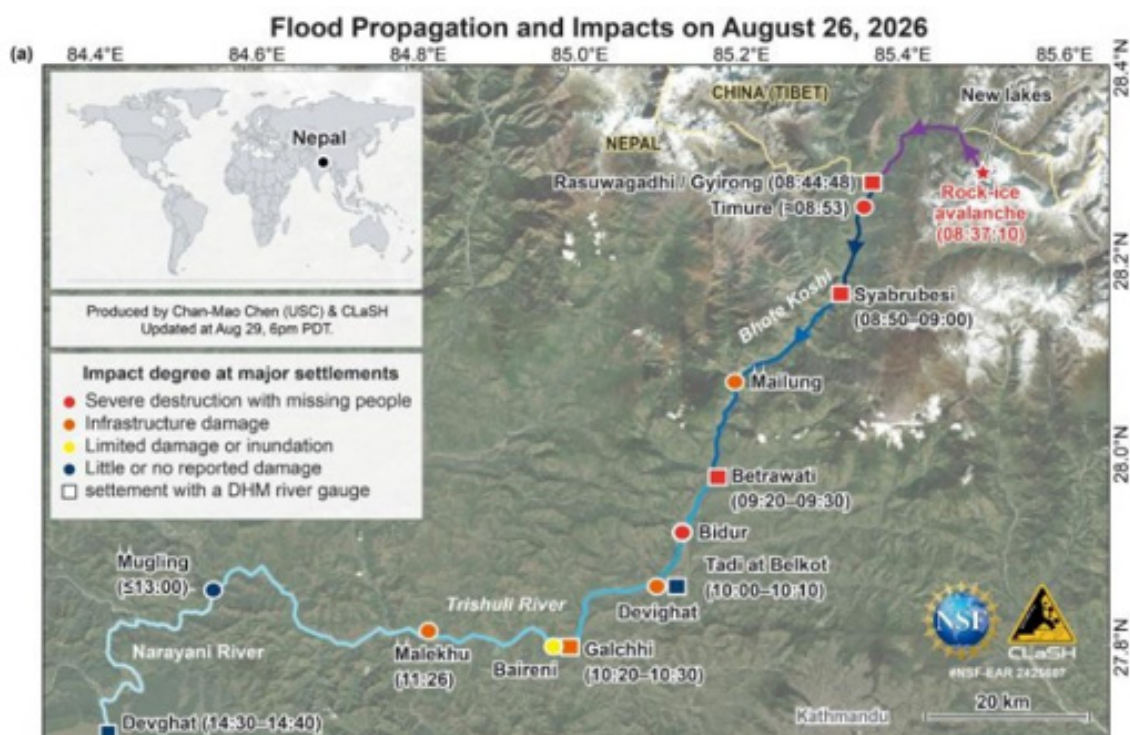
Source: Hendrickx (2026)

5. Timeline and flood propagation

Scientists, drawing on satellite imagery, real-time gauge readings, CCTV footage, and accounts from local residents, have reconstructed the flood wave's downstream path and pinpointed where its impacts were the most severe. The arrival times, flow speeds, and damage estimates presented here are preliminary and will likely be refined as further data become available.

Comparisons of pre- and post-event satellite imagery offer a way to measure the extent of the flood's inundation. Figure 12 shows the estimated arrival times, topographic profile, and relative water-level changes at DHM stations on 26 August (Center for Land Surface Hazards 2026).

