Government of Nepal

Water and Energy Commission Secretariat

Centre of Hydrology and Water Resources Research

(CHWRR)

Assessment Report II

Rasuwa–Bhote Koshi Flood Event, 2026 (2083)

Event Date: 26 August 2026 (10 Bhadra 2083)

13 September 2026 (28 Bhadra 2083)

Content

1. Executive Summary

An extreme and rapid-onset flood occurred in the Lhende Khola–Bhote Koshi–Trishuli–Narayani river system on 10 Bhadra 2083 (26 August 2026). The event originated in the upper Lhende Khola catchment, approximately 22 km upstream of the Nepal–China border, and propagated rapidly downstream through Rasuwagadhi, Syabrubesi, Rasuwa, Nuwakot, Dhading, Gorkha, and Chitwan before reaching the Narayani River at Devghat.

The magnitude 5.2 Ms seismic event recorded at 08:37 Nepal Standard Time at 28.271°N, 85.515°E is considered to have been associated with the dynamic movement and failure of the ice-rock avalanche/debris mass (USGS, 2026). However, no rainfall was recorded around the slope failure area or flood-initiated area during the time of the flood These observations indicate that the extreme flood was likely generated as a cascading consequence of the ice-rock avalanche and subsequent displacement of the debris mass, rather than by rainfall-induced runoff.

The flood event was characterized by exceptionally rapid flood-wave propagation and an extremely short warning lead time. Based on preliminary information, the flood wave travelled approximately 20 km from the upper source area to the Rasuwagadhi border within about 7–8 minutes. Further technical analysis confirmed that this represents an exceptionally rapid propagation condition, highlighting the limitations of conventional rainfall-based flood forecasting approaches for sudden high-mountain outburst events. The event also resulted in the failure or destruction of several hydrological monitoring stations and associated infrastructure along the river corridor, further limiting the availability of real-time observations during the event.

The Flood Forecasting Division (FFD), Centre of Hydrology and Water Resources Research (CHWRR), received information regarding a major flood entering the Bhote Koshi River from the National Disaster Risk Reduction and Management Authority (NDRRMA) and subsequently from the local gauge reader at approximately 09:00 AM. FFD immediately verified the information with the local administration and activated the emergency warning system. Immediate warnings were disseminated through the official social media platform, SMS, telephone communication with Chief District Officers and other concerned authorities, media outlets, and a Facebook Live briefing.

Between 09:05 AM and 09:14 AM, approximately 678,295 SMS messages were disseminated through Nepal Telecom and Ncell to people in and around the Trishuli River corridor across Rasuwa, Nuwakot, Dhading, Gorkha, Nawalparasi, and Chitwan districts. Continuous monitoring of the flood wave and downstream warning dissemination were maintained as the flood propagated toward Galchhi, Malekhu, Muglin, and Devghat.

It is assessed that the flood-wave velocity was approximately 188 km/h up to the Rasuwagadhi border. At Devghat, the water level reached a maximum of 6.57 m at approximately 04:00 PM before beginning to recede. Preliminary hydrological assessment indicates that approximately 20 million cubic meter (MCM) (2 crore m^3) of additional floodwater passed through the Devghat section.

Following the event, two additional temporary natural barrier lakes formed in the upper Lhende Khola, creating the potential for secondary outburst floods. The lower lake (Lake 1) formed near the confluence of the Lhende Khola and Lirung Khola, approximately 15 km from Rasuwagadhi, while the upper lake (Lake 2) formed near the glacier-collapse area, approximately 21 km from Rasuwagadhi. These newly formed lakes represent potential secondary hazards that could generate additional outburst flood waves if the natural barriers fail.

2. Event Overview

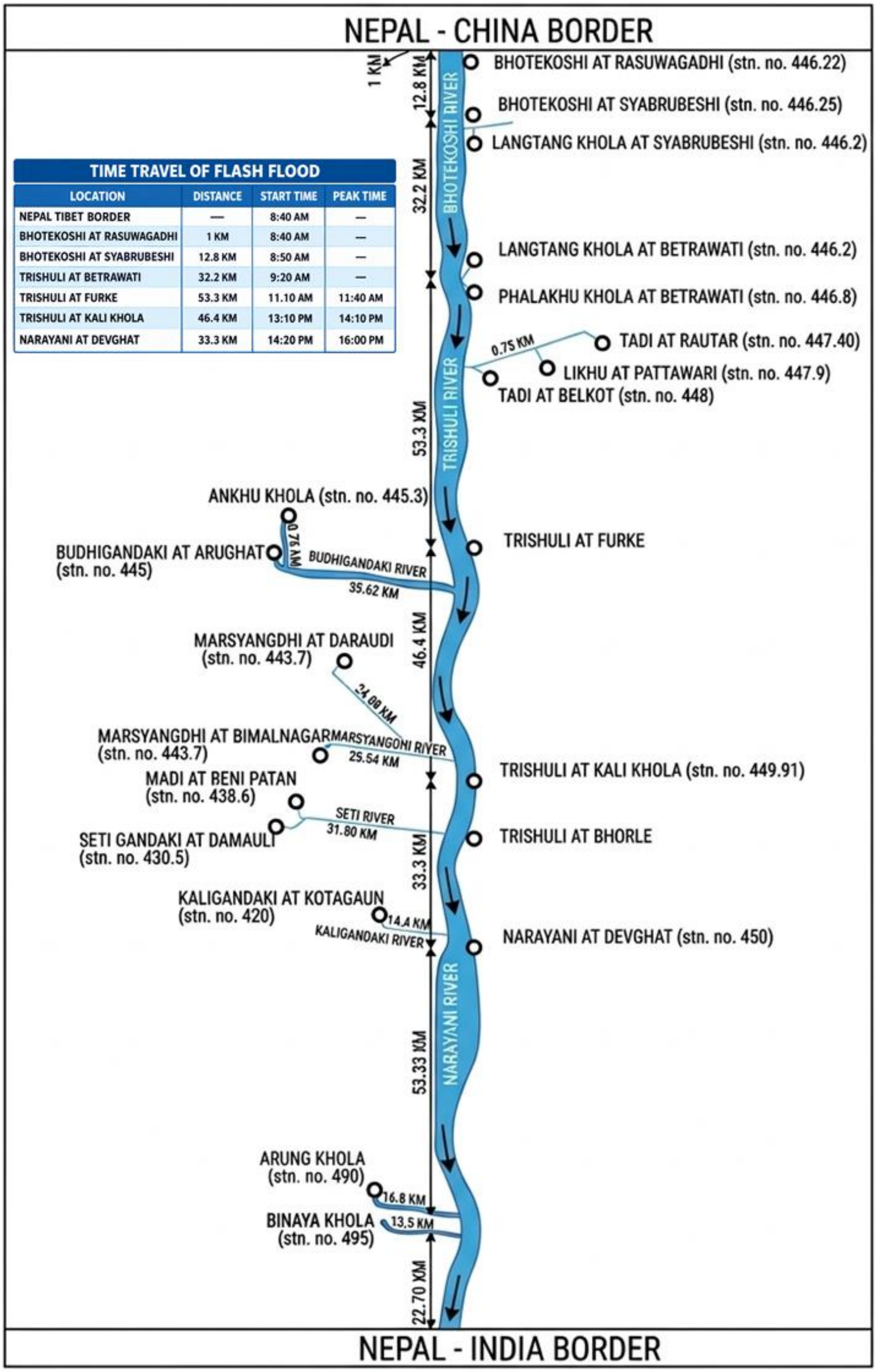
The schematic overview of hydrological profile tracking the downstream progression of the flash flood event from the Nepal-China border down to the Nepal-India border is shown in Figure 1 . It traces the path of the flood wave along the Bhote Koshi, the Trishuli, and the Narayani, documenting both the geographic distances between key hydrological monitoring stations and the precise travel times of the flood wave.

A vertical sequence of hollow dots represents a series of gauging stations, each accompanied by its name and station number as shown in Figure 1. The vertical distance between these dots corresponds to physical river kilometres, with cumulative distances clearly marked for each river segment. On the left side of the main timeline, a detailed table provides a synchronized list of these locations, their total distances from the origin, and their specific arrival times, running from the initial wave at 8:45 AM at the border to a much later arrival of 2:20 PM at the Devghat station.

