Preliminary Study Report on Ice-Rock Avalanche During Bhotekoshi-Trishuli Flood Tragedy

1. General Overview of the Flood

In 26 August 2026, 8.30 -9.15 NST (02:55 GMT), Bhotekoshi–Trishuli rivers along the Himalaya China-Nepal Border experienced a devastating flooding caused by a massive ice and rock avalanche from the northern flank of Langtang-Lirung Peak of Nepal. The flood caused substantial disturbance to the river corridor and surrounding infrastructure forcing up to river height of more than 100m in average. Preliminary scientific assessments suggest that an ice–rock avalanche entering the Lhende Khola may have initiated a cascading sequence involving melt water, rocks, sediment and debris, although the precise triggering mechanism remains under investigation. Synthetic Aperture Radar (SAR) observations enabled the detection of surface changes under cloudy conditions and independently of daylight, while multispectral satellite imagery provides complementary information on land-surface disturbance. In this study, multi-temporal remote sensing images are used to investigate the condition before and after the Bhotekoshi–Trishuli flood and its disastrous effects. A comparative analysis of Landsat satellite imagery acquired on 3 March 2026 and 26 August 2026 over the upper Bhote Koshi watershed in Rasuwa District, Nepal, near the Nepal–China international boundary shows relatively clear and extensive snow- and ice-covered terrain, particularly around the Chhyochen and Chhyusumdu River, and surrounding high-altitude areas that ultimately sheared off to Lhende Khola. In contrast, the 26 August imagery shows substantial changes in the surface conditions, with reduced snow and ice coverage and increased exposure of underlying terrain. Satellite imagery indicated that massive glacier mass along with bed rocks sheared off and plunged into Lhende river basin around 02:55 GMT near Langtang-Lirung of north faces. This evidence supports that it's not glacial lake outburst flood (GLOF) event. Its subsequent cascading of catastrophic flash flood resulted by glacial mass wasting cascaded into Lhende river, the tributary of Bhotekoshi/Trisuli river. The similar kinds of flash floods phenomena are about to increase in the Himalayan region. The Chamoli flood during 2021 and Kedarnath flood Tragedy in India are similar in nature. Melamchi flood 2021 is also climate extreme flood in previous recent records of Nepal.

The ice–rock avalanche initiated at approximately 8:37 AM NPT propagated extremely rapidly downstream, reaching Rasuwagadhi at 8:44:55 AM after travelling about 22 km, corresponding to an estimated average velocity of ~46.3 m/s (167 km/h) under the steep, high-energy upper valley. The time was first recorded from USGS earthquake tremor of 5.2 magnitude (https://earthquake.usgs.gov/earthquakes/eventpage/us7000tbwb/executive), while Rasuwagadhi time was recorded based on publicly available CCTV footage. The flow subsequently reached Betrawati at around 9:20 AM, covering an additional ~44 km, with an estimated velocity of ~20.4m/s (73 km/h), indicating substantial deceleration as the channel gradient decreased. Further downstream, the flood reached Devghat at approximately 3:20 PM, with a much lower estimated average velocity of ~6.0 m/s (21.7 km/h) over the lower-gradient section, based on the stated 130-km distance. Overall, the progressive reduction in velocity from approximately 46.3 to 20.4 and 6.0 m/s demonstrates the strong influence of decreasing channel gradient, increasing flow resistance, and energy dissipation on downstream attenuation of the flood/debris-flow surge.

2. Key Preliminary Findings

2.1.Spatial Assessment at Glance

The origin of the debris flood is an enormous ice-rock avalanche in the northern slope area of Langtang Lirung peak, at ~5200 m asl, about 22 km upstream of the friendship bridge Nepal-China border (Figure 1). The langtang Lirung Peak itself is about 7200m above sea level. The failure was in bedrock, entraining the overlying glacier ice, and lots of debris and ice as it rushed downstream immediately falling 1200 m cliff. From many other events it is well known that the energy while moving downstream can melt large amounts of ice and producing the flood with high energy. Rough volume estimates of the avalanche tend to be 100 to 200 million m3. This is huge (4 to 8 times higher than similar Chamoli event in India). The avalanche triggered ground vibration created a strong seismic signal (M5.2). The ice-rock avalanche with debris descended to ~2930 at Lhende Khola (border between China and Nepal) from 5200, sharply falling 2270 m generating speed debris flow.

