Himachal Pradesh State Disaster Management Authority

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District Disaster Management Authority, Mandi

Suggestion on Short- and Long-term Mitigation Measures for Landslide and Land Subsidence Sites for <u>Mandi District</u>

Submitted by

Indian Institute of Technology

Mandi, Himachal Pradesh

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Chapter-1

Introduction

1.1 Background

The massive increase in urbanisation in many of these mountainous locations and its rising impact on socio-economic aspects has drawn worldwide attention to landslide studies. The triggers of the landslides in the Indian Himalayan region are attributed to natural (earthquakes and rainfall) and anthropogenic (slope cuts, deforestation, blasting) reasons. The geological landscape of Himachal Pradesh, situated in the Western Himalayas between latitudes 30°22'40" N to 33°12'40" N and longitudes 75°45'55" E to 79°04'20" E, encompasses a rich tapestry of diverse formations and dynamic processes reflective of ancient tectonic events and ongoing geological transformations. A complex interplay of rock types and tectonic boundaries characterizes the state's topography. The Lesser Himalayas dominate the southern part, composed mainly of sedimentary rocks such as shale, sandstone, and limestone, bearing witness to intense tectonic forces resulting from the collision between the Indian and Eurasian plates. Moving northwards, the Middle Himalayas unfold, revealing a mixture of sedimentary and metamorphic rocks, including slates, schists, and quartzite, indicative of regional metamorphism. The Greater Himalayas influence the northernmost regions, boasting high-grade metamorphic rocks like gneiss and schist, narrating the profound geological transformations during the Himalayan orogeny. Key tectonic features such as the Main Boundary Thrust (MBT) and the Main Central Thrust (MCT) delineate the geological landscape, symbolizing significant fault lines where seismic activity is notable. Glacial features further shape the landscape with U-shaped valleys, cirques, and moraines, while rivers and glaciers compose the intricate drainage system crisscrossing the mountain chain. However, amidst this geological splendour lies a pressing concern: the vulnerability of Himachal Pradesh to landslides, exacerbated by its geologically young and unstable slopes coupled with human activities like deforestation, road construction, and changes in agricultural practices. This report endeavours to comprehensively examine the multifaceted aspects of landslides in the Mandi district of Himachal Pradesh. Kangra bounds the district in the northwest, Kullu district in the East, Shimla and Solan in the south and southwest, respectively, and Bilaspur & Hamirpur in the southwest. The total geographical area of Mandi is around 3950 sq. km, consisting of 7.10% of the total area of Himachal Pradesh.

1.2 Geology of Mandi

Mandi comprises numerous geomorphological features like the intermontane valley, river terraces, alluvial flood plains, scraped slopes along the hills, etc. The general slope of the hills in Mandi belongs to the lesser Himalayan sequence. The rocks in this district range from the Precambrian to Quaternary period, with the lower Siwalik range being more prominent. The area comprises Lower Siwaliks, Sundarnagar Formation, Kullu member, Volcanic intrusion of different ages, Shali Formation, Kasauli Formation, Alluvium, and recent deposits. Western and southern parts of the district comprise sandstone, shale, siltstones, and conglomerates of

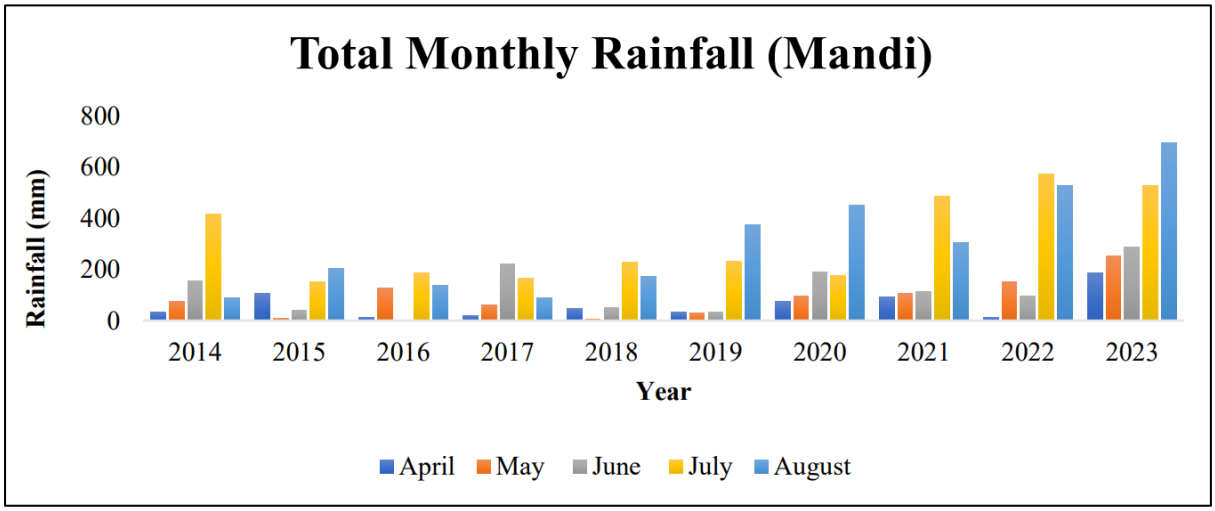
the Siwalik group of tertiary age. The Sundernagar Group comprised purple-coloured arenaceous sediments dominantly with argillites.