Ultimately, the figure provides a crucial operational timeline for flood management. By mapping the specific arrival times at locations like Bhote Koshi at Rasuwagadhi (8:45 AM), Trishuli at Betrawati (9:20 AM), and finally Narayani at Devghat (2:20 PM), it allows authorities to predict exactly when a flood pulse will hit downstream populated areas, providing vital lead time for warning systems. The diagram concludes with the flood continuing its journey past Arung Khola and Binaya Khola, finally crossing the national border into India.

Table 1 : General Overview of the Event

Parameter	**Preliminary Information**
Event	Rapid-onset/extreme flood
Origin	Upper Bhote Koshi/Rasuwagadhi area
Approximate source area	Upstream of Rasuwagadhi (28°17'14.8"N 85°31'29.6"E)
Primary cause	Assessment: Extreme flash flood associated with ice-rock avalanche/landslide
Rainfall contribution	Not considered the primary trigger
Main river	Bhote Koshi transitioning to Trishuli downstream
Main affected corridor	Rasuwagadhi – Syabrubesi/Trishuli corridor – Dhading/Galchi – Benighat – Muglin – Devghat
Initial detection	A clear flood-related signal (5.2 Ms in magnitude) was observed approximately 7 minutes before arriving at Rasuwagadhi
Major characteristic	Very rapid flood-wave propagation and limited warning lead time



TIME TRAVEL OF FLASH FLOOD

LOCATION	DISTANCE	START TIME	PEAK TIME
NEPAL TIBET BORDER	—	8:40 AM	—
BHOTEKOSHI AT RASUWAGADHI	1 KM	8:40 AM	—
BHOTEKOSHI AT SYABRUBESHI	12.8 KM	8:50 AM	—
TRISHULI AT BETRAWATI	32.2 KM	9:20 AM	—
TRISHULI AT FURKE	53.3 KM	11.10 AM	11:40 AM
TRISHULI AT KALI KHOLA	46.4 KM	13:10 PM	14:10 PM
NARAYANI AT DEVGHAT	33.3 KM	14:20 PM	16:00 PM

Figure 1 : Comprehensive hydrological profile tracking the downstream progression of the Rasuwa-Bhotekoshi flood event from the Nepal-China border down to the Nepal-India border

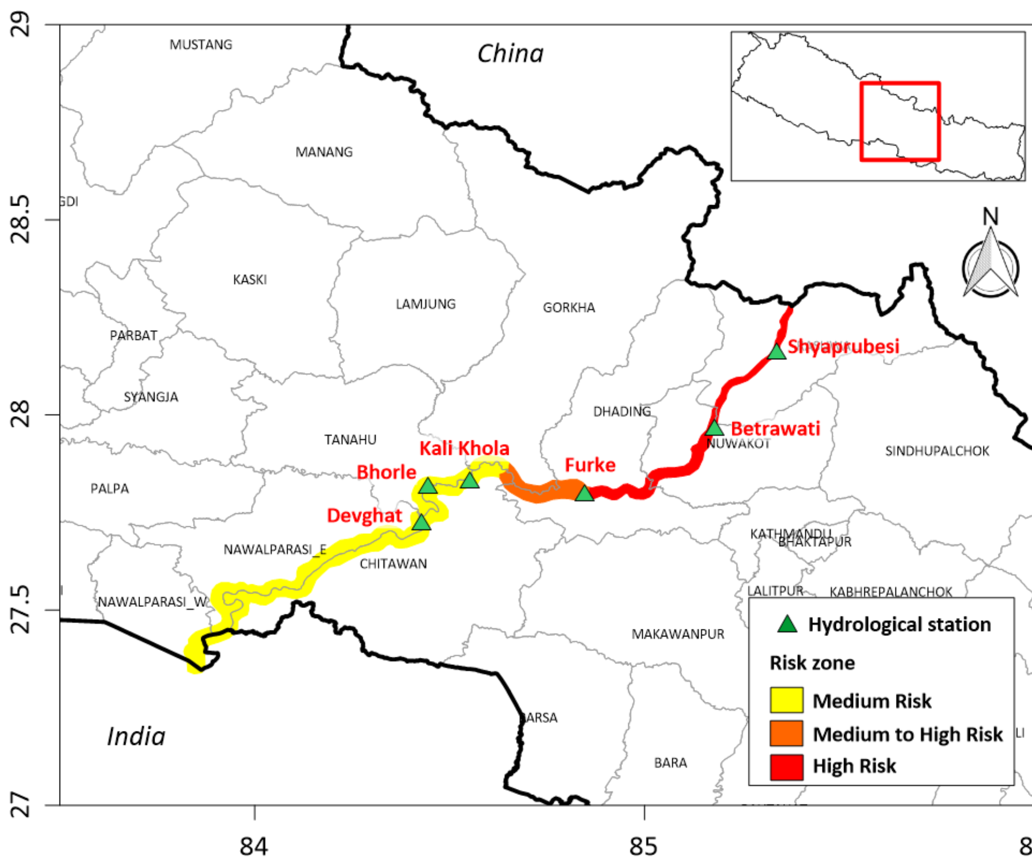


Figure 2

Figure 2 : Spatial distribution of flood risk zones along the Bhote Koshi–Trishuli–Narayani river corridor and locations of key hydrological monitoring stations.

Figure 2 highlights the downstream extent and relative severity of flood risk from Syabrubesi through Betrawati, Malekhu, Muglin and Devghat, together with the locations of key hydrological monitoring stations used for flood monitoring and early warning.

3. Geologic Consideration

The study area is situated within the tectonically active Himalayan orogenic belt along the Nepal–China transboundary region. The Higher Himalayan Crystalline Sequence is juxtaposed against the Lesser Himalayan Sequence along the Main Central Thrust (MCT) zone, located south of the avalanche source area. The region is underlain predominantly by metamorphic and crystalline rocks, including gneiss, schist, quartzite, granitoids, and leucogranites, which are characterised by intense deformation, pervasive fracturing, and structural discontinuities (DMG, 2020). The combination of steep and highly dissected terrain, high relief, and active glacial processes further contributes to slope instability and enhances the susceptibility of the region to large-scale rock and ice failures.

As shown in Figure 3, the failure area sits on an oversteepened slope between 4,000 and 5,600 m.a.s.l., flanked by Langtang Lirung and Tsangbu Ri east-northeast of Rasuwagadhi. The Profile

A-B cross-section shows a steep rock-ice mass detaching from the upper wall and descending into a runout zone before entering the Lende River valley floor at roughly 3,500 m.a.s.l. This vertical fall of 1,200 to 2,000 meters converted massive potential energy into kinetic force, funnelling the pulverised debris directly into the narrow river channel to trigger a devastating downstream surge.

