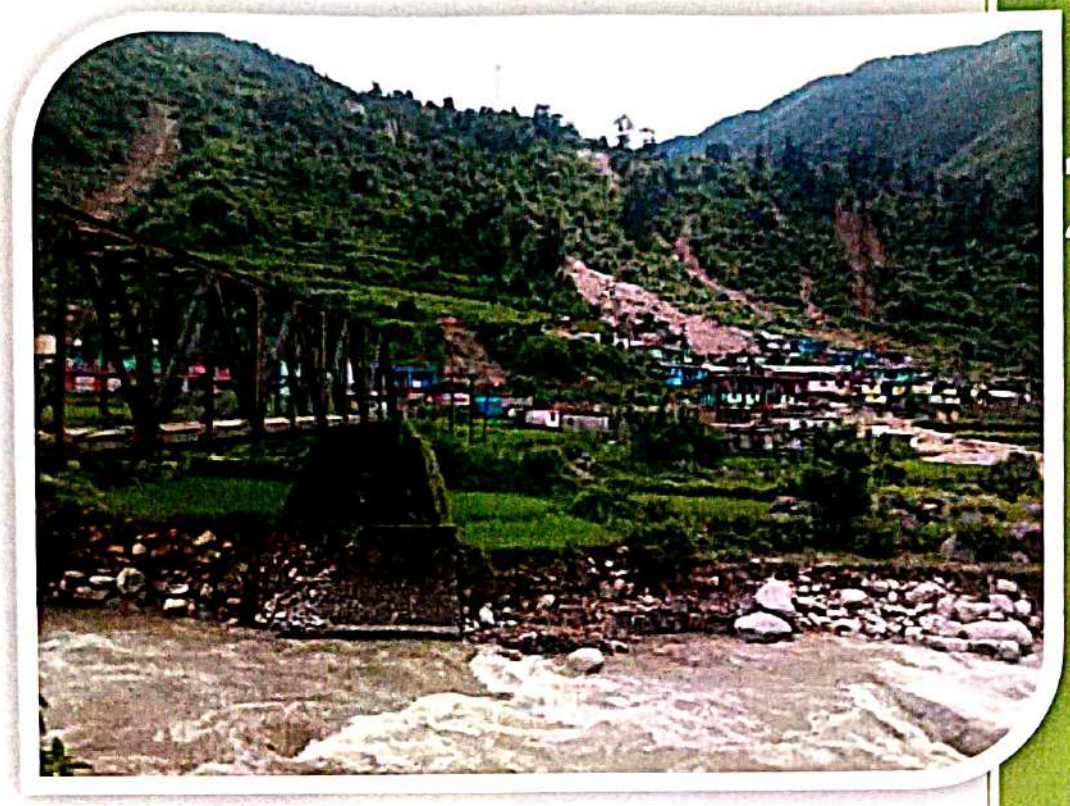

2024

Preliminary Field Investigations of landslides at Toli and Tingad villages, Tehri District, UTTARAKHAND

Ruchika Tandon
Prem Singh Negi
Tandrilla Sarkar
UTTARAKHAND LANDSLIDE MITIGATION AND MANAGEMENT CENTER (ULMMC)

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ABSTRACT

On midnght of 27th July 2024 a landslide was reported in Toli village, Ghansali Tehsil of Tehri Garhwal that resulted in severe damage to a residence and casualty of the members residing there. Consequently during afternoon of 28th July 2024 , major landslide activity occurred at Tingad village which is located infront hill of Toli village, but due to timely rescue , all the residents were evacuated before getting hit with the damaging wrath. The residents were evacuated to Rajkiya Inter College and apart from infrastructure loss, no casualties were reported.

Hence, an initial survey was carried out from 31 July to 2 August 2024 by the following technical experts from ULMMC and USDMA

1. Dr. Ruchika Tandon, Senior Geologist, Uttarakhand Landslide Mitigation and Management Center (ULMMC)
2. Mr. Prem Singh Negi, Assistant Engineer, , Uttarakhand Landslide Mitigation and Management Center (ULMMC)
3. Ms. Tandrila Sarkar, Geologist, (USDMA)

PRELIMINARY FIELD INVESTIGATIONS OF LANDSLIDES AT TOLI AND TINGAD VILLAGE, TEHRI DISTRICT

INTRODUCTION :

An information received in Dept of Disaster , Govt of Uttarakhand regarding a landslide event occurred at Toli Village in the Tehri District at approximately 2:30 am on July 28, 2024, following heavy rainfall. Tragically, two individuals were buried and found deceased under the debris, while one person sustained injuries.

In response to the incident, a State Disaster Response Force (SDRF) team was dispatched to the area to provide relief. Upon arrival, slope movement in the Tingad village located South of Toli village in the opposite hill activated thus SDRF initiated rescue operations. However, a subsequent major landslide was triggered at 2 pm , which resulted in the destruction of multiple houses and shops in Tingad Village on the afternoon of 28th July 2024. Fortunately, due to the timely rescue efforts, there was no loss of human life or livestock.

Subsequent to this, a team from ULMMC/USDMA carried out a preliminary survey of Toli and Tingad villages on 31st July 2024 in the Bhilangana block of Ghansali Tehsil to ascertain the cause of ongoing problems and suggest remedial measures accordingly.