Multi-temporal satellite imagery reveals a major ice–rock collapse/avalanche from an approximately 10 km² source zone from Nepalese side, including detachment of ~0.56 km² of the terminal glacier (at ~5200 m) (Figure 2). The collapsed ice–rock mass appears to have entered the border river valley (~2930 m) and generated a highly destructive debris-laden flood, dramatically widening the pre-event river corridor. The channel, previously ~100–300 m wide, expanded to approximately 900–1,300 m in places, indicating extensive erosion, sediment deposition and inundation. The spatial correspondence between the detached glacier section, collapse source area and the enlarged downstream channel supports an ice–rock avalanche–induced cascading flood process.

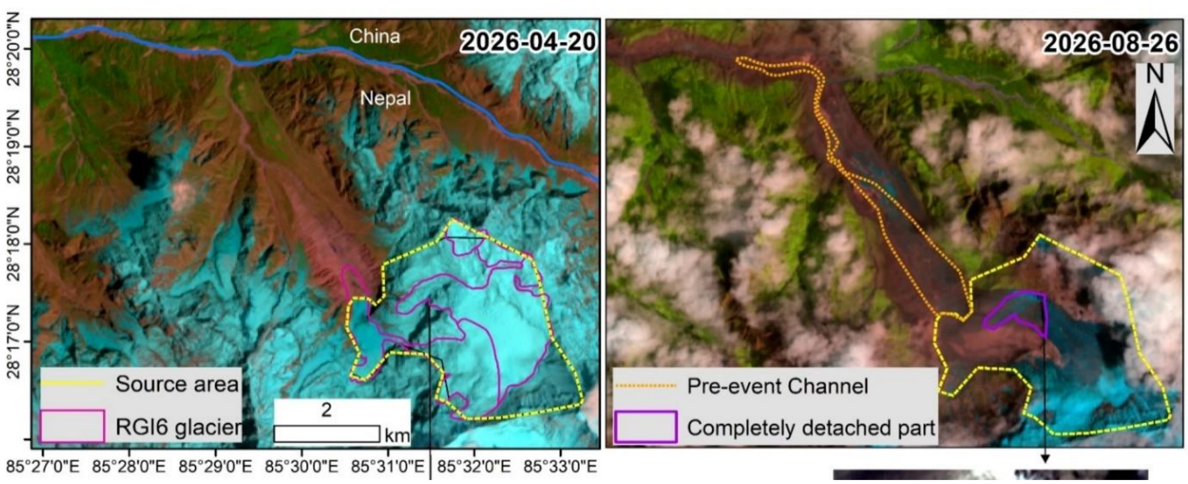

Fig 1: Landsat Image analysis before (March 20, 2026) and after flood (Aug, 26; 2026)