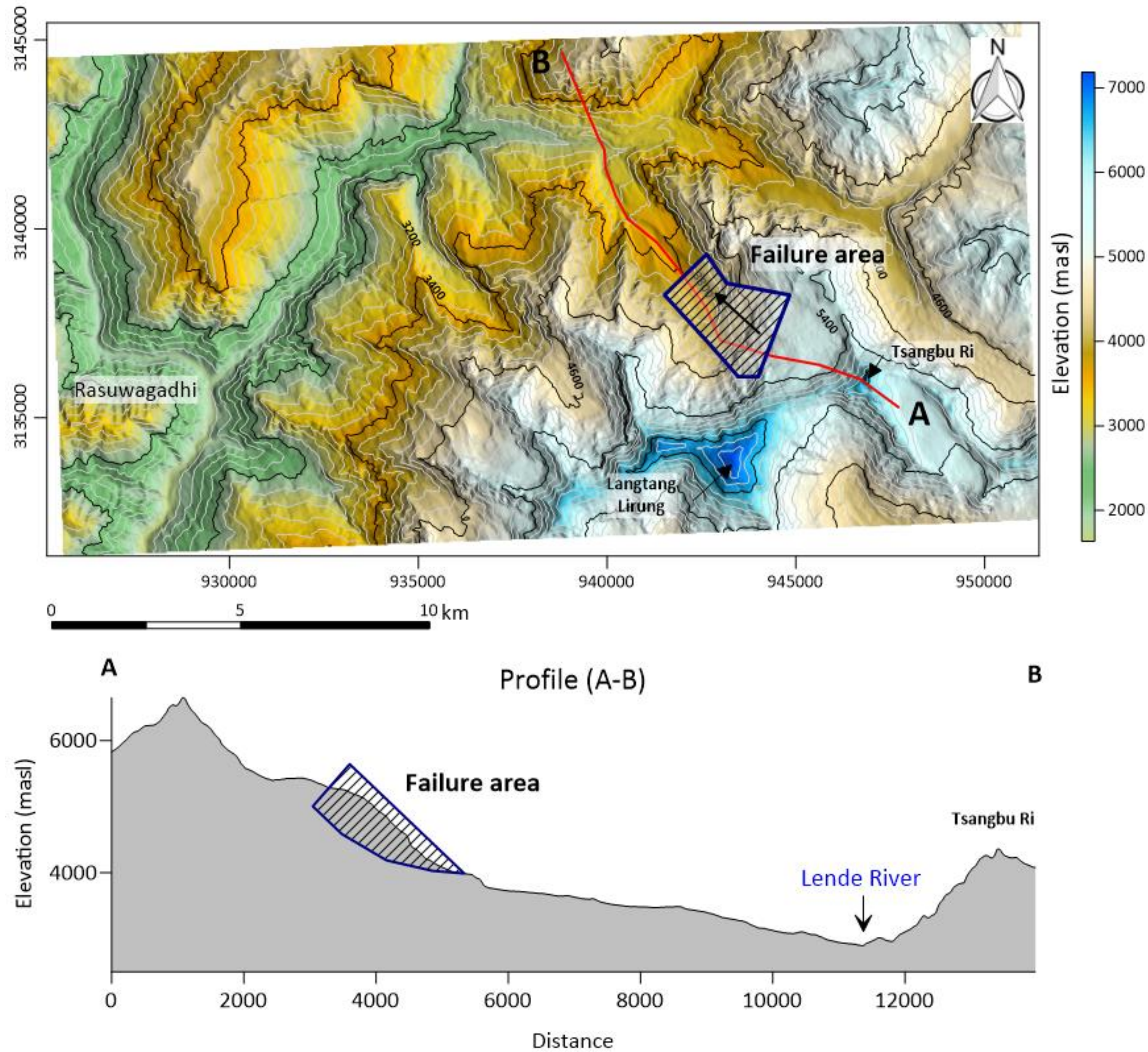


Figure 3

Figure 3: Topographic map and cross-sectional profile (A-B) of the failure area near Rasuwagadhi.

The landslide susceptibility map of Rasuwa District (Figure 4) shows considerable spatial variation in susceptibility, ranging from very low susceptibility (green) to very high susceptibility (red). A particularly prominent concentration of high susceptibility occurs in the southern and southwestern parts of Rasuwa, where extensive orange-red zones form along major valleys and steep slopes. These areas indicate a greater potential for rainfall- or earthquake-induced slope failures and are likely to be more sensitive to changes in slope saturation and drainage conditions. Additional linear and clustered high-susceptibility zones occur along several tributary valleys and steep hillslopes throughout the central and northern parts of the district.

The main ice-rock avalanche source area lies within a high to very high landslide susceptibility zone, indicating that the source slope is inherently prone to large-scale failure. The concentration of high-susceptibility zones around the source area reflects the unstable and highly dissected mountain terrain and provides a favourable setting for cascading slope hazards.

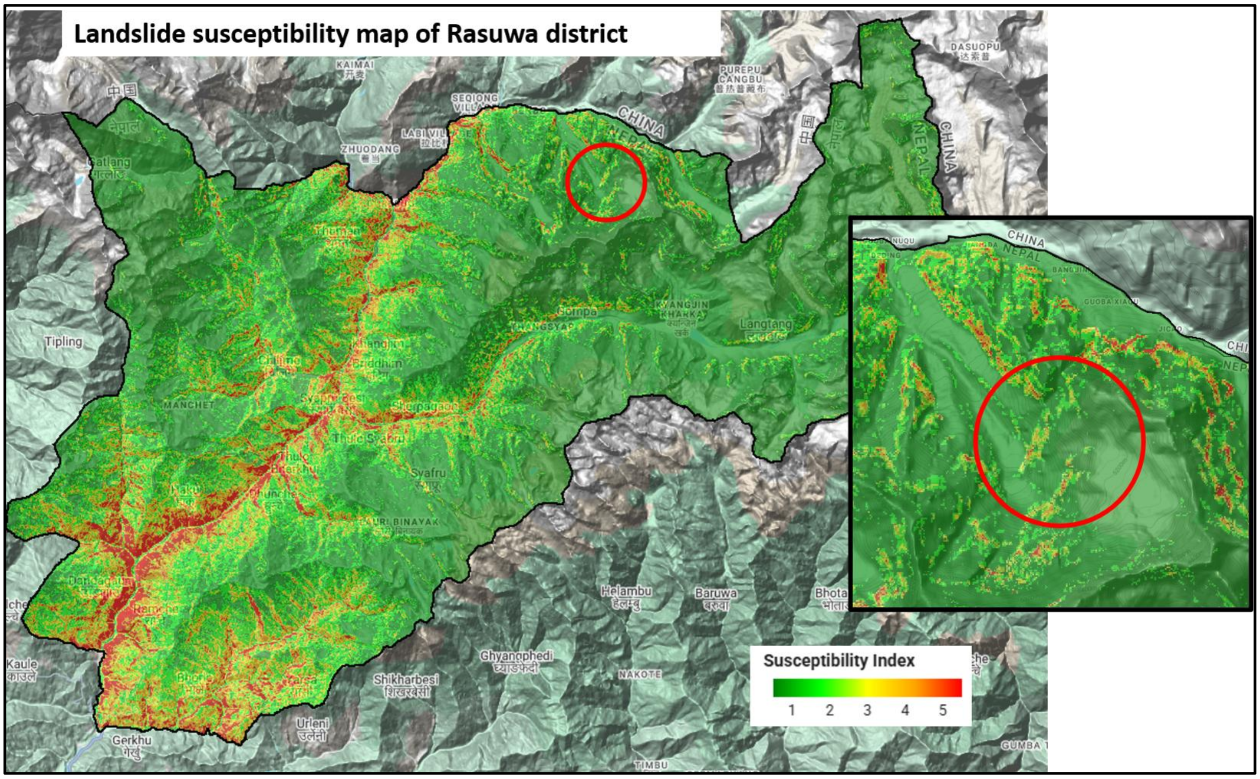


Figure 4: Landslide susceptibility map of Rasuwa District (failure area in the inset)

On 2083/05/10 (August 26, 2026), the USGS initially reported a 4.4 Ms earthquake measured in the China region of China (28.55, 85.538). However, on 2083/05/11 (August 27, 2026), the USGS, through further analysis of long-period seismic waves, stated that the seismic energy, measured 5.2 Ms in magnitude, was generated by glacial collapse and debris flow. The magnitude and characteristics of the seismic signals indicate that this collapse was exceptionally large and energetic, highlighting the remarkable scale and rapidity of the event.

USGS reported that a second seismic event (4.2 Ms in magnitude) occurred about three hours after the landslide that triggered catastrophic flooding in Nepal and China (Figure 5). It was identified during post-processing of low-frequency seismic records and shows characteristics consistent with a landslide. Due to the lack of high-frequency energy, a precise location could not be determined, so we fixed this event's location to that of the initial landslide.

