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Sediment disasters induced by the 26-28 September 2024 extreme rainfall event in Nallu Khola watershed of Central Nepal

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Study area & rainfall event

From September 26 to 28, 2024, Nepal experienced exceptionally heavy rainfall, severely impacting large areas, particularly the Kathmandu Valley and its surrounding districts, triggering flash floods and landslides.

This study presents preliminary findings from an assessment conducted approximately two months after the event, focusing on the upstream region of the Nallu Khola watershed (Fig. 1) in Lalitpur District, one of the areas most severely impacted.

The event recorded a cumulative rainfall total of 518 mm at the Lele AWS Station (Department of Hydrology and Meteorology, Nepal), located approximately 2 km NW of the study area (Fig. 2). This rainfall was about 4.3 times the total monthly rainfall for September 2023. The maximum hourly rainfall, observed at 5:00 AM on September 28, reached 39.8 mm, while the highest 24-hour rainfall was an extraordinary 441.2 mm.

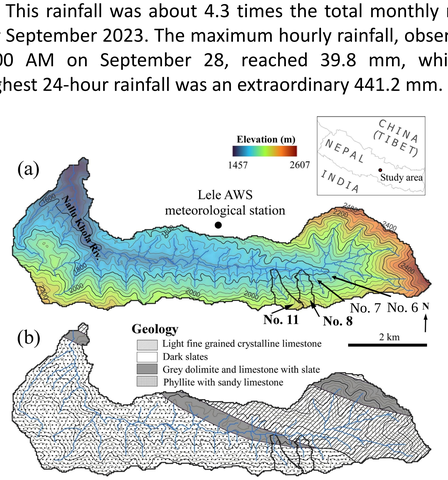

Fig. 1. Nallu Khola watershed, central Nepal.
(a) Topographic map, derived from a 30-m mesh Aster GDEM.
(b) (b) A 1:250,000 geological map (Shrestha and Shrestha 1986) .

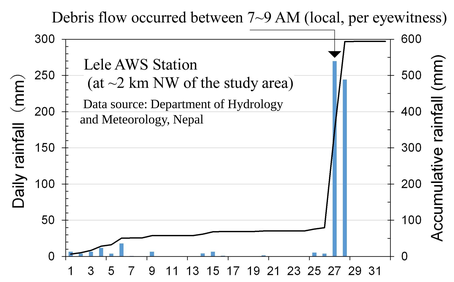

Fig. 2. Daily and cumulative rainfall. Sediment disasters occurred between 7~9 AM (local, per eyewitness).

Sediment disasters

The rainfall triggered a series of compound sediment disasters, including raising the river level by approximately 3 m above the riverbed, along with numerous landslides and debris flows (Fig. 3).

The landslides predominantly consist of shallow failures, primarily occurring along roads and in areas associated with cultivated land, while areas covered with forest exhibit relatively few failures (Fig. 3).

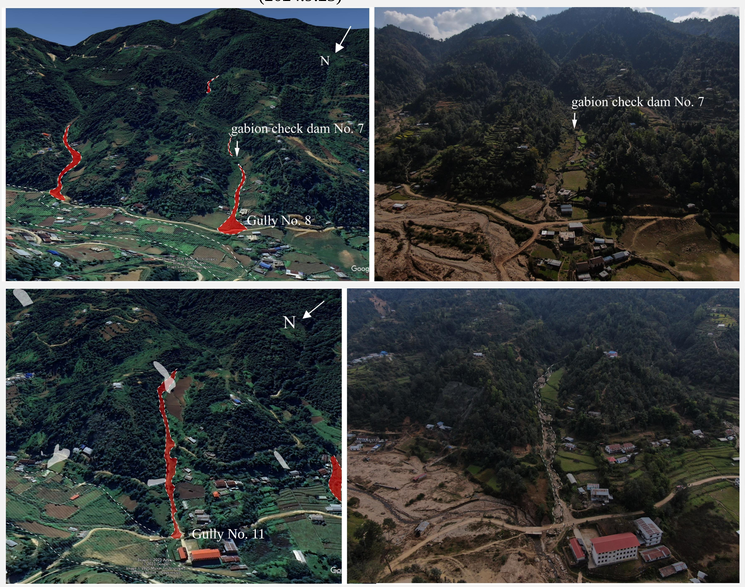

Fig. 3 Rainfall triggered compound sediment disasters, raising the river ~3 m above the riverbed, along with landslides and debris flows. Shallow landslides primarily occur along roads and cultivated land areas.

Debris flows are predominantly concentrated in creeks, with a comparable event having occurred on September 30, 1981. Following that event, debris flow mitigation engineering measures (e.g. gabion check dams and channel works) were implemented in some creeks and the impacts of the 2024 event appear to have been largely confined to these mitigated creeks. This underscores the importance of implementing and maintaining effective mitigation measures to manage debris flow hazards in vulnerable areas.

- ***Gullies (No. 8 & No. 11) with mitigation measures***

Before the event Google Earth (2024.9.23) ***After the event*** (2024.11.24)

- ***Gullies without mitigation measures***

Before the event Google Earth (2024.9.23) ***After the event*** (2024.11.24)

- ***Source areas of debris flows (gullies No. 8 & No. 11) involve remobilization of 1981 debris flow event remnants and shallow landslides***

- ***Mitigation measures (gabion check dams and channel works on gullies No. 8 & No. 11)***