2.0 LOCATION

Toli and Tingad villages are located in the Bhilangana block of Ghansyali tehsil within the Tehri Garhwal district. Toli Village is situated on the right flank, while Tingad Village is on the left flank of the Balganga River, at elevations ranging between 1600 and 1700 meters above mean sea level (Fig 1). It is part of the Bhilangana block and falls under the Toli gram panchayat. It is approximately 40 km from the sub-district headquarters of Ghansali. and can be reached via the Rishikesh-Chamba-Tehri road up to Ghansyali, where the Bhilangana and Balganga rivers converge. From Ghansyali, a metalled village road follows the Balganga River, providing access to the villages via Chamyali.

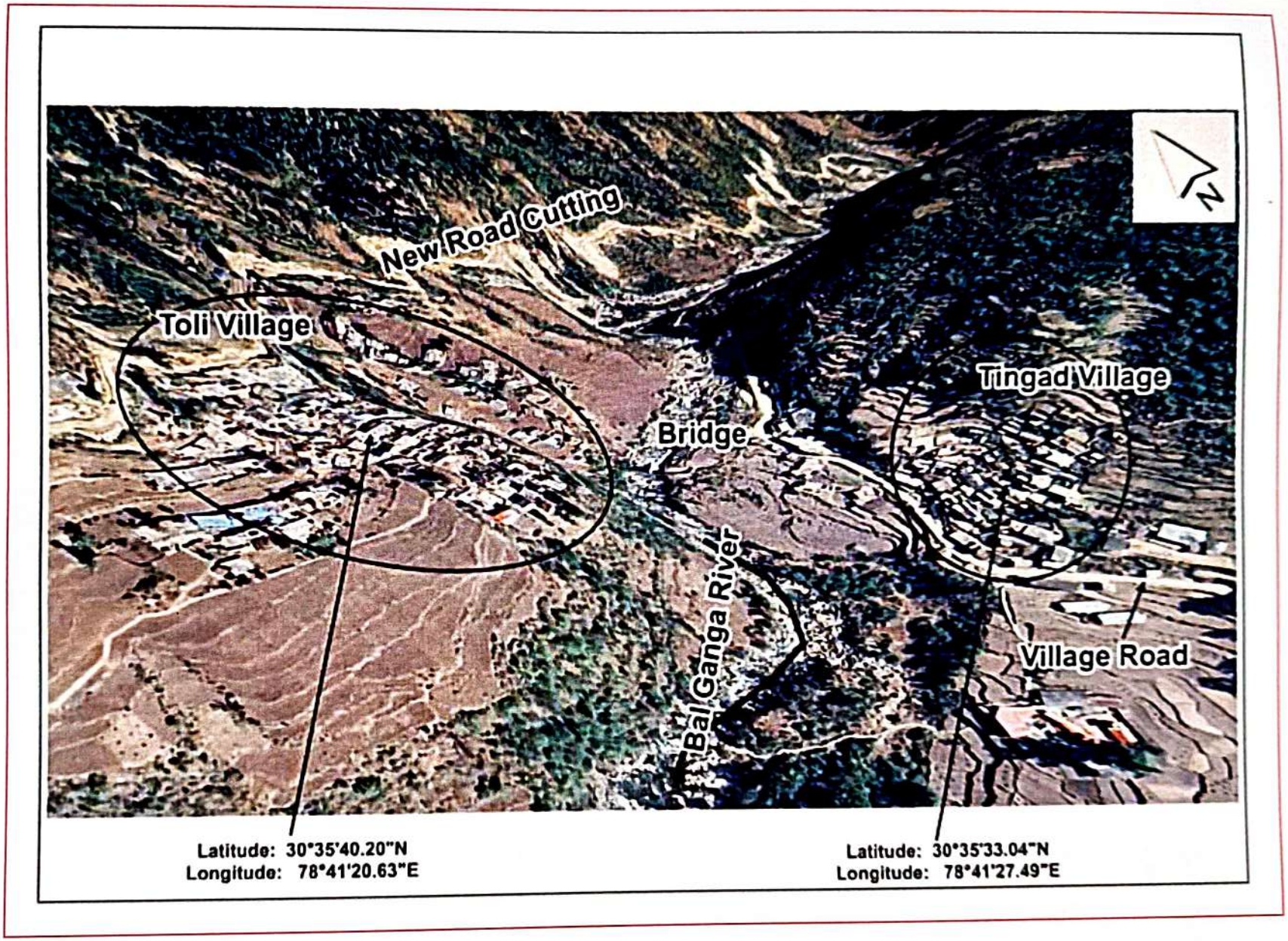


Figure 1: Google Earth image focusing on Toli and Tingad villages of Tehri district where the landslide incident occurred on 27-28 July 2024

3.0 GEOLOGY OF THE AREA :

The area represents the higher himalaya and situated to the north of the Main Central Thrust (MCT). Here MCT is also known as Bhilagana thrust which is equivalent to Chail Thrust, passes from the north of Budhakedar along Dharamganga river , a Tributary of Balganga river. The majority of the hilly terrain near MCT is covered with thick overburden where villages like Toli Tingad , Kot etc settled down. Towards the East of MCT near Toli and Tingad village, the imprints of tectonic thrust/fault is seen in form of highly leached and weathered rocks (Figure 2) , presence of sheared metabasics at one side of Balganga river (Figure 3) , Fault breccias, folds in sheared granite etc.