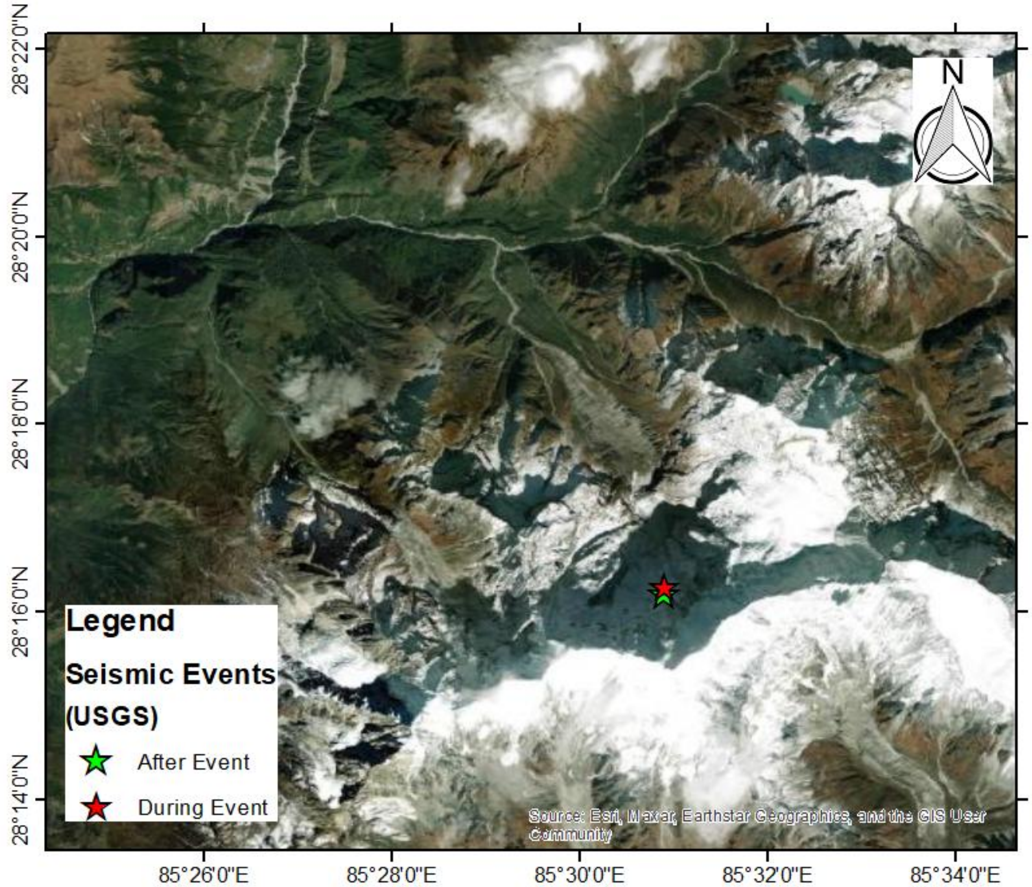


Figure 5 : Two seismic events reported by USGS (Modified after USGS)

4. Satellite Imageries Interpretation

Study of available satellite images (Landsat 9, Planet Labs) shows that a hanging glacier located on the northern side of Langtang-Lirung mountain in Rasuwa district, at an elevation of approximately 5200 masl (approximately 28.291242°N, 85.528066°E), collapsed, causing a huge ice–rock avalanche which fell onto a debris-covered glacier located approximately 3800 masl. This generated a large volume of water mixed with ice, rock and debris, forming a flood in the Chhochen Khola that entered Nepal's Bhote Koshi River via the border river, the Lhende River. Analysis of the satellite images indicates that approximately 2.0 square kilometres of the glacier, including rock mass, had detached.

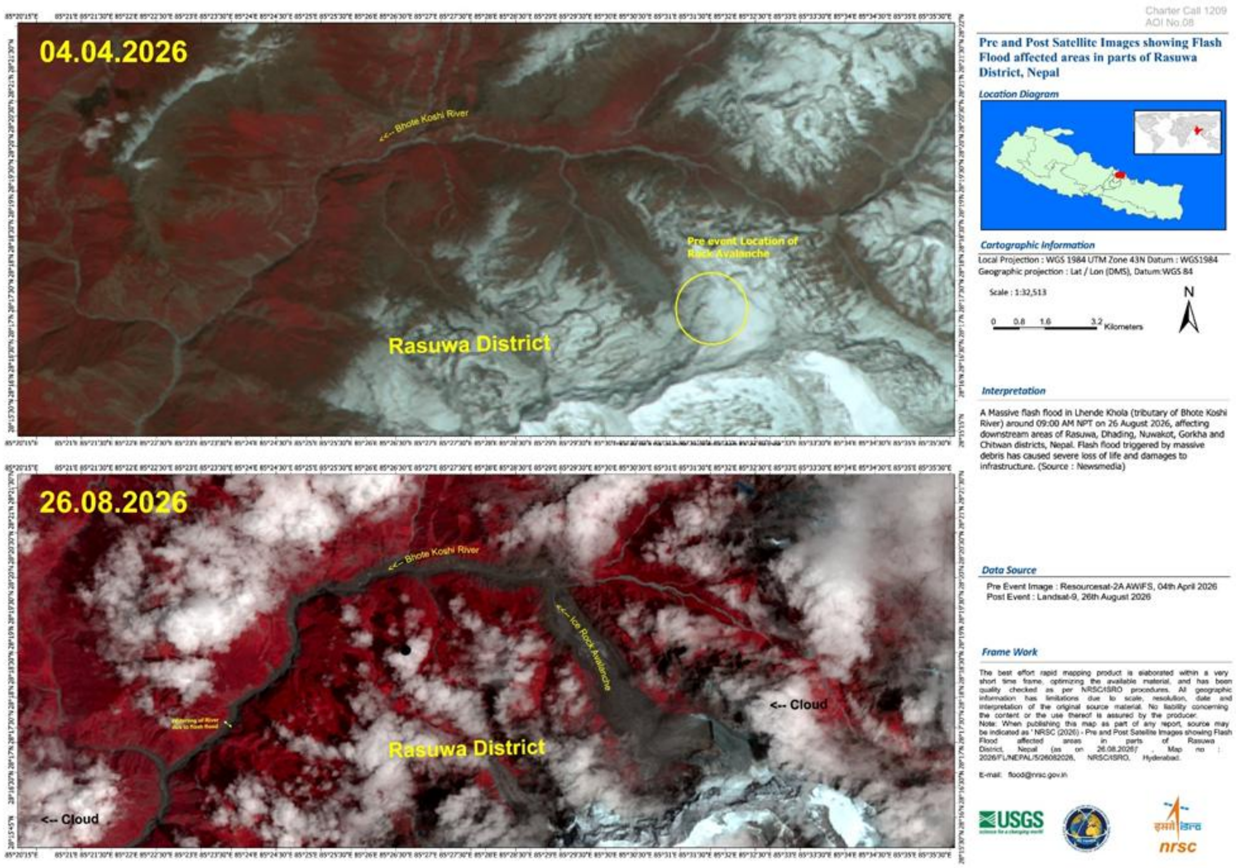


Figure 6 : Pre (Resourcesat-2A AWiFS) and Post (Landsat-9) Satellite Image of the glacier collapse location (source: NRSC/ISRO)

As shown in Figure 7, two lakes have appeared on the surface as a result of this event:

- **Lake 1**: Located approximately 300 metres downstream of the confluence of Chhochen Khola and Lhende River (approximately 28° 19' 59", 85° 28' 59"), with a surface area of approximately 160,000 m^2 on August 28, 2026 (Cartosat-3 image). Since August 28, natural overflow from this lake has resulted in continuous water flow, and the current risk is gradually decreasing.

- **Lake 2**: Located downstream of the glacial collapse area (approximately 28° 17 '36", 85° 30' 38"), with a water surface area of approximately 180,000 m^2 on August 28, 2026 (Cartosat-3 image). This lake overflowed on 29th August, causing a significant rise in water level in Bhotekoshi-Trishuli downstream.