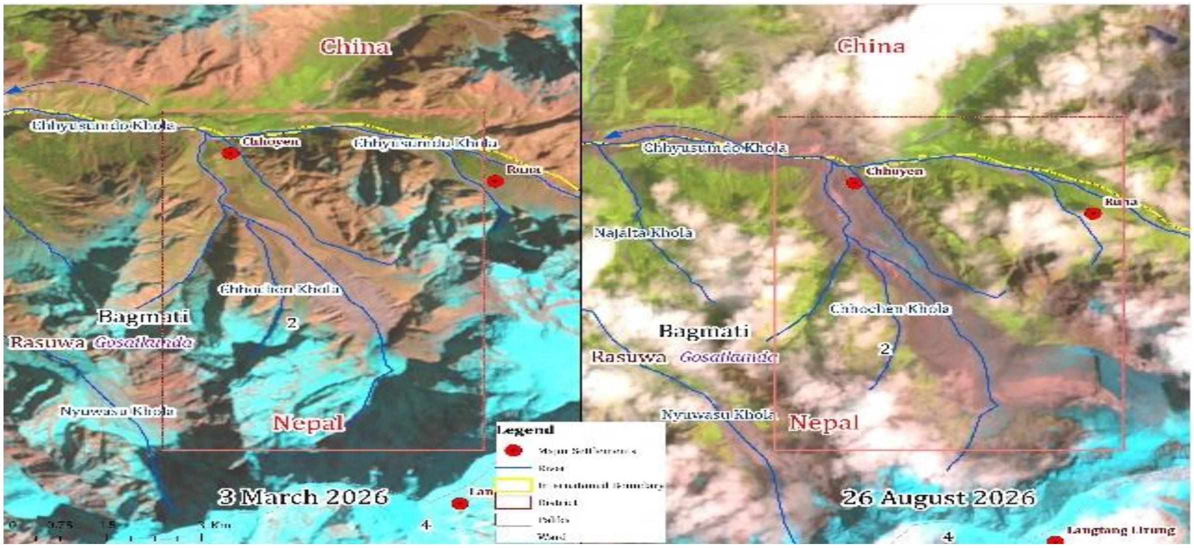

Fig 2: Landsat Images analysis before flood (March-3, 2026) and after flood (August-26, 2026)

After main event, satellite images show formation of two temporary lakes, one below the terminal moraine collapse and one landslide barrier lake at the confluence. This incidence that following the main events, a secondary landslide occurred and formed a barrier dam at the confluence. The upper lake just below the failed terminus was formed when melt water got impound on depression made by avalanche, the both lakes are smaller in size in term of volume and intending to burst.

2.2. Prior Event discharge indicator at Rasughadi and Saprubesi

During the event day, the observed hourly water level at Rasuwaghadi and Saprubesi prior to half an hrs of event shows that the average water level has been decreased since the morning 5 to 8 AM, NPT which indicates possible river blockage at upstream probably in Lhende river (Figure 3). However, the size of blocked dam and timing for river blocking has to be investigated in detail.

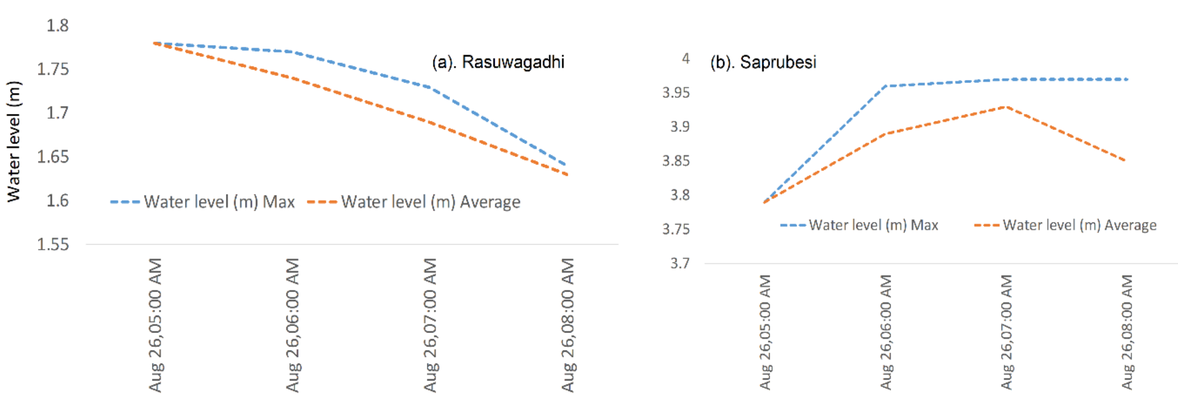

Fig 3: Hourly average and maximum water level at Rasuwaghadi (a) and Saphrubesi (b) before flooding of the event day, Aug 26, 2026 from 5AM to 8AM, NPT

The observed hydro climatic data shows that there was no big cloud burst in the upper catchment during the event day and the maximum and average discharge at Rasughadi site remain declined before flooding at 8.00AM, NPT which is located at the 15km downstream from the Lhende river. Similarly, the average discharge at Saprubesi located at 14km downstream from the Rasughadi also found declined from 7AM NPT. Analysis of several satellites images including Gaofen-1 (GF-

1), SAR, Sentinel, PlanetScope, and Landsat images indicates the presence of three glacial lakes at upstream in Tibet regions. However, no evidence and indicators of a glacial lake outburst flood were identified.