1.3 Rainfall Trend Analysis in Mandi

To supplement the view of heavy precipitation during 2023, the rainfall analysis for the district of Mandi was carried out using the available IMD data from 2014-2023 from April to August each year. Based on the analysis carried out, the following inferences were made:

- A large variation was recorded in the summer precipitation during 2014- 2023, i.e. in April 2023, the rainfall recorded was higher in 2023 than in the preceding years. In April 2014 (33.00mm), whereas in 2023, it increased to 185.20 mm at Mandi.
- Likewise, in May 2014, the rainfall recorded at Mandi was 76.50 mm (2014), whereas in 2023 (253.80 mm) with a few variations, i.e. 2021(104.80 mm) and 2022(150.80 mm) respectively.
- In June, the rainfall recorded at Mandi varies from 155.50 mm (2014) to 286.80 mm (2023), with high rainfall during 2017 (220.50),2020 (190.70),2021 (112.30), respectively, and the variation is mainly due to arrival of monsoon which generally arrives Himachal in June.
- July is the peak monsoon month, and the rainfall varies from 414.60 mm (2014) to 528.70 mm (2023), with comparatively more rainfall in 2022 (571.80 mm) than in 2023.
- In other words, we can say that during 2023, the rainfall was higher even in the state's summer months in April & May and at these stations with very high rainfall during peak monsoon months, i.e., July and August.
- On the other hand, it is also seen that the large number of rainy days in August have been reduced in 2023, and the rainfall has increased, indicating heavy spells during 2023.

Rainfall Mandi (Monthly Rainfall)										
Year	**No. of Rainy Days**	**Total Monthly Rainfall**	**No. of Rainy Days**	**Total Monthly Rainfall**	**No. of Rainy Days**	**Total Monthly Rainfall**	**No. of Rainy Days**	**Total Monthly Rainfall**	**No. of Rainy Days**	**Total Monthly Rainfall**
	April)	**(April)**	**(May)**	**(May)**	**(June)**	**(June)**	**(July)**	**(July)**	**(August)**	**August)**
2014	4	33	8	76.5	10	155.4	21	414.6	10	89.6
2015	8	105.1	1	9.4	9	41.6	12	150	15	204.4
2016	2	11.9	7	127	0	0	12	185.7	10	138.9
2017	2	20.2	4	60.4	9	220.5	12	164.8	9	87.3
2018	3	47.1	1	6.2	3	51.6	14	229.6	11	173.4
2019	4	32.6	3	28.5	5	33.6	18	232.3	20	372.6
2020	8	73.9	9	97.5	16	190.7	13	176.5	19	451
2021	5	93.6	12	104.8	13	112.3	23	485.8	22	305.4
2022	5	13.2	18	150.8	9	96.4	24	571.8	20	525.4
2023	14	185.2	18	253.8	15	286.8	27	528.7	17	693.7



Rainfall trend in Mandi (2014- 2023).

As per the discussion with the DDMA team of Mandi district, 10 sites have been communicated for the suggestion of landslide mitigation measures. Dr K V Uday, Dr Ashutosh and Dr Prasanna, alongside their students, are involved from IIT Mandi for the current analysis and recommendations for the site. As per the sites and the contacts of the concerned engineers at the site, IIT Mandi team have visited each of the site. The details have been collected from discussion from engineering team and locals, resorted to information from the resources, published reports and an engineering justification have been arrived. Based on the site details, relevant expertise and experience, engineering judgement, the suggestions for mitigating landslides have been arrived at. The report presents the site photographs, fewer details of information gathered, and suggestions for landslide mitigation. To the end, a summary of recommendations for mitigation along with levels of hazard, current risk and scope of mitigation have been tabulated for quick reference. The preface states that the recommendations presented in the report are for representative purposes; the final choice shall be based on the rigorous exploration, investigation and analysis details.