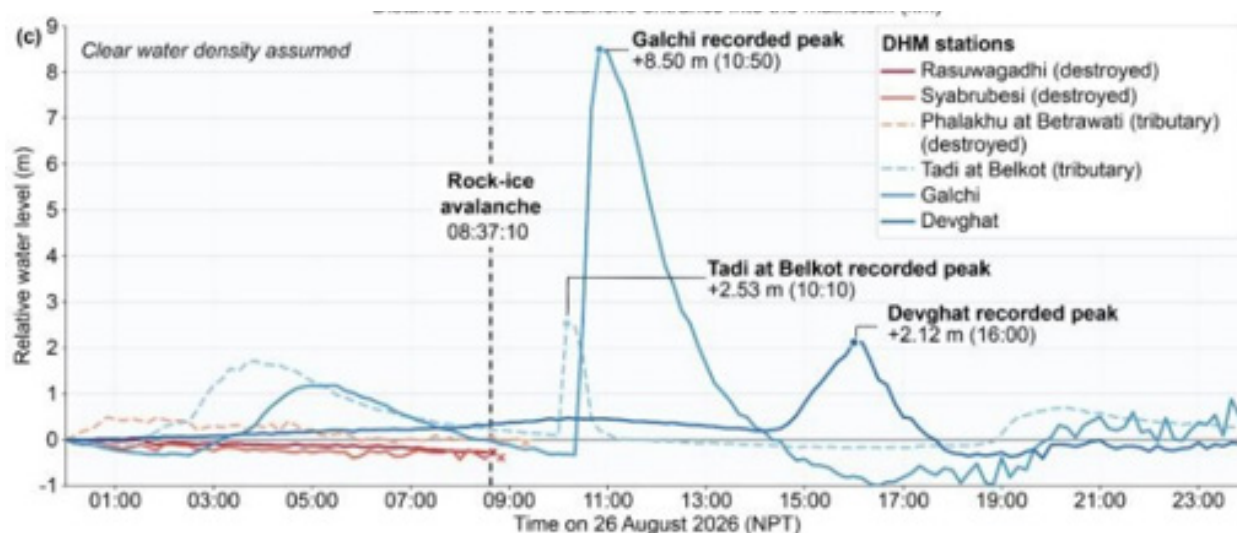
FIGURE 12 FLOW PROPAGATION AND IMPACTS ON 26 AUGUST 2026



The flood corridor, estimated arrival times, and preliminary impact classification of major settlements



Longitudinal topographic profile along the rock-ice avalanche pathway and downstream channel, together with elevation ranges within ± 5 and ± 10 km of the mapped river centre line



Relative water-level changes at DHM stations on 26 August
Source: Center for Land Surface Hazards (2026)

Information from Figure 12 was combined with seismic timing, gauge records, CCTV footage, witness accounts, and satellite and UAV imagery to reconstruct the propagation of the flood wave downstream (Table 1). Because these sources use

different methods and time references, the resulting velocities should be interpreted as preliminary ranges rather than exact measurements.

TABLE 1 FLOOD WAVE PROPAGATION: A TIMELINE

Date and Time (NPT)	Location/Reach	Event/Observation	Flow speed (if reported)	Sources
26 Jul–19 Aug	Source glacier and adjacent slope	Pre-event Sentinel-1 InSAR, NISAR InSAR shows line-of-sight displacement of up to ~30 to ~40 cm	–	ICIMOD, Quinn Brencher
26 Aug, 8:37	Source (Langtang Lirung massif, north face)	Seismic signal detected; first reported as a Ms 4.4 earthquake, later reassessed as Ms 5.2 (USGS)/Mw 5.7 (GFZ), consistent with mass movement	–	GFZ; USGS
26 Aug, ~8:37–09:00	North face → Lhende Khola Valley	Flow descends into Lhende Khola; goes up the opposite side of the valley up to ~450 m	–	Marc Hendrickx (2026); USGS
26 Aug, ~9:00–09:05	Gyirong Port/ Rasuwagadhi	Flood arrives; enters Bhotekoshi; Rasuwagadhi discharge station shows no prior rise, later destroyed	~20 m/s (~78 km/h) from collapse site to Rasuwagadhi	CLaSH; DHM
26 Aug, ~9:05–9:07 (implied)	Source to ~22 km downstream (Lhende–Bhotekoshi)	Debris front travel estimated from seismic onset to first downstream observation	≈54 m/s (~193 km/hr average); 22 km in 6 min, 50 s	Jeffrey Kargel (PSI) via CNN

Date and Time (NPT)	Location/Reach	Event/Observation	Flow speed (if reported)	Sources
26 Aug, 9:15–9:16	Rasuwa, Nuwakot, Dhading, Chitwan	DHM Flood Forecasting Division sends SMS alerts to ~679,000 residents; Timure already inundated	–	DHM
26 Aug, ~9:20	Betrawati	Flood wave reaches Betrawati	~20 m/s (Rasuwadaghi–Betrawati); flagged as possibly not physical; may reflect errors in timing or an air-blast/debris front ahead of water	CLaSH , DHM
26 Aug, 11:26	Malekhu	Gauge crosses danger level	~5.2 m/s (Betrawati–Malekhu–Kali Khola)	DHM
26 Aug, 11:40	Source region (secondary)	Second, smaller mass movement detected seismically, ~3 hrs after the first	–	USGS
26 Aug, 11:43	Malekhu	Malekhu bridge destroyed	~4–5 m/s (Rasuwadaghi–Betrawati and beyond, average speed)	CLaSH ; DHM
26 Aug, 14:20	Kali Khola	Arrival of flood wave	~5.2 m/s (Betrawati–Malekhu–Kali Khola)	CLaSH
–	Mailung → Devghat (~78 km)	Downstream propagation	~6 m/s (~22 km/hr)	CLaSH
26 Aug, ~16:00	Devghat	Arrival of flood wave	~4.0 m/s (Kali Khola–Devghat)	CLaSH
–	Into India (Gandak, 180–390 km from Timure)	First crest at Triveni ~7.6 hrs after event; Rewaghat ~52.6 hrs after event	Effective celerity ~2–3 m/s	CLaSH
27 Aug	Chhochen–Purepu confluence	China MoWR reports ~2 Mm ³ barrier lake, already overflowing; second small lake reported near source	–	MoWR, China
28 Aug	Barrier lake site	Rasuwa Chief District Officer reports Chinese notification of a breach of the barrier lake; riverside circular issued; additional debris/lake visible in imagery	–	Rasuwa District Administration Office
30 Aug	Trishuli at Galchhi	River rises ~3 m with renewed inflow from Rasuwa plus heavy rainfall in Gandaki Basin	–	NDRRMA/DHM bulletin
For comparison	2021 Chamoli disaster	Debris flow speed benchmark	~10.6 m/s (NDMA) to 12–13 m/s (CWC)	NDMA India joint study, April 2022