2.3. Preliminary glimpse of loss and damage

The losses caused by floods are massive and irreversible. Major damages of the flood was found in the river corridor from Rasuwagadi, Timure, Saprubesi, Bedrabati, Trishuli to Galchi. Fatalities are high and recorded 626 dead till August 29, and missing expected are around 5000 individuals, more than 8692 households have been severely damaged and swipe out. The number of affected populations are 39114. The missing numbers and dead body records are yet to be declared by the government. The floods have caused extensive damaged to hydropower infrastructure, the NEA information indicated that 13 hydropower and one solar plant project were affected disconnecting about 431MW in the national system. Altogether, 1098 hydropower staffs including technical and non-technical manpower are missing until August 30. The highest numbers are missing from Upper Trishuli 1, Trisuli 3A, Trisuli 3B, Langtang and Rasuwagadhi hydropower project. The 220KV Trishuli 3B substations was completed destroyed. Approximately 32 suspension bridge were damaged from source to Dhading.

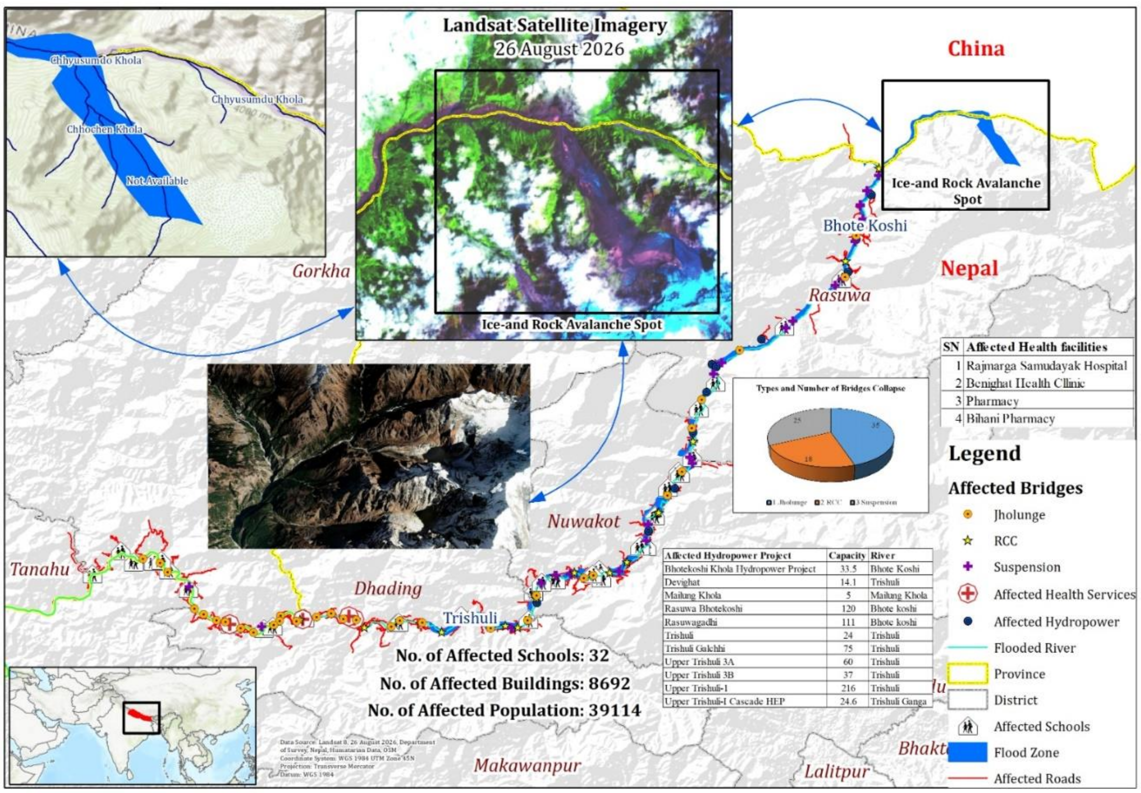

Fig 4: Affected zone and structures from avalanche zones to Galchi, Trisuli based on the records collected by 29 August, 2026

The Rasuwa and Nuwakot districts are severely affected from the floods (Figure 4). The preliminary economic loss caused by the floods based on the government official is approximately NRs 3 trillion including significant losses to social and physical infrastructures. The detail loss and damage statistics in different sectors yet to be finalized.