Chapter-2

Geotechnical Assessment of Damages

2.1 General

This report presents the outcomes of a comprehensive geotechnical assessment conducted in Mandi district, Himachal Pradesh, following unprecedented monsoon rainfall. Various site visits were conducted, primarily focusing on identifying and recording the damages caused by geotechnical issues such as landslides, debris flows, toe erosion, subsidence, etc., on infrastructure, including residences, commercial establishments, bridges, and roads. The purpose of this report is to document the extent of the damage and provide suitable recommendations. The findings emphasize the need to promptly address immediate concerns and implement long-term solutions to prevent future damages.

2.2 Information Received

The unprecedented torrential rainfall and cloud bursts experienced by the state in this monsoon season, especially in July and August 2023, have led to severe landslides and settlements in the Mandi district. Observations indicate that various regions in Mandi district undergo slow rotational failure and toe erosion, resulting in settlement in numerous areas downhill. Consequently, buildings near the landslide area have suffered complete or partial damage. Subsidence has also been observed. Many buildings above the roadside, displaying cracks, pose a significant threat to commuters and must be dismantled. During our site visit, we engaged in insightful conversations with locals, during which they shared their concerns and hardships.

2.3 Observations

The following observations are made from the rapid visual-based screening:

2.3.1 Sub-Division: Sundernagar

Site 1: Rela

High risk – Evacuation needed

1. The locals reported a mini cloud burst (sudden heavy downpour of rain) during the rainfall event of 14 August 2023 at the starting point of the development of the cracks. A lateral displacement of around 20 cm was observed in buildings due to the subsidence from heavy water flowing through the slope.

Cracks developed in houses.

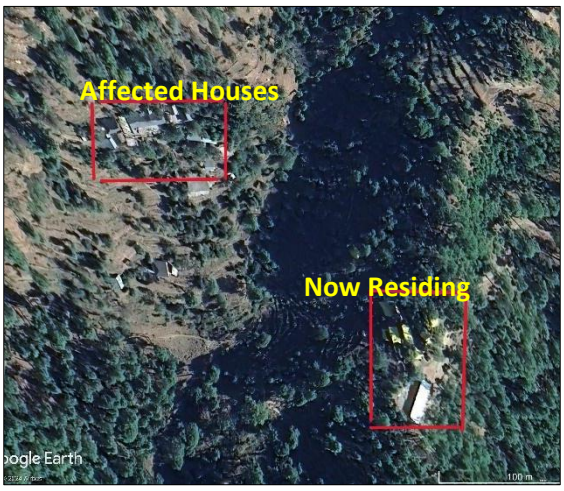
2. A lateral shift of 30 cm was observed in a local path. Around 35 cm of settlement was observed in the fields due to the lack of a proper drainage system, resulting in large amounts of water seepage and reduced slope stability.

Road displacement due to settlement.

3. Around 14 families are displaced due to the development of large cracks of around 9 cm in their houses, which are now unsafe to reside in. According to locals, these cracks developed within two to three days after the mini-cloud burst.

Large cracks developed on walls of houses.

4. The families affected currently reside in tents on the nearby hill, while their cattle are housed in a communal shed, which again appears to pose risks to the families and their livestock.



Temporary accommodations provided to affected families.

Suggestions:

- The area should be evacuated as landslides are likely in the next rainfall events.
- Provisions for drainage should be made to reduce water infiltration in huge tension cracks developed at the site.
- Proper dwelling structures should be provided to the displaced families.

Site 2: Nihri

Low risk

1. At Nihri, cracks were developed in a building under construction, accompanied by a lateral displacement of approximately 9 to 10 cm due to settlement.

Cracks developed on the wall of building under construction.

Displacement of building under construction.

2. A building showed a settlement of approximately 10 to 15 cm, while extensive cracks were observed in nearby fields and roads.
3. During the inspection, it was noted that there was inadequate road infrastructure to access these areas. A local unpaved road served as the primary means of transportation, with construction starting two years ago and remaining unfinished.

Settlement in house.

Cracks developed due to settlement in field.