Note: Speed estimates are derived from different reconstruction methods (seismic timing, CCTV/gauge-based flow mapping, gauge-to-gauge travel time) and are approximate. Some (for example, the ~20 m/s Rasuwadaghi–Betrawati figure) are explicitly flagged by the original analysts as potentially unreliable due to reporting-time uncertainties or the presence of an air blast/debris front ahead of the main flood wave.

Three patterns emerge from the available chronology. First, the initial 20–25 km was the fastest reach, with estimates indicating velocities of tens of metres per second. Jeffrey Kargel's estimate of approximately 54 m/s over 22 km would place the event among the fastest documented large debris flows. Second, some reported arrival times between Rasuwagadhi and Betrawati imply velocities exceeding approximately 20 m/s, which may be physically unrealistic for a channelised water flow. This discrepancy could reflect inaccurate reporting times or the arrival of an air blast or debris front ahead of the main flood wave. Third, once the surge entered the Trishuli River, it slowed to approximately 4–6 m/s before attenuating to a crest moving at about 2–3 m/s as it flowed through the Gandak.

Hydrologically, the event was a debris-laden surge rather than a rainfall-generated flood. The DHM identified no rainfall sufficient to produce the observed discharge; only light rainfall was reported in the Mala River catchment. A rainfall-threshold warning system would therefore not have detected the initiating event.

The Rasuwagadhi gauge record remains ambiguous. The modest decline recorded from the afternoon of 25 August until the station was destroyed a

little after 9 am on 26 August could indicate an upstream blockage, but it could also represent the normal recession of a monsoon river following a daytime melt peak. Resolving this question requires comparison with flows from the Lhende, Mala, and other tributaries.

The changing velocities indicate a transition from a high-energy, hyper-concentrated debris flow in the steep and confined Lhende–Bhotekoshi gorge to a channelised, sediment-laden flood in the Trishuli. The deposition of coarse debris and widening of the valley below Betrawati reduced the flow's velocity and destructive energy, consistent with the more limited impacts reported in the wider reaches downstream.

The direct peak discharge remains unknown because no surviving gauge recorded the flood peak in the upper corridor. The overtopping of the Rasuwagadhi and Trishuli 3A barrages and the destruction of the 220 kV Trishuli 3B Hub Substation indicate an exceptionally large flow, but its magnitude can only be reconstructed using surveyed high-water marks, post-event channel geometry, sediment deposits, and hydraulic modelling.

FIGURE 13

PEAK DISCHARGE ESTIMATE AT GALCHHI USING RIVER CROSS-SECTIONAL CHARACTERISTICS, FLOOD TRAVEL TIME, WATER LEVEL, AND DISCHARGE RELATIONSHIPS

