

Rasuwa 2026 Flood Disaster: Field Experience, Rescue Challenges, and Lessons Learned from Upper Trishuli 3A and Chilime Hydropower Projects

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Abstract: The Rasuwa Flood Disaster of 26 August 2026 caused severe flooding and debris surges along the Bhotekoshi-Trishuli River corridor, resulting in casualties, missing persons, and extensive damage to infrastructure and hydropower projects. This paper presents field-based experiences from emergency response and rescue operations at Upper Trishuli 3A (60 MW) and Chilime Hydropower Project (22.1 MW), focusing on geotechnical, hydraulic, structural, and operational challenges. At Upper Trishuli 3A, debris accumulation, large boulders, tunnel blockages, water ingress, and unstable ground severely restricted access to the underground powerhouse and associated tunnels. Rescue teams reviewed tunnel drawings and geological information to identify alternative access routes. Operations involved excavation, debris removal, drilling, controlled blasting, ventilation, dewatering, temporary lighting, and confined-space inspections. Excavators, compressors, down-the-hole drilling equipment, water jets, and pumps supported tunnel access and water management. The response involved Nepal Army, Armed Police Force, Nepal Police, Nepal Electricity Authority, technical specialists, medical teams, and volunteers. Rescue strategies continuously evolved according to changing site conditions. By 4 September 2026, two individuals had been rescued alive and one deceased person recovered, while others remained missing. The operation highlighted the importance of multidisciplinary coordination, rapid decision-making, geotechnical assessment, and adaptive rescue strategies in complex underground hydropower emergencies.

Keywords: *Rasuwa flood 2026, Flash flood, Debris surge, Hydropower, Upper Trishuli 3A, Geotechnical engineering, Emergency response, Water-Jet debris removal, Disaster risk reduction*

Introduction

The Himalayan region is highly susceptible to flash floods and debris surges due to steep topography, fragile geological formations, intense monsoon rainfall, and active tectonics. These hazards pose significant risks to hydropower infrastructure, particularly underground facilities where debris accumulation, water ingress, and unstable ground can severely restrict emergency access and rescue operations.

The Rasuwa flood disaster of 26 August 2026 caused casualties, missing persons, and extensive infrastructure damage along the Bhotekoshi-Trishuli River corridor, affecting the Upper Trishuli 3A (60 MW) and Chilime (22.1 MW) Hydropower Projects. Rescue operations encountered contrasting challenges, including large boulders, tunnel blockages, unstable ground, and saturated fine-grained debris. Conventional excavation, drilling, controlled blasting, dewatering, and water-jet-assisted debris removal were employed according to site conditions.

Despite the importance of hydropower infrastructure in Nepal, documented field evidence concerning underground rescue operations following extreme flood events remains limited. This study presents field experiences from both projects, examining geological and geotechnical constraints, hydraulic conditions, debris-removal techniques, equipment requirements, and multidisciplinary coordination. It further identifies lessons for improving emergency preparedness, responder safety, real-time monitoring, alternative rescue access, and risk-informed design provisions for underground hydropower infrastructure in mountainous environments.

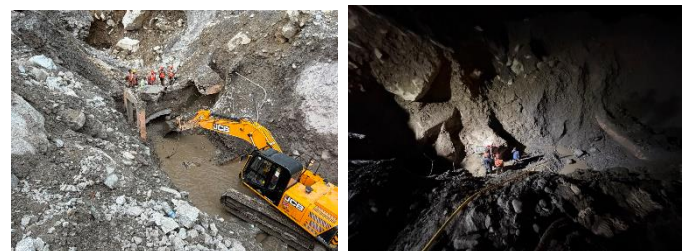


Figure 1, (a) Flood-affected Upper Trishuli 3A site and emergency excavation. (b) Tunnel access and debris-clearing operation inside UT 3A

Field experience, adaptive rescue methods, and lessons learned

Experience from the Chilime Hydropower Project further demonstrated the importance of understanding underground geometry, geological conditions, groundwater pathways, and the relationship between water pressure and debris behaviour. Available project

drawings were reviewed to identify a technically feasible and comparatively safe rescue alignment. A clear-water source was identified at approximately 220 m chainage, with water collected and pumped from a lower chainage. A measured discharge of approximately 1.66 L/s was observed, allowing gravity drainage and reducing hydraulic pressure in the affected area. Field observations indicated predominantly fine-grained debris, including approximately 10–15% clay, 60–70% silt, and 10–20% sand, with other material fractions after the chainage of 90m but before that materials with large boulders were found and cleared by manually and excavator, loader etc. This fine-grained and saturated material significantly restricted mechanical excavation and prolonged clearing.

Based on these observations, a water-jet-assisted debris-removal approach was adopted. Water was directed into the obstructed material to loosen and mobilize fine-grained debris; while pumping and manual clearing were used to establish a safe passage. The field record indicates that two water jets achieved breakthrough after approximately 36 hours, demonstrating the potential effectiveness of hydraulic methods where conventional mechanical excavation is severely constrained by confined conditions and fine-grained saturated debris. No survivors were found. Five bodies were recovered out of the six missing persons, while one person remains unaccounted for.

The field experience confirms that underground disaster rescue cannot rely on a single predefined method. Rescue planning must remain flexible, evidence-based, and continuously updated according to actual geological, hydraulic, structural, and environmental conditions. Major challenges included unstable tunnel conditions, water ingress, poor access road condition, large boulders, uncertain internal geometry, ventilation and air-quality concerns, equipment limitations, adverse weather, communication difficulties, and the need to protect rescuers while maintaining urgency for trapped persons. Continuous monitoring of tunnel progress, material encountered, water flow levels, ventilation, oxygen/air quality, equipment condition, and other hazards was therefore essential.

The experience also demonstrates the importance of preparedness before disasters occur. Hydropower projects and other critical infrastructure in mountainous and geologically sensitive environments should maintain updated emergency response plans, accessible tunnel drawings and geological records, designated rescue access points, emergency equipment, trained personnel, reliable communication systems, and arrangements for rapid mobilization of specialized machinery. Regular risk assessment, early warning systems, river and slope management, drainage, remote sensing, GIS, drone surveys, and real-time monitoring can strengthen preparedness and reduce disaster impacts.



Figure 2, Water management and hydraulic debris-clearing works at Chilime



Figure 3, Multidisciplinary field team during the rescue/recovery operation

Key lessons for future disaster preparedness

- Integrate geotechnical, geological, hydraulic and structural assessments into emergency decision-making.
- Maintain flexible rescue strategies and alternative access routes rather than relying on a single rescue method.
- Strengthen specialized tunnel-rescue training, PPE, communication systems and emergency equipment.
- Institutionalize multi-agency coordination, rapid technical support and systematic documentation of lessons learned.

Global thinking, Development of real time monitoring system, Changing the design guideline and codes, Application of Safety measures like bunkers, vertical shaft etc.