2.4. *Longitudinal profile development from glacial collapsed zone to Saprubesi*

The longitudinal profile was developed in three sections as Zone 1: The glacial collapsed zone as "Ice and Rock Avalanche to Lhende river" (Around 8 km); Zone 2: From Lhende river to Rasuwagadhi Nepal-China Boarder (around 15km) and Zone 3: Rasuwagadhi to Syaprubesi (around 14km). The longitudinal elevation profile of **Zone 1** indicates an extremely steep terrain, with a maximum local downhill gradient of approximately 98.7% (equivalent to about 44.6°) (Fig 3). Once the ice–rock mass detached, it could rapidly accelerate down the extremely steep valley, entraining additional snow, ice, rock and sediment along its path. As the avalanche entered the Lhende Khola, the process likely evolved from an ice–rock avalanche into a highly mobile debris flow and sediment-laden flood, substantially increasing its destructive potential downstream.

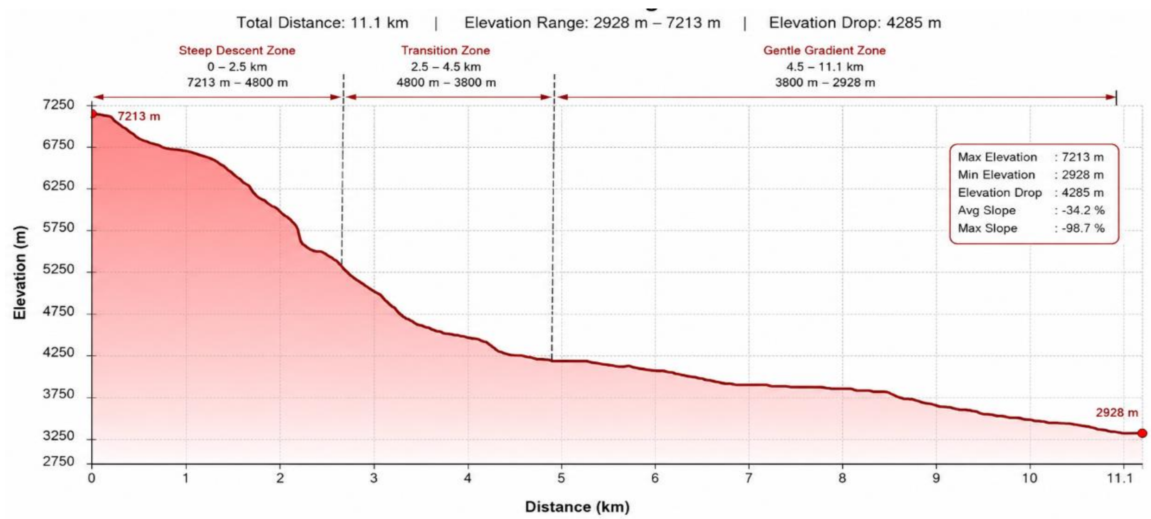

Fig 5: Longitudinal profile from top of the Langtang Lirung Hinal to Dowenstream in Lhende river (zone 1)

Zone 2 covering a total distance of approximately 15 km. The profile shows a general and continuous decrease in elevation from approximately 2,928 m at the upstream section to about 1,831 m downstream, representing a total elevation loss of approximately 1,097 m. The upper section (approximately 0–5 km) shows a relatively continuous and steeper decline in elevation, from about 2,928 m to around 2,500 m, indicating a section where the flow could maintain substantial gravitational energy and downstream momentum. The lower section (approximately 10–15 km) is characterized by a more irregular and undulating profile, particularly around 12–13 km, where pronounced local elevation fluctuations are visible. Despite these local fluctuations, the overall longitudinal trend remains strongly descending toward the downstream outlet at approximately 1,831 m (Figure 6)