Figure 2 exhibits presence of shear zone just before Tingad village on roadside

Figure 3 shows the exposure of sheared metabasics at base of hill and toe cutting by river Balganga below Toli vill

The predominant rock types exposed in the area are coarse-grained biotite granitic gneiss and granite with bands of metabasics. The granitic gneiss outcrop is prominently exposed above Toli village along the new road cut, where the rocks dipping towards North with a dip amount of 40° (Figure 4) . In contrast, to the east of Tingad Village, a vertical outcrop of sheared granite is observed, along with evidence of recumbent folding

Figure 4 . An outcrop of dipping Granitic Gneiss exposed at new road cutting above Toli

Figure 5 exhibit the presence of fractured and cataclastic rocks

In several locations along the new road cutting approaching Jakhana Village, cataclastic rocks is observed (Fig 5), accompanied by the development of multiple landslide scarps. Just below Toli village, along the riverside, sheared and weathered metabasics are exposed, displaying evidence of toe cutting and erosion caused by river water. The absence of metabasics bands on the opposite side of the river suggests the presence of a fault or thrust. Further evidence of faulting is indicated by the change in the dip direction of the sheared and crushed rock outcrops on both sides of the river.

The entire Tingad village area is covered with a thick overburden, where agricultural practices are prevalent. This overburden consists of a mixture of fine and coarse materials, along with boulders of varying sizes. These characteristics suggest that the village is partially situated on river-borne material and partially on slope wash deposits, which have been modified into terraces for agricultural use.

Geomorphologically, the area around Tingad village exhibits a gentle slope near the ridge, where a canal is observed on satellite imagery or Google Maps, running towards the periphery of the hill near the village of Bachdobha. The canal's alignment just above Tingad Village is difficult to track due to the thick vegetation covering the area. The slope above Tingad village becomes steep, followed by flatter lands at the base of the hill, which are used for agricultural purposes. The Balganga River is situated at a considerable distance from the settlement. In contrast, the terrain around Toli Village is characterized by a moderately steep hill with no distinct slope break.