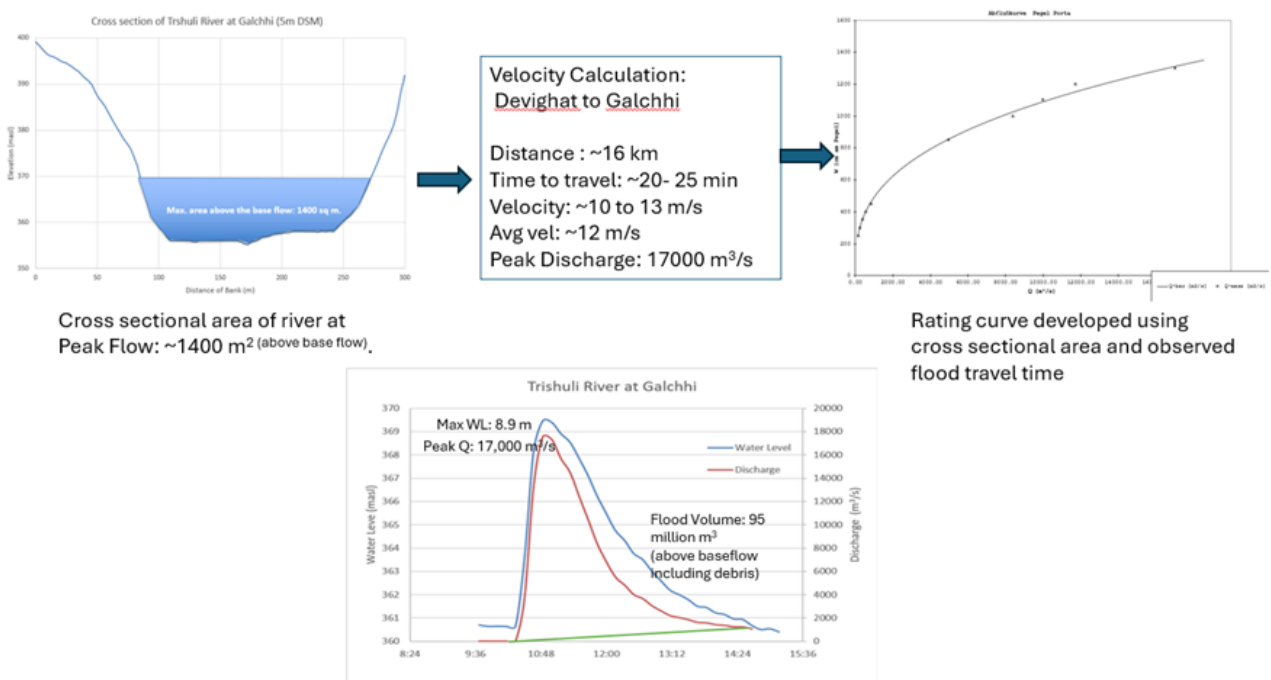


Image credit: Pradeep Dangol, ICIMOD.

Preliminary peak-flow reconstruction at Galchhi

A preliminary peak-flow reconstruction at Galchhi combines channel geometry, flood travel time, water level, and stage–discharge relationships (Figure 13). A cross-section derived from a 5-m resolution digital surface model indicates a maximum inundated area of approximately 1,400 m² above the estimated baseflow water surface. The flood travelled approximately 16 km from Devighat to Galchhi in 20–25 minutes, corresponding to a flood-front celerity of about 10–13 m/s, with a mean of approximately 12 m/s. Assuming that this celerity approximated the cross-section mean flow velocity, the application of $Q = AV$ (used to measure the discharge flow rate) gives a peak discharge of approximately 17,000 m³/s.

The reconstructed hydrograph indicates a maximum stage of approximately 8.9 m and a total event volume of about 95 million m³ above baseflow, including water and entrained debris. These estimates remain preliminary because flood-front celerity may differ from mean flow velocity, the digital surface model-derived cross-section requires field verification, and the rating curve is extrapolated far beyond the observed stage–discharge range. Field surveys of high-water marks, post-event channel geometry, deposit measurements, and event-specific hydraulic modelling are therefore required to validate the reconstruction.

6. Surge height, impact distribution, and exposure

The reported vertical measurements represent different quantities – run-up, local flow depth, downstream stage rise, and sediment deposition – and therefore do not constitute a single surge height. Together, they show extreme source-zone impact, confinement through the Lhende–Bhotekoshi gorge, severe losses and damage where high flow energy met concentrated exposure, and progressive attenuation downstream.

Near the source, preliminary DEM analysis indicates a run-up of approximately 450 m above the thalweg onto the opposing valley (Figure 3). These values record the momentum of the rock–ice mass, not downstream flow depth. Further downstream, monitoring stations at Rasuwa reportedly recorded water levels of about 7 m before being destroyed, while the Trishuli rose by as much as 9 m within 30 minutes at Galchhi. The relative rise was below 1 m in the Gandak, consistent with deposition, valley widening, and tributary mixing.

The damage was greatest at geomorphic and infrastructural chokepoints. Rasuwagadhi, the first comparatively flat reach below the steep Lhende corridor, was favourable for the spreading of flows and the deposition of coarse debris; the same confined area held the Friendship Bridge, a customs yard, a dry port, a parking area for trucks, hydropower works, and the border crossing. The narrow gorge toward Timure and Syabrubesi experienced destructive conditions, with Copernicus mapping reportedly identifying more than 240 buildings destroyed and 32 damaged around Syabrubesi. The damage was more contained below Betrawati as the valley widened, although bridges, roads, hydropower plants, substations, and riverside settlements remained exposed.

Mapping channel width downstream corroborates this pattern: measured cross-sections widen from approximately 250 m near the source at Rasuwagadhi to a maximum of 527 m at Betrawati Bazaar, adjacent to the Trishuli Hydropower Dam, more than double the upstream width (Figure 14). This pronounced widening at Betrawati may reflect local valley geometry combined with a hydraulic backwater effect induced by the dam structure, though this remains to be confirmed.