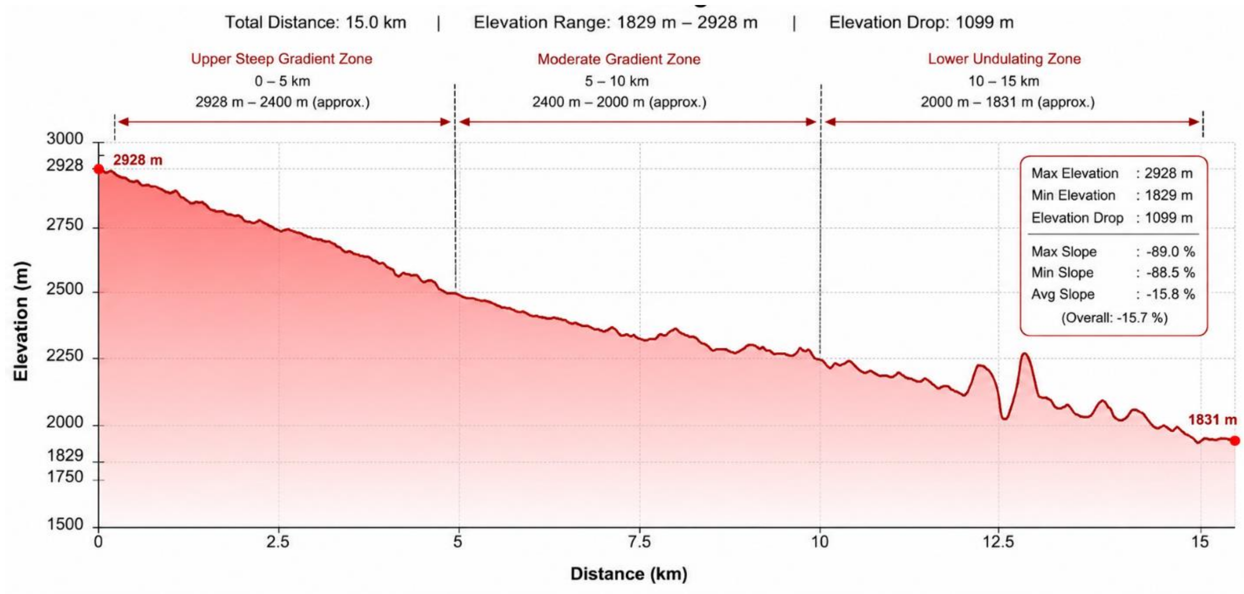

Fig 6: Longitudinal profile from Lhende river to Rasuwagadhi port (Nepal- China friendship bridge)

Zone 3 Longitudinal profile shows a continuous downstream decline in elevation over a distance of approximately 14.6 km (Figure 7). The elevation decreases from about 1,830 m at the upstream end to 1,428 m at the downstream end, representing a total elevation loss of approximately 831 m. Although the overall profile is downward, several localized rises and steeper sections are evident, particularly around 5 km, 8–8.5 km, and 12–12.5 km. The average slope ranges from approximately 10.2% to 12.3%, indicating a relatively steep and highly variable channel profile. Overall, the profile suggests a steep upstream-to-downstream gradient with localized breaks in slope, which may influence flow velocity, sediment transport, and flood-wave propagation.

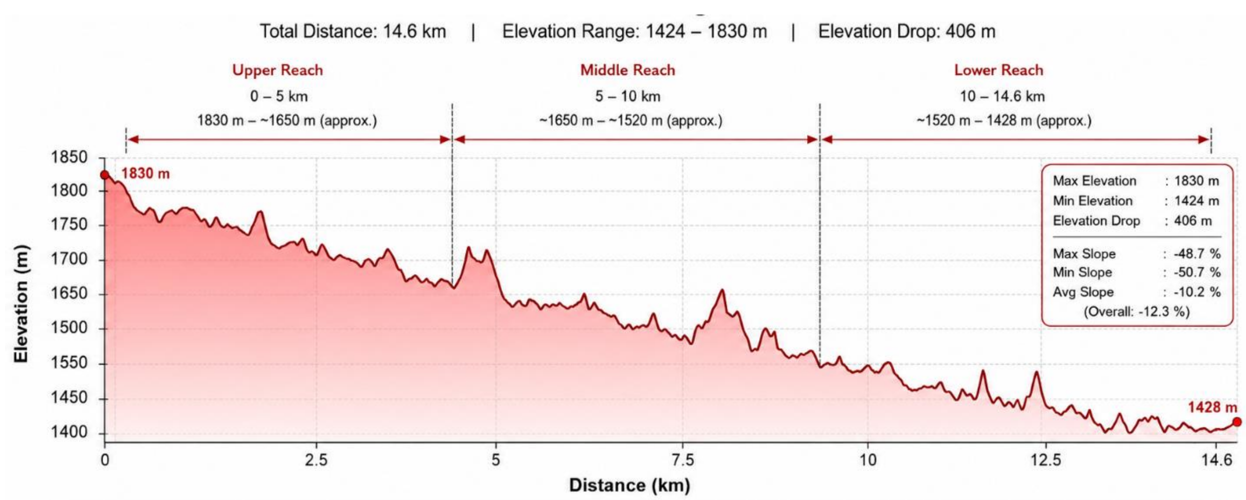

Fig 7: Longitudinal profile from Rasuwagaddi port to Saprubesi (Zone 3)