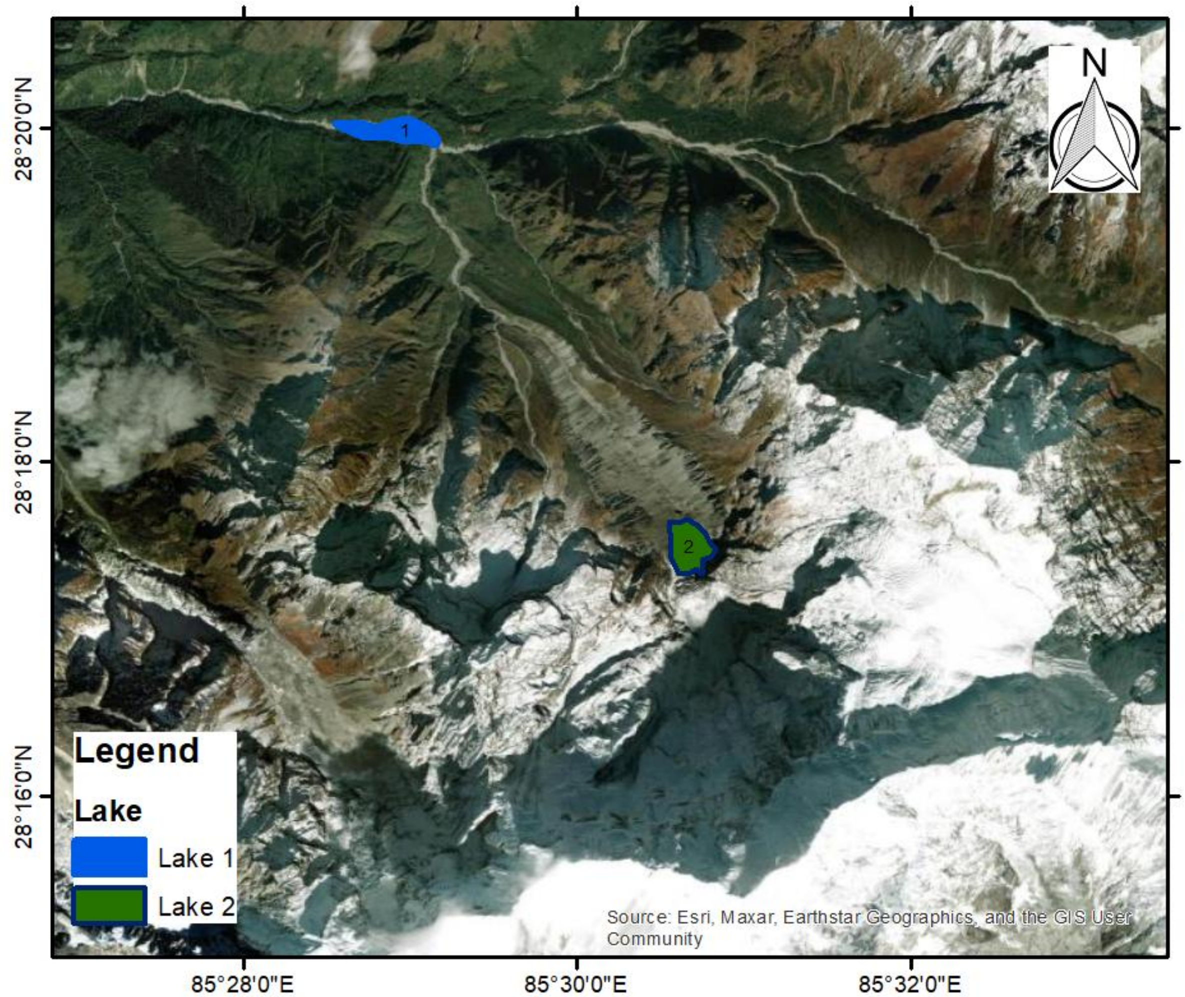


Figure 7 : Detected newly formed barrier lakes (Modified after United Nations Satellite Centre UNOSAT)

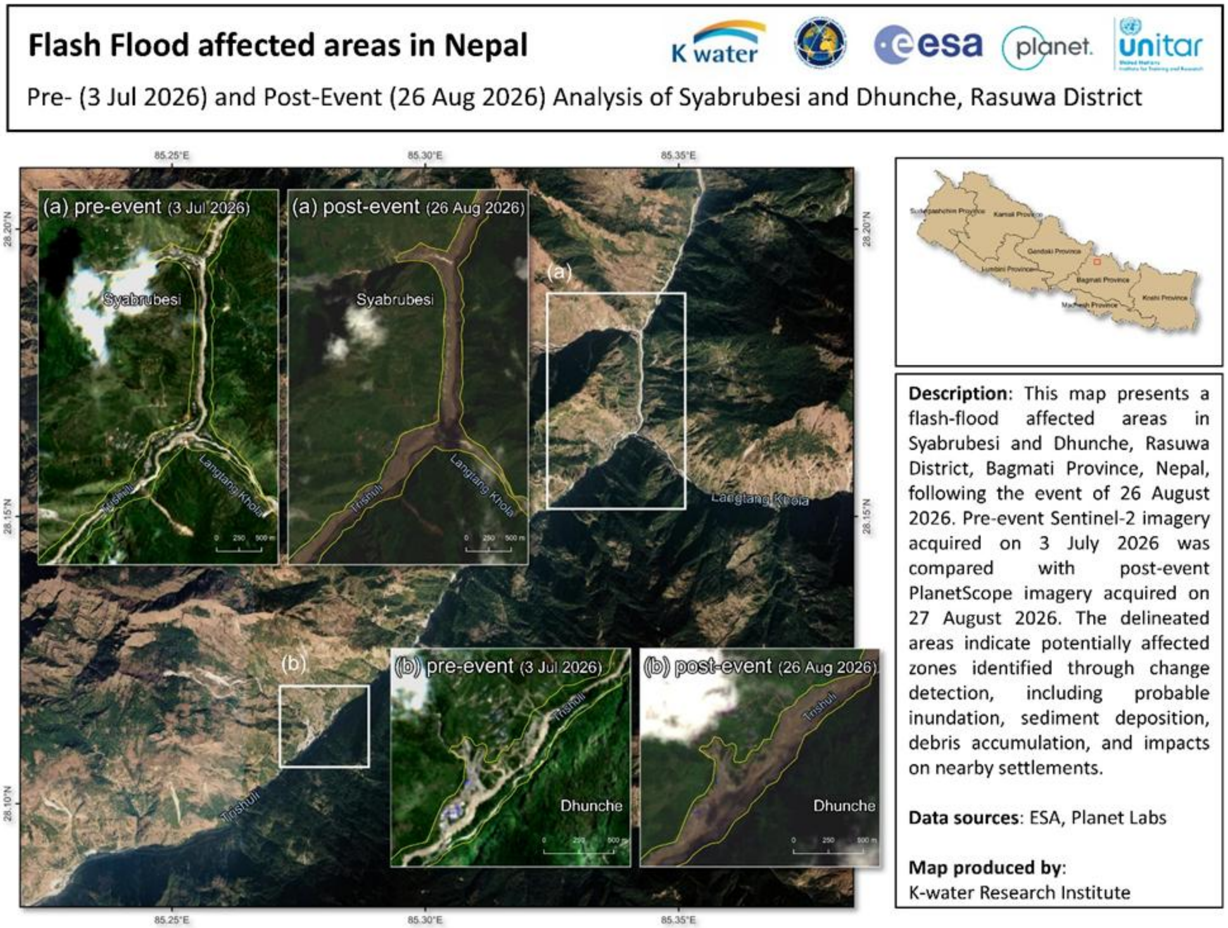


Figure 8: Pre-event (Sentine-2) and Post-event (PlanetScope) Satellite Image showing flooding in Syaphrubesi and Dhunche (source: K-water Research Institute)

5. Hydrological Analysis

5.1 Rainfall and Temperature Analysis

The FFGS six-hour accumulated rainfall product (Global Hydro-Estimator (GHE), a NOAA/NESDIS satellite-based precipitation-estimation product, Figure 9) for 26 August 2026 at 03:00 UTC (08:45 NST) indicates generally light rainfall over the Bhote Koshi–Rasuwa region, with accumulated rainfall in the disaster-affected area generally below or around 10 mm over the preceding six hours. The spatial distribution does not show any significant or concentrated rainfall over the source area that could reasonably explain the sudden and exceptionally rapid rise in the Bhote Koshi River.

This satellite-based assessment is further corroborated by in situ rainfall observations from the Kyangjing station located in the upper Bhote Koshi catchment. Analysis of the station's 10-minute rainfall data from August 20–30, 2026, reveals that although the period leading up to the event was characterised by typical monsoon rainfall, the immediate pre-event conditions do not indicate extreme rainfall. In the 24 hours preceding the event (August 25–26), the station recorded 27.0 mm of rainfall, with only 12.6 mm falling on the event day itself (August 26). Crucially, in the six hours before the reported avalanche time (approximately 08:37 NST on August 26), the Kyangjing station recorded only 1.5 mm of rainfall. The maximum 10-minute rainfall intensity during this six-hour window was 0.14 mm, which is negligible in terms of its capacity to trigger a large-scale mass movement or generate a significant flood pulse. Furthermore, the peak 10-minute rainfall intensity recorded during the entire August 20–30 period was 1.83 mm (on August 22), which, while notable, occurred several days before the event and cannot be directly linked to the failure mechanism.