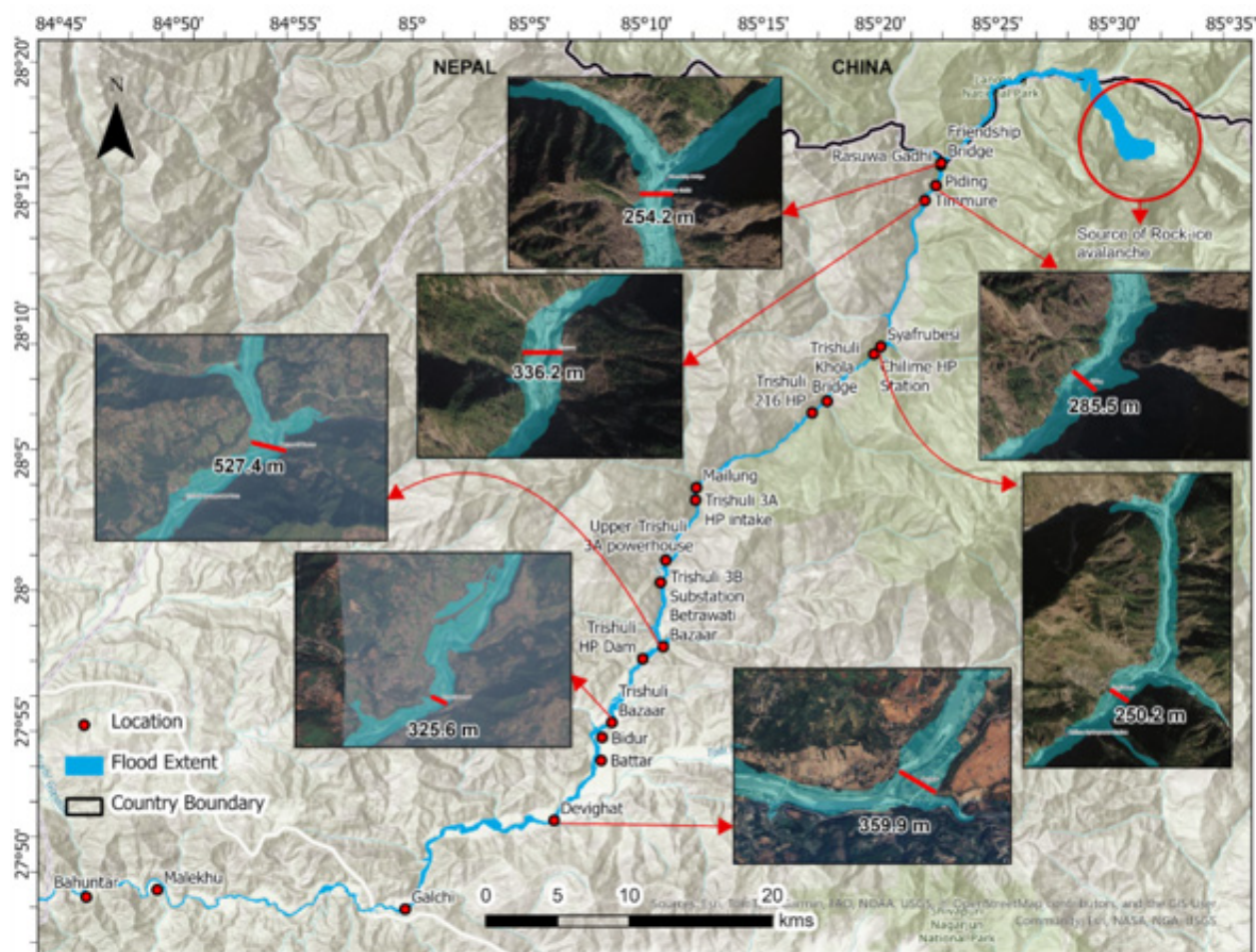
Exposure was unusually high because it was the Kailash pilgrimage season, when tourists, drivers, traders, foreign nationals, and hydropower workers were at the border and along the river corridor. Many were transient visitors, absent from local registers, and less likely to understand Nepali-only warnings or know evacuation routes.

Hydropower emerges as the largest single sector to suffer physical damage from the disaster, accounting for approximately 44% of the total assessed damage (NPR 119,960 million out of NPR 274,480 million) (RDNA, September 2026). This concentration reflects the exposure pattern described above: a substantial share of the corridor's hydropower capacity, including headworks, powerhouses, and the 220 kV Trishuli 3B Hub Substation, sits within the same confined, flow-spreading reaches Rasuwagadhi and the narrow gorge toward Timure and Syabrubesi that recorded the corridor's most severe impacts of the surge. The inundation extent that has been mapped digitally intersects at least six hydropower facilities directly – Chilime HP Station, Trishuli 216 HP, the Trishuli 3A intake and powerhouse, the Trishuli 3B substation, and the Trishuli HP Dam – and also passes through the Nuwakot Solar Power Plant at Bidur, extending the corridor's exposure profile beyond hydropower alone (Figure 14). The same assessment records 13 hydropower projects with a combined capacity of nearly 759 MW within the corridor: seven operating projects (250 MW) and six under-construction projects (509 MW), as well as five operating solar plants (24 MW). Approximately two-thirds of the affected hydropower capacity was under construction, implying that the principal effects of the disaster will fall on Nepal's future electricity generation as much as on electricity already being supplied. Reconstruction needs for the power sector are assessed at NPR 390,620 million (USD 2,579 million).