The profile further demonstrates that this was not simply a conventional river flood originating gradually upstream with high elevation loss. Rather, the event represents a cascading mountain hazard, in which a high-elevation slope or glacier failure was transformed through successive processes as ice-rock collapse – avalanche-sediment and debris entrainment-possible valley blockage for small time and sudden release - catastrophic flash flood.

3. Conclusion

This flood is the glacier mass wasting (Ice avalanche) flash flood ever recorded in Nepal. The flood has caused due to the glacier mass wasting from the high gradient of the Langtang Lirung Himalaya and temporarily blocked and breached the Lhende river. Based on the preliminary multi-temporal satellite observations, hydro-climatic evidence, and spatial analysis, the 26 August 2026 Bhotekoshi–Trishuli flood tragedy is a high-impact flash-flood in Nepal. The longitudinal profile from collapse points to Saprubesi shows high elevation loss creating huge water surge power potential. The observed collapse of a large ice–rock mass from the northern slope of the Langtang–Lirung region at higher elevation around 5200masl to ice rock avalanche entered into Lhende Khola at 3000m asl. The large detached ice mass grounded to 2200m steepe down at the Lhende river which is likely to have generated an enormous debris-laden flood wave in the river. The different multispectral images such as PlanetScope, Landsat and Sentinel-2 imagery show that there are no any indicators of glacial lake breaching. Thus, GLOFs is not identified a major triggering factor. The two lakes form after primary events at the confluence seems smaller in size now but may may pose substantial hazards if drained catastrophically. It is reported that both lakes have been drained by morning of 30th August. The severe destruction of settlements at the river corridor, bridges, hydropower facilities and other infrastructure, and the reported loss of life demonstrate the high magnitude and cascading nature of the event. Nevertheless, the estimated volume of ice avalanche, led to contribution of glacier ice, rock, and sediment to flow, exact failure mechanism, seismic characteristics, meltwater contribution and landslides induced river blockage require further field verification and quantitative analysis.

4. Lessons to be Learned and Way Forward

The intensity and frequency of flash floods in snowfed rivers of Nepal Himalayan are increasing and records breaking on their extremity in every trailing event. The glaciers in the Nepal Himalaya and melting in response to climate warming and urgent need to its protection and monitored. In future, the integrated high computing and data driven technologies where real time hydroclimatic and cryospeheric stations with telemetric data, cloud layer (Satellite, Radar and sensor based data mining, RCM output), Internet of Thing (IoT), edge computing technology need to be adopted for cryosphere and cross border upper catchment monitoring. In downstream, the numbers and mechanism of early warning system with GSM based receiving station should be increased in large numbers. It is necessary to strengthen and capacitated for climate and cryospheric monitoring systems in high temporal resolution for himalaya security and early flood hazard preparedness. In a nutshell, such integrated scientific understanding, together with effective data-sharing mechanisms and transboundary collaboration, is essential for strengthening early warning systems and improving disaster risk reduction.

The Study was carried by expert team of Nepal Environment Society (NES) under the leadership of Dr. Binod Baniya (Climate Scientist) along with Dr. Nitesh Khadka (Cryospheric Hazard Expert), Dr. Amrit Prasad Sharma (Flood Hazard and Hydraulic Modeling Expert), Mr. Bishnu Maharjan (Spatial Analyst and RS expert) and Dr. Jayaram Karki (Mountain Environment Specialist). For any citation pls refer as follows

Baniya, B; Khadka, N, Sharma, AP, Maharjan, B and Karki, J 2026; Bhotekoshi-Trishuli Flood Tragedy; Ice-Rock Avalanche; Nepal Environment Society (NES), August-30, 2026; Kathmandu, Nepal