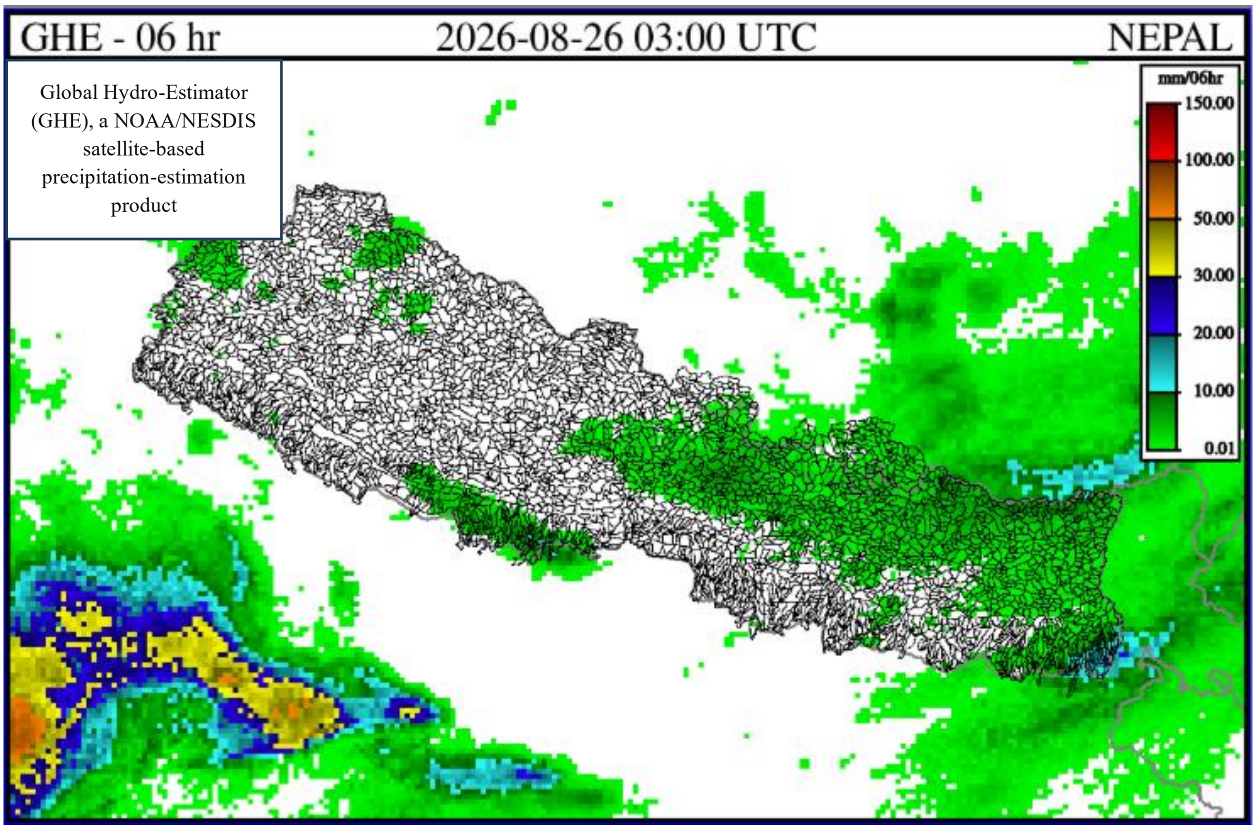


Figure 9: FFGS six-hour accumulated rainfall over Nepal at 03:00 UTC (08:45 NST), 26 August 2026, showing generally light rainfall (up to approximately 10 mm) over the Bhote Koshi–Rasuwa disaster area during the six hours encompassing the event.

This observation therefore supports the assessment that the 26 August flood was not a rainfall-induced flood, but was associated with a sudden high-altitude ice-rock avalanche and subsequent blockage and release of water/debris. The reported seismic signal at approximately 08:37 NST, initially characterised as a magnitude 4.4 event, occurred almost contemporaneously with the avalanche; subsequent geological/seismological assessment has indicated that the recorded seismic signal was associated with the avalanche itself rather than a conventional tectonic earthquake. Although light rainfall was present in the broader region and antecedent monsoon rainfall had saturated the catchment, the available FFGS product and Kyangjing station data provide no evidence of rainfall intensity or accumulation sufficient to identify rainfall as the primary trigger for the rock-ice avalanche. Minor rainfall could theoretically contribute to the destabilization of an already highly unstable ice–rock mass through processes such as surface melting, infiltration, or lubrication; however, there is currently insufficient evidence to establish such a role in this event, and this aspect would require detailed geological, glaciological, and meteorological investigation. The event displayed characteristics substantially different from a conventional rainfall-induced river flood.

Observation of air temperature (Figure 10) at Kyanjing Snow Station (28.2109776, 85.5671679) at Langtang, which is about 10 km southeast of the glacier collapse area, shows that the average daily temperature was increasing, reaching a maximum of 11.78°C on 24 August 2026.

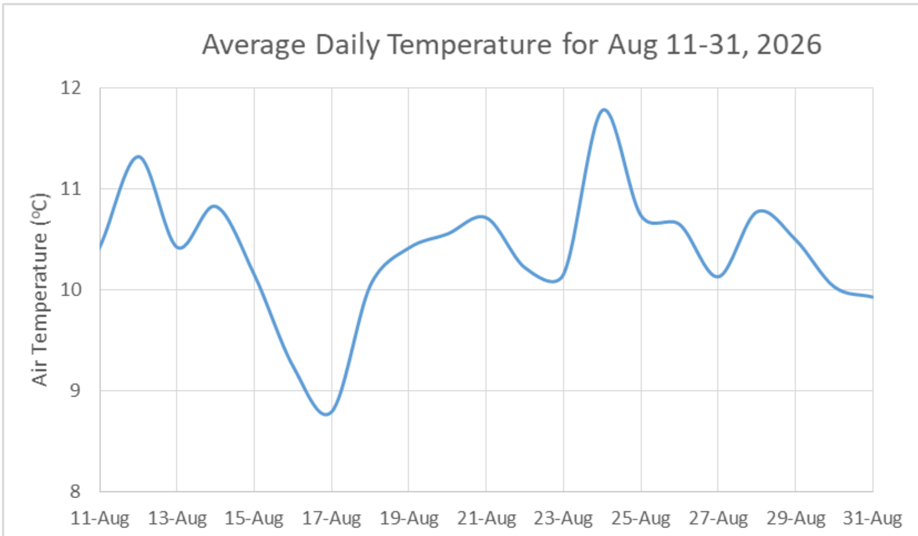


Figure 10: Average Daily Temperature at Kyanjing Snow Station

5.2 Flood Propagation Timeline

The flood wave originated from the Bhote Koshi headwaters near the Nepal-China border following an ice-rock avalanche that temporarily blocked the river and subsequently released a large volume of water and debris. Based on information received from Chinese authorities, a lake had formed at the blockage site and had not completely opened at the time of initial reporting, indicating that the flood release was partial and potentially posed ongoing risks to downstream areas.

The flood wave propagated downstream through the Bhote Koshi–Trishuli–Narayani river system, with the following key milestones documented through real-time monitoring and public communication as depicted in Table 2.

Table 2 : Flood Wave Propagation Timeline

Time (NST)	Location/Event	Observation/Action
08:37	Seismic detection	Magnitude 4.4 event recorded by the Department of Mines and Geology (later confirmed as an avalanche signal)
08:50	Syaphru Besi station	Data transmission ceased; last recorded water level: 1.62 m (Warning: 6 m, Danger: 7 m)
09:00	Bhote Koshi border	Information received from the Rasuwa District Administration and Betrawati station staff about a large flood entering from China
09:05	FFWC notification	First information received by the Flood Forecasting Warning Centre (FFWC) under the Flood Forecasting Division
09:15	Initial warning issued	SMS warnings sent to Rasuwa, Nuwakot, Dhading, Gorkha, Nawalparasi and Chitwan districts; the public advised moving to safe locations
09:20	Betrawati station	Data transmission ceased; last recorded water level: 3.55 m (Warning: 4.1 m, Danger: 5.0 m)
10:28	Galchi area, Dhading	A flood wave reached the Galchi area and is estimated to cross Muglin within hours; warnings were issued for Prithvi Highway and the Muglin-Narayanghat road section.
11:26	Phurke (Malekhu) station	The water level exceeded the warning threshold and continued rising.

Time (NST)	Location/Event	Observation/Action
11:43	Phurke (Malekhu) station	The water level exceeded the danger threshold; the station and bridge were subsequently washed away by flood.
11:50	Malekhu Bazaar	A flood wave reached the Malekhu market area; it is estimated to cross Muglin within approximately 30 minutes; SMS warnings were issued.
13:00	Muglin crossing	A flood wave crossed Muglin; warnings issued for areas up to Devghat.
13:20	Devghat station	Water level: 4.76 m; main flood wave estimated to reach Devghat around 15:30; preliminary estimate suggested ~3 m rise, potentially reaching ~8 m
13:35	Information from China	The lake at the blockage site had not completely opened; there is an ongoing risk for the Bhote Koshi–Trishuli system.
14:14	Kalikhola station	Water level exceeded danger threshold (12.1 m); maximum recorded: 12.3 m
15:20	Narayani-Devghat	A flood wave reached the Devghat area; the water level was rising; data from the automatic station confirmed
16:00	Devghat Peak	Maximum water level recorded: 6.57 m; subsequently began receding
18:30	Devghat normalising	Flow returned to normal levels (~4 m); estimated excess volume passed: approximately 20 million m^3.