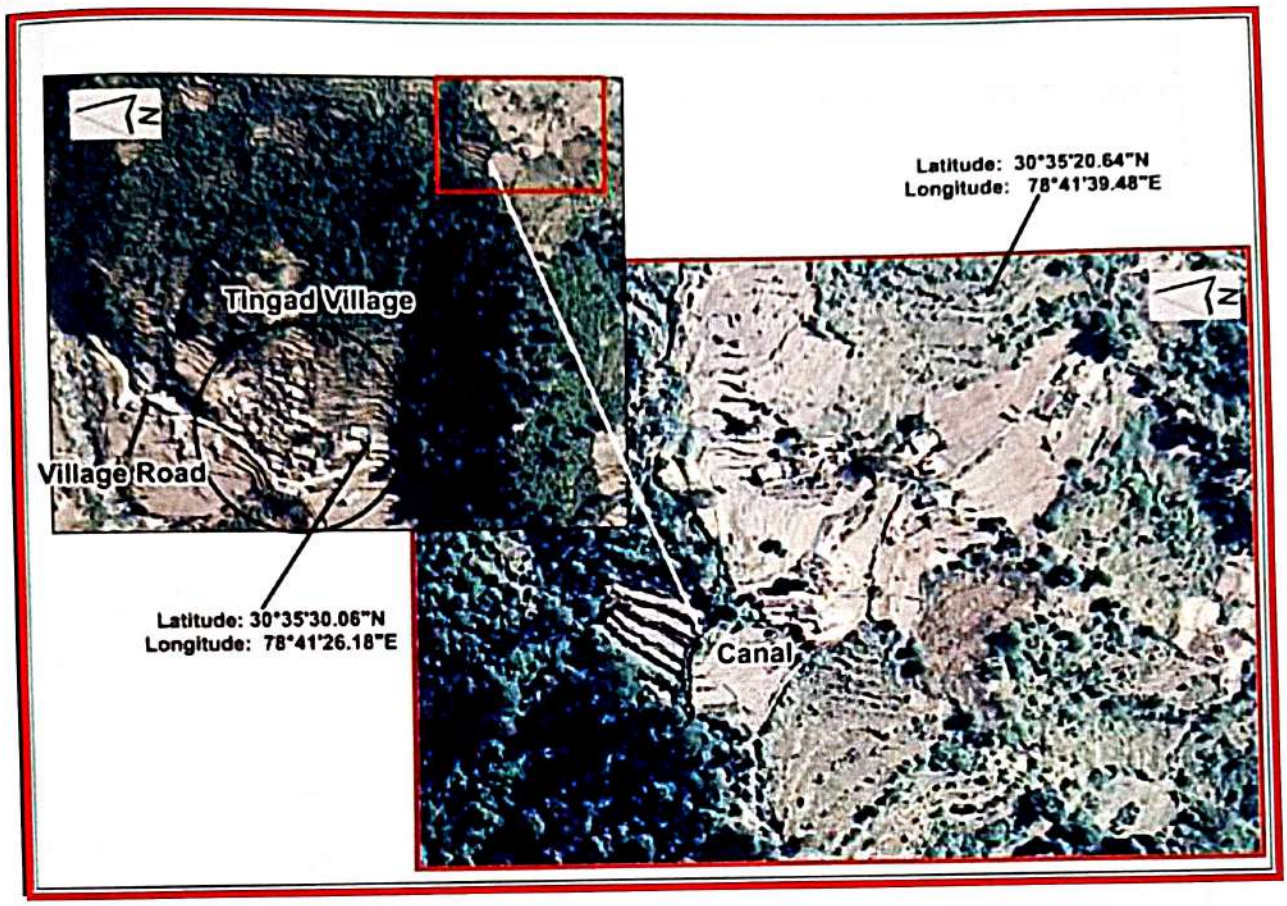


Figure 6 : Location of Canal above Tingad Village

4.0 DESCRIPTION ABOUT LANDSLIDE EVENT

TINGAD VILLAGE: At Tingad Village, six scarps were formed where hillslope soil and sediment were stripped away by debris flows on the afternoon of July 28, 2024, following heavy rainfall. The debris flows were relatively shallow and occurred in two major events spaced one hour apart.

The first debris flow originated at an elevation of 1780 meters, traveled approximately 120 meters, and deposited sediment and debris at a primary school. The school premises sustained

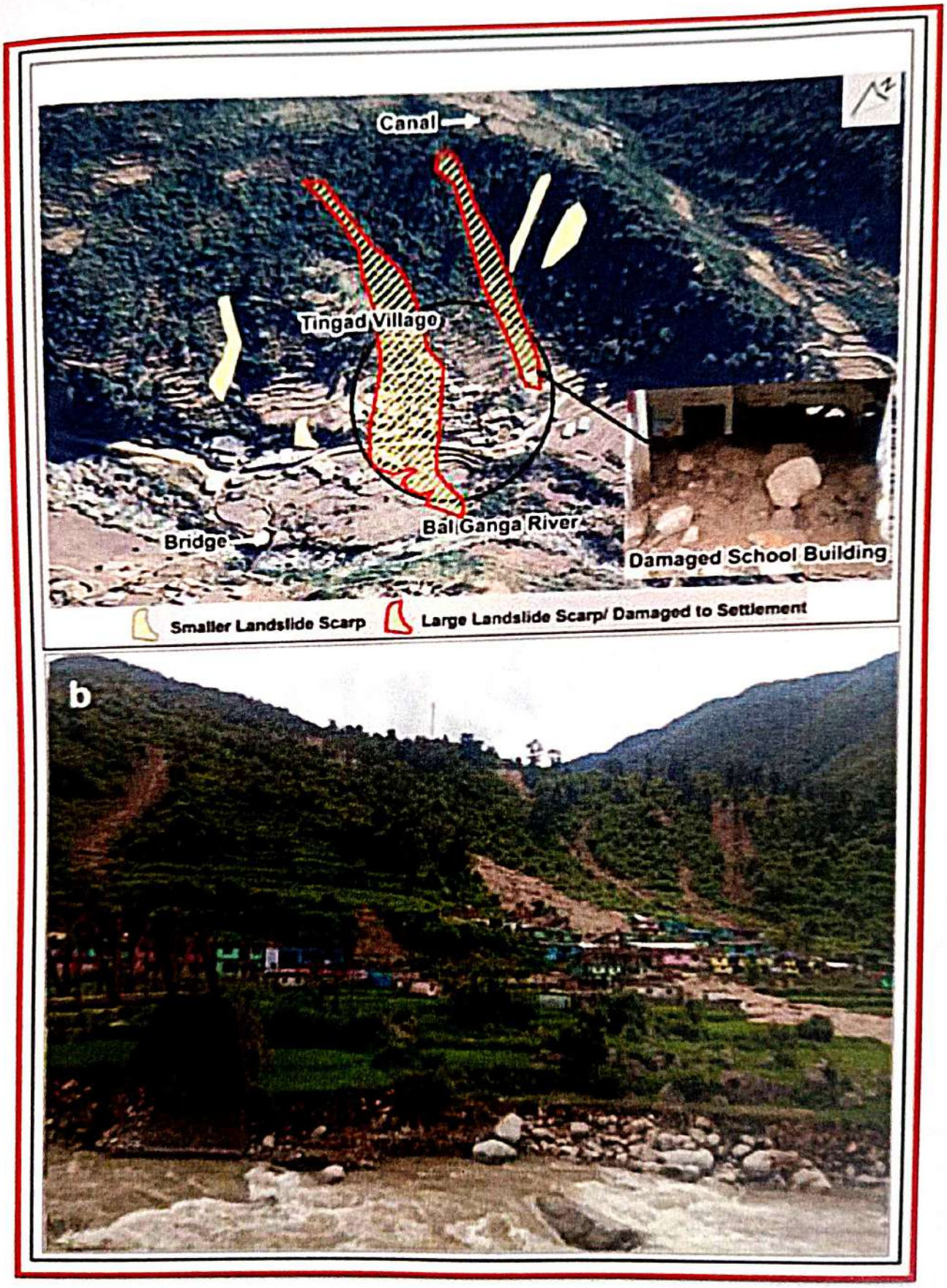


Figure 7: Six Landslide scarps developed at Tingad Village

significant damage due to the deposition of a highly saturated clay-sand mixture containing large boulders of granite and granitic gneiss. Continuous water flow from the scarp suggests either oversaturation of the ground or seepage at some point. The volume of the debris from this event is estimated to be around 1500 cubic meters.