Risks persist because the floods of 2025 and now 2026 have left damaged infrastructure, unstable slopes, temporary lakes, and abundant sediment that future rainfall or lake drainage may remobilise. Repeat satellite mapping, high-water-mark and sediment surveys, and updated exposure inventories are therefore essential for a safe recovery from the present disaster.

FIGURE 14

FLOOD EXTENT ALONG THE TRISHULI RIVER CORRIDOR, FROM THE AVALANCHE SOURCE DOWNSTREAM TO BAHUNTAR



Notes: The extent of inundation was manually digitised using multi-sensor optical imagery pertaining to the days immediately following the event (Landsat, 26 August; Sentinel-2, 27 August; PlanetScope, 26 and 28 August 2026). The insets display the flood extent overlaid on Google satellite basemap imagery (May 2026) at the seven most heavily impacted cross-sections, with measured channel widths ranging from 250.2 m at Syabrubesi/Chilime Hydropower Station to 527.4 m at Betrawati Bazaar/Trishuli Hydropower Dam.

Image credit: Sunwi Maskey, ICIMOD.

7. Unresolved questions

Despite rapid progress in reconstructing the event, several important questions remain unresolved:

- **The exact volume, geometry, and composition of the failed mass:** Preliminary estimates suggest approximately 132 million m³, including about 13% glacier ice, but these values require validation using high-resolution pre- and post-event DEMs.
- **The origin and volume of water within the surge:** The relative contributions of impact- and friction-induced ice melt, pre-existing meltwater, river water, temporary impoundment, and entrainment along the flow path remain to be determined.
- Whether **the pre-event InSAR displacement** represented a precursory deformation of the failing bedrock–ice slope, glacier movement, an atmospheric or geometric effect, or a combination of these processes.
- **Identifying the dominant cause of failure:** The relative contributions of geological structure, long-term seismic damage from the 2015 Gorkha earthquake, progressive loading, freeze–thaw activity, permafrost degradation, glacier change, and anomalously warm conditions in 2026. No single factor can yet be identified as the dominant cause of failure.
- **The role of earlier sediment:** How much sediment left by the 2025 flood was entrained by the 2026 event and how strongly this inherited material increased the volume and destructive power of the downstream flow remains to be conclusively assessed.
- **The present geometry and stability** of the remaining source-zone rock and glacier mass, valley-side deposits, and debris stored along the Lhende–Bhotekoshi corridor, including their potential for secondary failures and remobilisation.
- **The peak discharge, flow depth, inundation limits, and sediment thickness in the upper corridor,** particularly at Rasuwagadhi, Timure, and Syabrubesi. Assessing these robustly requires field-surveyed high-water marks, post-event channel geometry, sediment mapping, and hydraulic modelling.
- **The exact arrival times and velocities in the upper corridor:** Some reported timings imply physically implausible speeds and must be reconciled using seismic records, CCTV footage, satellite observations, witness accounts, and downstream gauge data.

8. Implications for regional risk assessment and cooperation

The event was cascading in its origin, with transboundary impacts, as was its warning. The mass detached just inside Nepal, immediately above a slope system it shares with China; the flow crossed the border within minutes; and the temporary lakes that formed afterwards, together with their breaching on 28 August and 31 August respectively, became known to Nepali authorities through administrative channels rather than through a standing, real-time data-exchange mechanism. Two implications follow for how hazards of this kind are assessed and warned about.

The need for a multi-hazard risk assessment at the regional scale

The chain here of a rock-slope failure, entrained ice, valley impoundment and breach, and a debris-laden surge conditioned by sediment from 2025 and a warming permafrost base is a cascading sequence that single-hazard, glacial lake or flood inventories do not capture. The 26 August 2026 event was not a single, isolated debris flow but comprised a chain of linked hazards that also built on the recent past. Debris left in the river by the earlier July 2025 supraglacier discharge provided the 2026 surge with extra material.