5.3 Water Level Analysis at Key Stations

The water level data from the Bhote Koshi–Trishuli–Narayani river system during the flood event reveal a clear spatial and temporal pattern of propagation. At the Furke Khola station, the water level rose progressively from about 7.5 m to 10.48 m, with the station being swept away by the flood after recording this peak value. At Kalikhola station, the water level increased rapidly from about 7.4 m to 12.3 m. At Devghat, the water level increased steadily from 4.76 m to 6.57 m over the same period, indicating successful downstream propagation of the flood wave with some attenuation. In contrast, the Marsyangdi at Bimalnagar and the Kali Gandaki at Kota Gaon remained stable at normal levels (7.5 m and 4.0 m, respectively), confirming that downstream additions did not affect flood magnitude. This pattern of rising water levels at Kalikhola and Devghat, coupled with the destruction of the Furke (Malekhu) station after recording 10.48 m, demonstrates the severity of the flood wave as it travelled downstream. At the same time, the stable readings at Marsyangdi and Kali Gandaki confirm that the flood was not a regional rainfall event but rather a localised GLOF originating from the upper Bhote Koshi catchment.

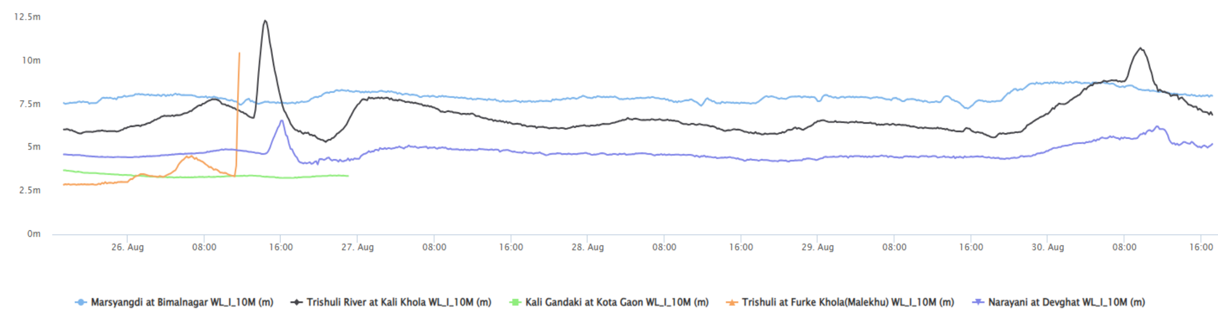


Figure 11 : Water levels observed at key hydrological stations

5.4 Peak Discharge and flood wave volume at Devghat

Considering a stable cross-section and minimal debris impact, a detailed analysis was carried out at the Devghat Hydrological Station as outlined in Table 3.

Table 3 : Details of the flood wave hydrograph recorded at Devghat

Parameter	Observed Value	Notes
Pre-event level	~3.5-4.0 m	Normal base flow
Initial flood arrival	~4.76 m (13:20)	Preliminary warning level

Parameter	Observed Value	Notes
Peak level	**6.57 m (16:00)**	Maximum recorded
Peak discharge	**~5,850 m³/s**	Based on the rating curve
Time to peak	~2.7 hours	From initial rise to peak

Using the Devghat rating curve and observed water levels, the following volume estimates were calculated as shown in Table 4.

Table 4: Volume Analysis of the Flood

Parameter	Value
Initial discharge	2,600 m^3/s
Peak discharge	5,850 m^3/s
Total volume passed (14:10-18:00)	~57.40 million m^3
Excess volume (above base flow)	**~19.96 million m^3**

The excess volume of approximately 20 million m^3 represents the additional water contributed by the ice-rock avalanche event. This volume estimate is critical for understanding the magnitude of the event and calibrating future prediction models.

5.5 Flood Wave Travel Time

Based on the hydrological station network and real-time observations, the flood wave travelled approximately 191 km from the Nepal-China border to Devghat. The propagation characteristics, derived from the station chainage data and timing of peak water levels, are summarized as presented in Table 5.

Table 5 : Flood Wave Travel Time and Average Speed

Segment	Distance (km)	Stations/Key Locations	Travel Time	Average Speed (km/hr)
Source to Rasuwagadhi Border	~22	Source to Border	7 minutes	~188
Border to Syabrubeshi	~ 13.8	Border → Syabrubeshi (stn. 446.25)	~10 minutes	~83
Syabrubeshi to Betrawati	~32.2	Syabrubeshi (446.25) → Betrawati (stn. 447)	~30 minutes	~65
Betrawati to Phurke Khola (Malekhu)	~53.3	Betrawati (447) → Phurke Khola (Malekhu)	~1 hour 50 minutes	~29
Phurke Khola to Kalikhola (Muglin)	~46.4	Phurke to Kalikhola (449.91)	~2 hours	~23
Kalikhola (Muglin) to Devghat	~33.3	Kalikhola → Devghat (stn. 450)	~1hours 15 minutes	~26
Total	~201	Nepal-China Border to Devghat	~6 hours 42 minutes	~30

The flood wave exhibited a classic pattern of downstream translation with gradual attenuation. The relatively high initial propagation speed reflects the steep gradient and confined nature of the upper Bhote Koshi valley. As the flood wave entered the broader Trishuli and Narayani river systems, the travel speed decreased, and the wave began to spread, as evidenced by the longer travel times observed in the lower reaches.

5.6 Station Losses

The flood event was severe enough to destroy or disable several key hydrological monitoring stations (Figure 12).

1. Rasuwagadhi (Bhote Koshi): Data ceased at 08:40 with a final recorded water level of 3.8 m. The station was subsequently washed away.
2. Syaphru Besi (Bhote Koshi)**:** Data ceased at 08:50 with a final recorded water level of 1.62 m. The station was subsequently washed away.
3. Langtang Khola station at Syaphrubesi

4. Betrawati (Trishuli)**:** Data ceased at 09:20 with a final recorded water level of 3.55 m. The station was washed away.
5. Palakhu Khola Station at Betrawati
6. Phurke (Malekhu): Data ceased at 11:43 when water levels exceeded the danger threshold. The flood washed away the station and associated bridge.

The loss of these stations highlights the extreme nature of the flood event and poses challenges for future monitoring in the region.