Adjacent to this scarp, another debris flow impacted several houses in Tingad village and nearby

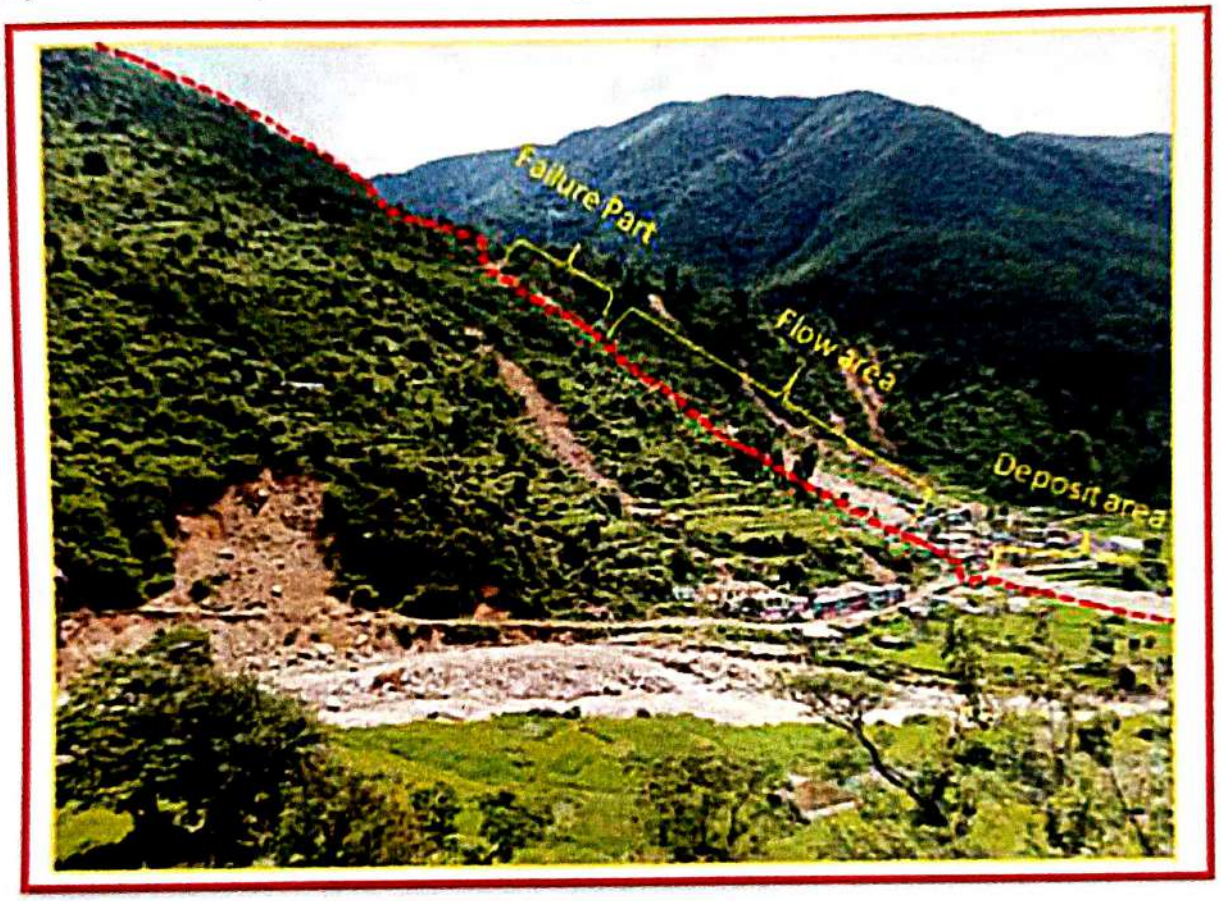


Figure 8 marks the area of failure, Flow and Deposition of debris

agricultural lands. The estimated volume of debris deposited in the main settlement is approximately 3000 cubic meters, with large boulders included in the deposition (Fig 8). Similar to the first scarp, continuous water flow was observed through a narrow channel within the landslide-affected area. Satellite imagery reveals the presence of a canal, locally known as the "Basa Canal," located at the top of the hill.

Figure 9 : Location of damaged house of Toli Village above which small scale andslip occured