The same MCT-proximal, permafrost-bound, seismically damaged geometry recurs across the shared high-mountain catchments of the Himalayan border corridors and on Manaslu, Annapurna, Ganesh Himal, and Kanchenjunga. Identifying the next analogous source zone before it fails requires a regional, multi-hazard risk assessment (MHRA) that treats these catchments as a single system rather than as national fragments. This requires cross-border cooperation, as transboundary multi-hazard events occur on one side of the border while the communities at risk are on the other, as seen in the July 2025 supraglacier discharge. Critically, the same techniques that retrospectively revealed instability at this site – spaceborne InSAR displacement mapping, tracking glacier surface velocity, and permafrost-probability modelling (Section 4) – can be applied

prospectively to screen analogous source zones before they fail, converting post-event forensics into a regional early-detection capability.

A related form of prospective screening already exists for this corridor. A 2024 climate-resilience assessment by ICIMOD for the Narayani Basin, drawing on a 2015 post-Gorkha-earthquake landslide-damming inventory, identified four potential damming sites upstream of the Upper Trishuli-3A HPP and flagged the Upper Trishuli-1 HPP as vulnerable to damage from dammed water (ICIMOD & NDRI, 2024). Both projects were subsequently among those damaged on 26 August, which was triggered by a different upstream mechanism than the one originally assessed. This illustrates that project-level exposure in a structurally hazard-concentrated reach can be identified even when the initiating mechanism cannot yet be anticipated.

Regional collaboration on sharing hazard information

Much of the precursory and real-time signals before the event, such as InSAR displacement, the state of the glacier, and any upstream impoundment, originates on or above the border, while the exposure lies downstream in Nepal. The roughly 30-minute gap between the surge reaching the border at around 8:45 am and the first downstream SMS alerts at 9:15, and the reliance on notification through administrative channels of the breach in the barrier lake, illustrate what the absence of shared upstream monitoring and real-time data exchange costs. A standing bilateral and ideally HKH-wide arrangement for exchanging satellite observations, gauge and InSAR data, and early-warning messages across the border would materially shorten warning times for the settlements most at risk. At the HKH regional scale, the standards and protocols that enable such exchanges to be replicated are those set out in Target G of the Sendai Framework for Disaster Risk Reduction 2015–2030 (UNDRR, 2015) and the United Nations Early Warnings for All (EW4All) initiative (WMO & UNDRR, 2022).

9. Role of early warning systems and community preparedness

The flood also exposed several critical vulnerabilities and gaps related to early warning infrastructure and local community preparedness. Although instruments such as water-level sensors were installed to detect swells from possible flood events, these were not designed to detect an extremely rapid-onset rock-ice avalanche and debris-flow event. For the source-proximal upper corridor Rasuwagadhi, Timure, and Syabrubesi, the interval between detection and impact was effectively non-existent, leaving no actionable lead time, however fast an alert is issued. Risk reduction in these reaches therefore depends less on the speed of warning than on hazard-informed land-use planning, avoidance of the highest-exposure sites, and the resilient siting of critical infrastructure and settlements, measures that must *substitute for*, rather than *merely complement*, real-time warning.

The high-velocity debris flow is reported to have also swept away or damaged several monitoring stations, including the one at Rasuwagadhi that stopped transmitting data at 8.50 am, roughly 13 minutes after the avalanche struck. This is also a reason for a lack of automated alerts. A situation report by the NDRRMA, Government of Nepal, also notes that the DHM disseminated downstream SMS alerts at 9:15 am. It states that 679,295 SMS warnings were sent via Nepal Telecom and Ncell, while the flood wave reached Galchhi at 10:28 am, Malekhu by 11:50 am, Mugling by 1 pm, and Devghat by 3:20 pm, and peak discharge was recorded at 4 pm. This indicates that while the automated sensor-to-alert chain failed, the manual response was comparatively fast and gave downstream communities, unlike those nearer the source, several hours of possible lead time.

While over 679,000 SMS alerts were reportedly disseminated downstream, the effectiveness of any warning system ultimately depends not only on transmission of warnings but also on their receipt, comprehension, and timely action by those at risk. Future assessments could therefore examine whether intended recipients received the warnings in time, understood the nature and severity of the threat, knew the appropriate protective actions to

take, and could respond promptly and safely. Such analysis would help identify remaining gaps in the last-mile warning chain and strengthen future preparedness and response measures.

A previous preparedness assessment following the July 2025 Rasuwa glacial flood by the Nepal-based Disaster Preparedness Network (DPNet) noted the complete destruction of considerable critical infrastructure in the Lhende Khola, including the Nepal–China Friendship Bridge, hydropower plants, and a dry port (NDRRMA, 2025). Other assessments include one of the Upper Trishuli 3B Hydroelectric Project, which also notes the risk of hazards including floods and GLOFs. More assessments are needed to ascertain if existing community-level disaster response or evacuation plans also account for hazard risks other than floods and even for multi-hazards.