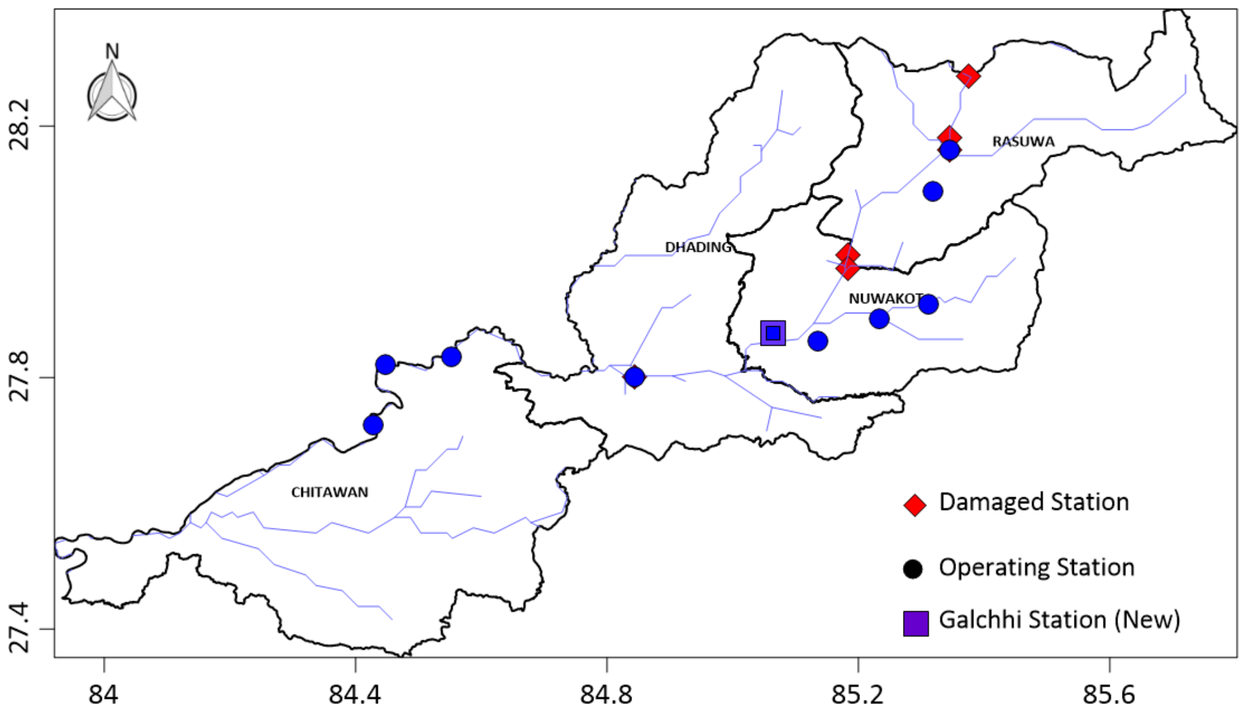


Figure 12: Spatial distribution of operating and damaged hydrological stations across the affected districts along the Bhote Koshi-Trishuli corridor, highlighting the new Galchi station

6. Initiation of CCTV-Based Real-Time River and Flood Monitoring

For the first time in Nepal, a CCTV-based system for real-time observation and monitoring of river and flood conditions has been initiated. On the seventh day following the major flood event in the Bhote Koshi River in Rasuwa, a CCTV camera was installed at Timure, near the Nepal–China border, under the leadership of the Centre for Hydrology and Water Resources Research (CHWRR), marking an important step toward strengthening direct river monitoring and flood early warning capabilities in Nepal. The camera has been installed at approximately 70 meters above the river level, providing a clear view of the river and its surrounding area. The live feed from the CCTV has been connected to the 24-hour flood forecasting and early warning services of the Flood Forecasting Division under CHWRR, allowing continuous visual monitoring of river conditions.

The primary objective of this initiative is to enable the early identification of sudden changes in river conditions and to provide additional real-time information for flood assessment and early warning. The system is particularly relevant for sudden-onset events such as Glacial Lake Outburst

Floods (GLOFs), ice avalanches, landslides, river blockages, or other processes that can cause a rapid increase in river discharge. In such situations, direct visual information from the river can provide an important indication of an evolving event, particularly when the available flood travel time is very short. The CCTV observations can be assessed together with water-level measurements, rainfall observations, real-time telemetry, satellite and radar information, and other hydrological and meteorological data to support timely situation assessment and decision-making.

The CCTV system is intended to complement, rather than replace, existing hydrological monitoring and telemetry infrastructure. Conventional water-level and rainfall stations provide quantitative measurements, while CCTV provides direct visual evidence of the actual condition of the river. The combination of these sources can improve understanding of river behavior and help verify whether observed changes in water level and discharge are consistent with the actual river conditions. This can support the verification and validation of flood forecasts and warnings and contribute to improving the reliability of the overall flood forecasting system.

The real-time visual feed can also support the early detection of unusual river conditions, including sudden increases in flow, changes in river channel conditions, movement of logs, boulders and other large debris, formation of obstructions, or potential temporary blockage of the river. Once such conditions are visually identified, relevant authorities can be informed promptly for further technical assessment, field verification, preparedness, and response. This capability is particularly important in the Bhote Koshi and other high-risk mountainous rivers, where flood conditions can develop rapidly and downstream communities and infrastructure may have only limited time to respond.

The location at Timure is particularly significant because it lies close to the Nepal–China international border and within a sensitive section of the Bhote Koshi River. Continuous visual monitoring from this location can therefore provide useful information for assessing potential risks to downstream settlements, roads, bridges, markets, hydropower and other critical infrastructure. The information can support decisions related to transportation and road operations, preparedness for rescue and relief, and timely communication with communities and authorities in potentially affected downstream areas.

In addition to its operational value, the CCTV system will generate an important visual archive for future flood analysis and research. Recorded footage can be used to study flood travel time, changes in river flow and channel behavior, movement of debris, development of flood waves, and the evolution and impacts of flood events. Such records can also support post-event assessment, verification of flood forecasts and early warnings, evaluation of forecasting models, and improvement of future flood forecasting and early warning practices. Over time, the availability of such visual records from multiple locations will contribute to a better understanding of flood dynamics and river behavior in Nepal.

The initiation of CCTV-based river monitoring at Timure represents an important first step toward developing a more comprehensive and multi-source river monitoring system in Nepal. Based on the experience from this initial installation, similar CCTV systems can be gradually expanded to other high-risk rivers, glacial lake and glacier-affected areas, border rivers, important bridges, and strategic hydrological monitoring locations. In the longer term, integration of CCTV observations with real-time hydrological and meteorological data, telemetry, radar, satellite observations, and flood forecasting models can contribute to the development of a modern, technology-enabled and integrated river monitoring and flood early warning system.

The initiative at Timure therefore marks a significant advancement in Nepal's flood monitoring approach by adding direct visual observation to existing measurement and forecasting systems. The experience gained from this installation following the Bhote Koshi flood will provide a practical foundation for expanding real-time river surveillance across other vulnerable areas and strengthening Nepal's capacity for timely flood detection, assessment, warning, and response.

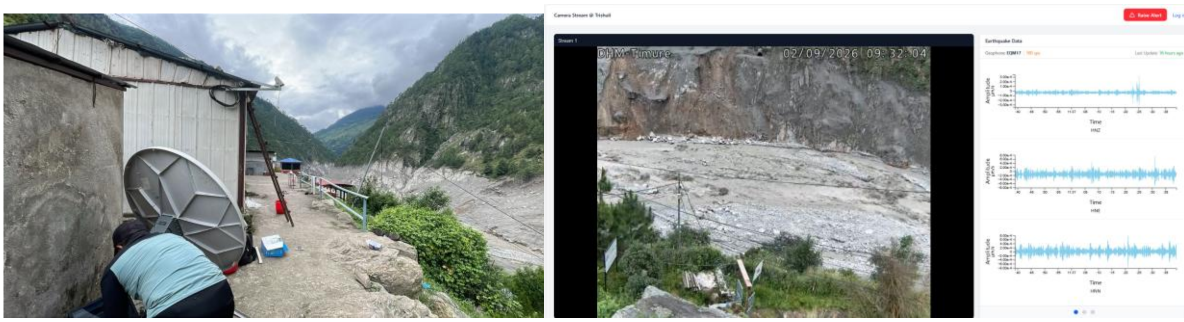


Figure 13: CCTV installation at Timure

7. Conclusions

The Bhote Koshi–Trishuli flood event of 10 Bhadra 2083 was a highly unusual and rapid-onset hydrological event. Its preliminary characteristics indicate that it was not a conventional rainfall-induced flood, but rather a sudden flood wave generated by an upstream outburst associated with an ice-avalanche/landslide-dam failure.

The event demonstrated the importance of real-time telemetry, rapid interpretation of abnormal river behavior, timely warning dissemination, inter-agency coordination and downstream preparedness. It also urges to put further effort for modernization of existing automatic discharge measuring stations and establishment of robust flood forecasting and warning system to reduce risk from such extreme hydrological events.

Immediately after the notification of event, CHWRR has put its full effort for informing people about the event through SMS, public notifications, official media. Additionally, CHWRR has installed alternative measure of flood monitoring system as the existing gauging stations are washed away and issuing the flood warning messages based on information received from alternative sources. The approximately 20-minute early indication at Rasuwagadhi represents an important achievement of the monitoring system, while also demonstrating the need to improve the speed and certainty with which such information is converted into actionable warnings.

The ice-avalanche/landslide-dam failure might be triggered by the climate change induced mechanism such as climate change-induced melting, permafrost thawing, and slope destabilization; which shall be studied in detail to access future risk on other glacier lakes. A detailed post-event investigation, combining hydrological observations, remote sensing, hydraulic modelling, field verification and communication-log analysis, is recommended to establish the final magnitude, source mechanism, flood-wave characteristics and lessons for Nepal's future GLOF, landslide-dam outburst and flash-flood early-warning systems.