TOLI VILLAGE

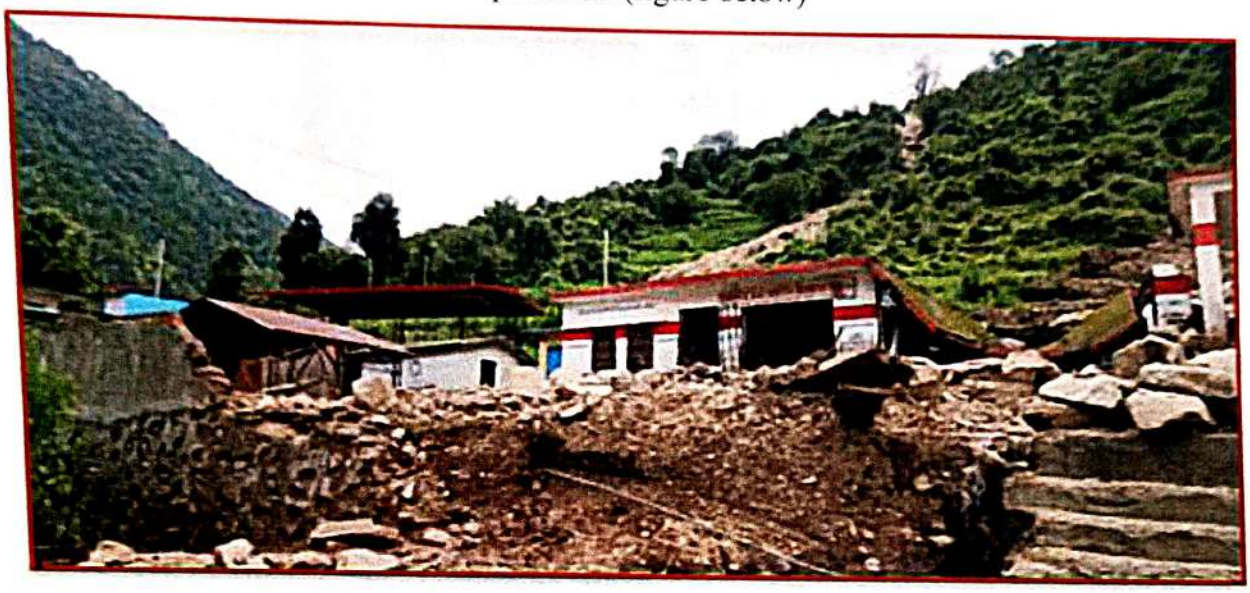
A small-scale debris slide occurred at approximately 2:30 AM on July 27, 2024, in Toli Village. The debris slided towards a house, damaging the back wall and tragically burying two individuals, while one person was injured (Fig 9). No other issues related to subsidence, poor drainage networking, or seepage were observed in Toli Village, and no new scarps were identified near the settlement, except for gully erosion observed on the right side of the metalled bridge.

A new road cutting above the village, leading to Jakhiyana village, shows evidence of landslide activity and road washout to the east of Toli Village. A nala with moderate water flow runs alongside this new road cutting. The nala is properly channelized as it passes through the settlement and eventually joins the Balganga River, with no additional landslide activity observed near it.

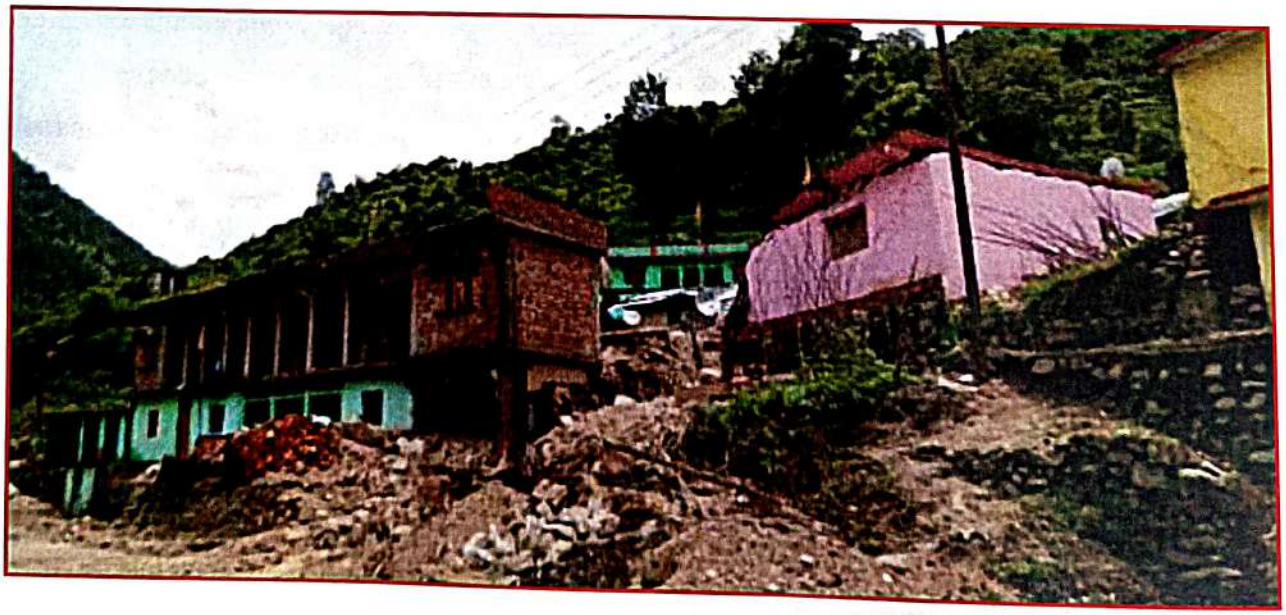
DAMAGED OCCURRED :