Incorporating multi-hazard considerations into risk dissemination for events such as this would also influence how future monitoring systems capture and convey these signals to relevant stakeholders. In the case of Rasuwa, the event generated a seismic signal, and pre-event satellite observations indicated deformation in the source area, but there was no heavy rainfall or a preceding rise in river levels sufficient to explain the observed flood. Hence, these signals could be explored together in future monitoring systems, rather than treating seismic, cryospheric, hydrological, and meteorological hazards separately.

The August 2026 event provides an opportunity to also explore whether combinations of signals such as seismic activity, temperature anomalies, rainfall, rapid changes in river levels, and changes in data transmission could be used to identify an emerging cascading hazard. This would require incorporating multiple complementary data streams, including hydrological monitoring, seismic observations, ground- and satellite-based monitoring, communication networks, and community-based observations, to maintain situational awareness even if a single component fails.

Given the concentration of hydropower infrastructure along the corridor, there is also an opportunity to explore joint monitoring and information-sharing among hydropower operators, DHM, NDRRMA, and local authorities. Existing monitoring equipment, communication systems, and operational observations maintained by hydropower projects could potentially provide complementary information for a distributed hazard-monitoring network, with appropriate protocols for data sharing and warning. Innovative EWS technologies could also be explored for the HKH region; for example, a 2016 GLOF in the Bhotekoshi was detected using a broadband seismometer (Cook et al., 2018). Such approaches could help prevent the loss of monitoring equipment installed along the riverbed during extreme events of this kind.

Finally, the very rapid onset of the event raises questions about how local communities can be prepared when the available warning time may be extremely short. Preparedness measures therefore need to consider not only whether a warning can be generated, but whether it can reach people in time and whether communities have simple, pre-agreed actions and safe locations that can be reached without relying on infrastructure that may itself be damaged. Though essential for saving lives and property, the success of early warning systems depends on community trust and on translating that trust into action. When communities trust EWSs, they are more likely to value risk-related knowledge, take warnings seriously, and translate alerts into anticipatory action and response.

This is particularly important for transient populations, especially in similar corridors frequented by tourists, pilgrims, traders, and hydropower workers, as well as for settlements and critical facilities along river corridors. This connects to the issue of anticipatory action and impact-based forecasting, in which pre-agreed actions, and sometimes pre-arranged financing, are triggered once a forecast crosses an agreed threshold, rather than after impacts are confirmed. Most such systems assume hours-to-days of lead time, as with

cyclones or riverine floods, which the near-source lead time here does not allow. They may therefore apply more readily downstream, where several hours of lead time existed, while the source area still needs pre-positioned, infrastructure-independent preparedness rather than a forecast trigger.

Impact-based forecasting and warning services combine hazard information with information about the exposure and vulnerability to its consequences, including who and what lies in the path, and the protective actions required, rather than issuing information about hazard magnitudes alone (WMO, 2015, 2021). For this corridor, where exposure intensifies sharply with the Kailash pilgrimage season and hydropower construction rosters, an impact-based approach would prioritise warnings and pre-agreed protective actions for the specific populations and assets at risk at a given time, and would help convert short lead times into decisions that transient travellers, drivers, and workers unfamiliar with the area can act on.

Framed against the four pillars of the United Nations Early Warnings for All initiative (WMO & UNDRR, 2022) – risk knowledge, detection and monitoring, warning dissemination, and preparedness and response – this event exposed weaknesses across all four, underlining that progress on any single pillar in isolation would leave the corridor exposed. Addressing them together calls for an integrated approach that combines multi-hazard monitoring, resilient warning and communication systems, community preparedness, and risk-informed infrastructure planning. This ought to be reinforced by stronger cross-border mechanisms for the timely sharing of upstream hazard information, observations, and warnings between Nepal and China. In the recovery and reconstruction process, hazard information should also be used to assess whether critical infrastructure and settlements can safely be rebuilt in their existing locations, taking into account cascading and multi-hazard risks, evacuation access, and the potential for secondary failures and sediment remobilisation.

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About ICIMOD

The Hindu Kush Himalaya (HKH) region stretches 3,500 km across Asia, spanning eight countries – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. Encompassing high-altitude mountain ranges, mid-hills, and plains, the zone is vital for the food, water, and energy security of up to two billion people and is a habitat for countless irreplaceable species. It is also acutely fragile and vulnerable to the impacts of the triple planetary crisis of climate change, pollution, and biodiversity loss.

The International Centre for Integrated Mountain Development (ICIMOD), based in Kathmandu, Nepal, is an international knowledge organisation focused on the HKH region, working since 1983 to deliver greener, more inclusive, and climate-resilient development. Our work is guided by our [Strategy 2030](#), [Medium-Term Action Plan V \(2023–2026\)](#) and the associated Results Framework, and our various [policies](#). Learn more on our [website](#).

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