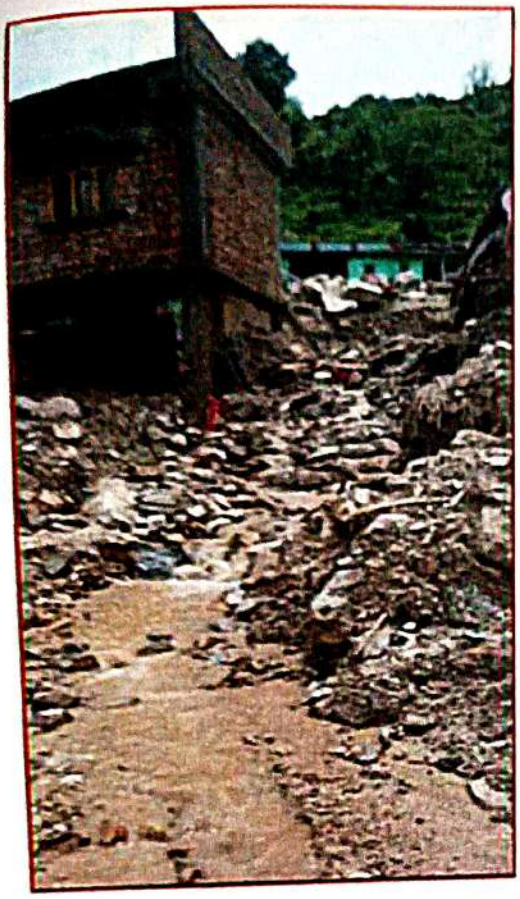
TINGAD VILLAGE:

- The landslide in Tingad Village caused severe damage to the primary school, where the walls of the school building were broken, and debris consisting of mud, sand, and large granite boulders settled on the school premises. (figure below)

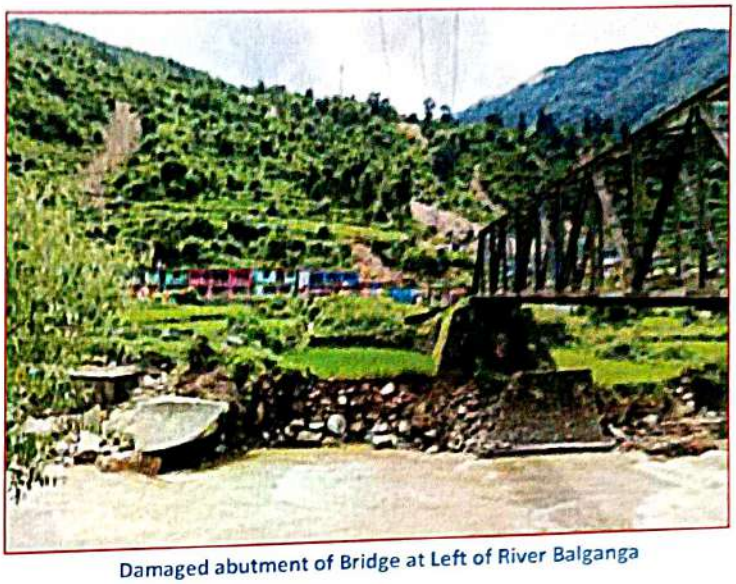


- To the right of this scarp, another landslide occurred, severely affecting several houses belonging to 68 families. (Figure below) The debris from this slide settled on the flat agricultural land below.





Water flowing from the Landslide Scarp towards the Settlement

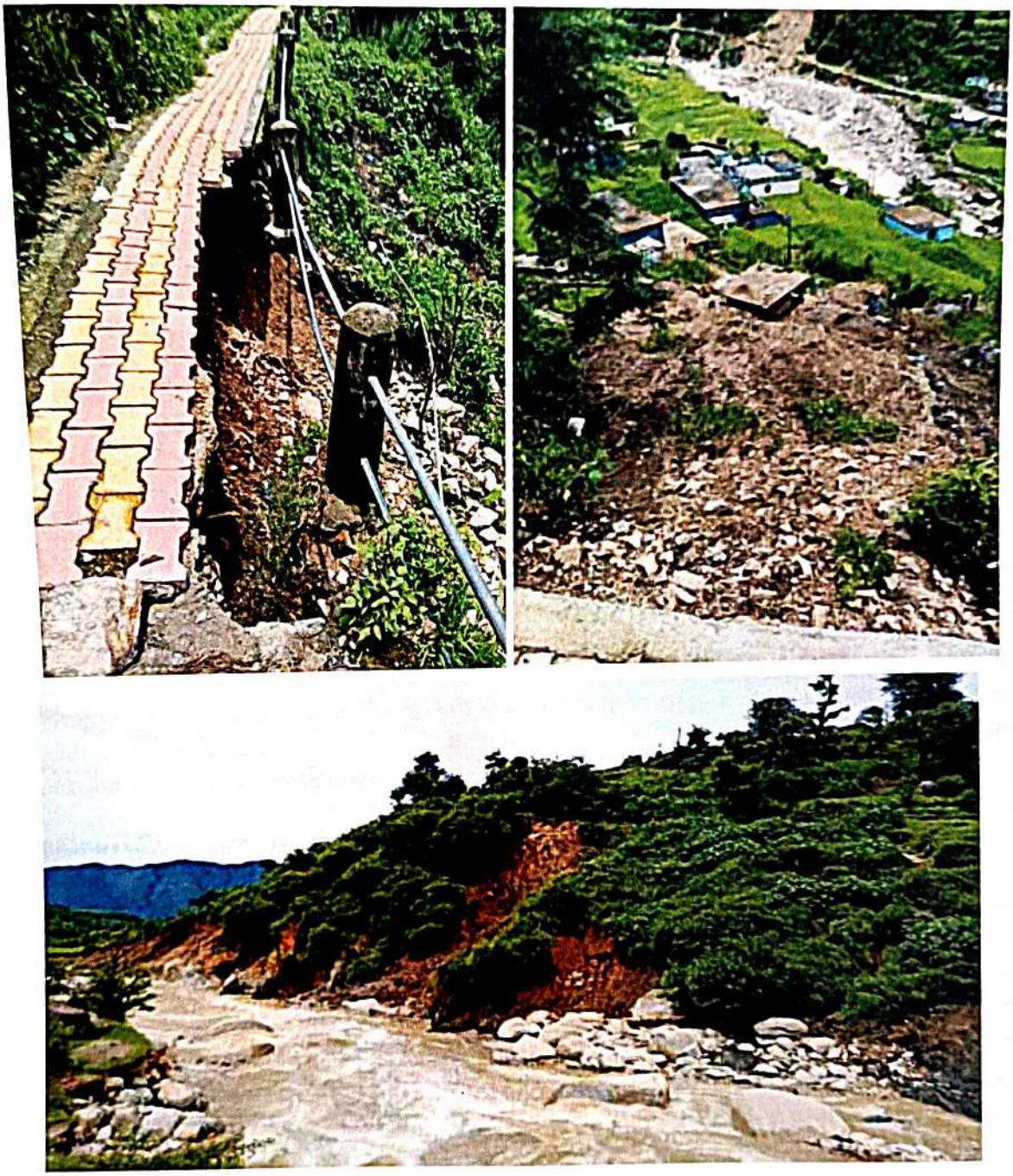


Damaged abutment of Bridge at Left of River Balganga

- The landslide debris remains fully saturated, and continuous water flow has been observed. (figure above)
- The right abutment of a bridge in the area was damaged, though this damage is unrelated to the landslide activity and was instead caused by side cutting from river water.

Toli Village

- A house is damaged with reporting of two persons dead and one injured.
- Toe cutting is observed just below Toli village in the vicinity of Balganga river



Crown of landslide scarp , buried house and Toe cutting at Toli village

SUGGESTIVE MEASURES

1. Canal Seepage Inspection and Repair Recommendations

An inspection of the canal above Tingad village is required to check for any signs of seepage. If seepage is detected, immediate repair is recommended. Additionally, it is crucial to ensure that water does not infiltrate the slope direction towards Toli village settlement . Personnel involved in the inspection and repair must exercise caution and avoid entering any areas that show signs of being affected.

2. Flood Protection and Bridge Abutment Repair

Flood protection walls are necessary on both sides of the river near Toli and Tingad villages. Alongside this, the bridge abutments in the vicinity should be repaired to prevent further structural deterioration.

3. Landslide Mitigation and Debris Management

Tingad village has been observed to have multiple scarps, two of which have caused damage to the settlement area. To protect the village, it is recommended to install debris barriers at various elevations. Additionally, flow paths for debris should be channelized to direct potential landslide material away from populated areas.

4. Landslide and Subsidence Risk Management

The area surrounding Toli and Tingad villages is prone to landslides and subsidence. It is essential to conduct mass awareness campaigns and prepare the local population for potential emergencies. Training on evacuation and safety measures should be provided to minimize risks.

5. Early Warning System and Evacuation Planning

An early warning system should be installed in the area to trigger alarms during periods of soil oversaturation and heavy rainfall. This system should be coupled with a comprehensive evacuation plan to ensure the safety of the residents.

Additional Recommendations for Kot and Village

The Kot village located to the west of Toli village, has recently developed three new scarps. This area has a history of landslide-related fatalities, with three deaths recorded during 2018 and collapsed of several houses. The new scarps indicate that the area is under significant stress and requires immediate attention. In addition to this, area around Bhikun village is also showing earlier sign of instability in form of road cracks, subsidence and developement of new scarps and require attention. Mitigation measures including landslide prevention strategies along with early warning system should be implemented promptly to ensure the safety of the residents at critical sites.

Three news scarps developed at Kot village, located west of Toli village

Cracks on roads near Bhigun village

CONCLUSIONS :

Mitigation measures for debris flow involve a combination of structural and non-structural strategies aimed at reducing the risk and impact of such events. Structurally, the construction of debris barriers, check dams, and retention basins can effectively control and slow down the movement of debris, preventing it from reaching vulnerable areas. Slope stabilization techniques, such as the installation of retaining walls, soil nailing, and bioengineering practices, can help reinforce slopes and reduce the likelihood of debris flow initiation. Additionally, proper drainage systems must be designed to manage surface water and reduce soil saturation, which is a key trigger for debris flow. Non-structural measures include effective land-use planning, where development in high-risk zones is restricted, and the implementation of early warning systems that can alert communities to impending debris flows, allowing for timely evacuations. Public education and community preparedness are also essential, ensuring that residents understand the risks and know how to respond in the event of a debris flow. Regular monitoring of high-risk areas, coupled with prompt maintenance of existing mitigation structures, is crucial for long-term risk reduction.

Tanvika Sankar
Geologist, USDMA

Prem Singh Negi
AE ULMMC

Dr Rachita Tandon
(Senior Geologist)
ULMMC