Suggestions

- Provisions for drainage should be made to reduce water infiltration in huge tension cracks developed at the site.

2.3.2 Sub-Division: Balichowki

Site 1: Jalanal

High risk - Immediate action needed

A landslide spanning approximately 50 meters occurred at the site under consideration. Notably, near the landslide area, there was ongoing tunnel construction. Additionally, a national highway road was in existence near the site.

1. In July, the soil exhibited a state of increased porosity, characterised by a lack of visible cracks. However, in August, the occurrence of water seepage occurred, consequently leading to a landslide event.

2. The road infrastructure had visible cracks and instances of settlement. The road segment proximal to the river is susceptible to potential hazards, necessitating foundational measures to mitigate risks and ensure structural stability.

3. Residents have reported that the implementation of tunnel blasting and bolting procedures has resulted in the development of structural cracks in nearby buildings.

4. Significant tension cracks of length, ranging from 2 m to 5 m, were noted, with varying widths of cracks 5 cm, 10 cm, 15 cm, 20 cm, etc.

Landslide at Site 1.

5. The landslide initiation was attributed to the combined effects of rock bolting activities and tunnel construction, leading to the downward displacement of soil mass during the rainy season.

Cracks are seen on the road at the site.

6. A stream close to the site is presently devoid of water, indicating its current dry state.

7. The settlement exhibited a considerable depth, reaching 5 to 10 meters at a specific location.

8. Upon the occurrence of the landslide, the government facilitated the relocation of affected individuals to nearby areas where they continue to reside. However, aside from the resettlement efforts, the government has provided no additional financial assistance or specific schemes.

Cracks in residential buildings above landslide at site 1.

Suggestions

- Implement erosion control measures to minimise the impact of rainfall on soil stability and reduce the likelihood of future landslides.

- Design and construct retaining structures to stabilize the slope and prevent further soil displacement.

- Assess the impact of previous rock bolting activities on slope stability. If necessary, reinforce or modify the existing rock bolting system to ensure it does not contribute to further instability.

Site 2: Thalaut

Moderate risk - Early warning measures

1. At this site, a landslide spanning a length of 250 m occurred during August. Adjacent to the landslide site was a residential area comprising around 35 houses. While the

landslide did not directly impact this residential area, the residents were made to evacuate their homes during periods of heavy rainfall to ensure their safety.

2. Observations at the landslide site revealed the presence of large boulders, with one notable boulder measuring 5.2 meters in length and 2 meters in width.

Landslide at site 2 (left view).

Landslide at site 2 (right view).

3. A retaining wall, installed five years ago, was identified at the site. Unfortunately, the retaining wall has exhibited signs of deterioration, marked by numerous cracks. Notably, one of these cracks stands out with a width measuring 14 centimetres.

4. The observation revealed that certain weep holes in the retaining wall were clogged.

5. Propagating cracks may be seen at the top of the hill, with a slope of between 50 and 60 degrees.

6. Wire netting has been employed in specific sections of the landslide-affected area.

A big boulder at site 2.

Clogging of weep holes.

Cracks in retaining wall.

Suggestions

- The fallen debris should be removed to ensure the functionality and safety of the existing road infrastructure.
- The retaining structures should be provided at the site with proper filters to avoid clogging of weep holes.
- To address the issues, a comprehensive restoration plan should be implemented.

2.3.3 Sub-Division: Sadar

Site 1: Deori

Low risk

1. There were cloudburst events at the site on August 14th and 23rd of August. However, the second cloudburst proved more severe, resulting in greater damage.
2. There is no evidence of a landslide; the incurred damage is attributed solely to the cloudburst.
3. At the site, a total of 10 buildings were constructed. Three buildings suffered complete damage (including a Govt. School), while five sustained partial damage. The government has pledged compensation of up to 7 lakhs for each fully damaged building to address the impact.

4. Upon exploring the site, it became evident that a stream was meandering through the landscape.

5. In response to the damage, residents whose houses were affected relocated to their old homes nearby, where they continue to reside till date.

Cloudburst site.

Damaged Govt. School Building.

Damaged residential building.

Suggestions

- Proper channelization of drains should be done to direct the water flow in a controlled manner. This process aims to optimize drainage efficiency, minimize erosion risk, and prevent flooding.

- The construction of diversion structures (like culverts), with due consideration given to their appropriate sizing, is essential, particularly in light of the historical occurrences of debris flows in the area.

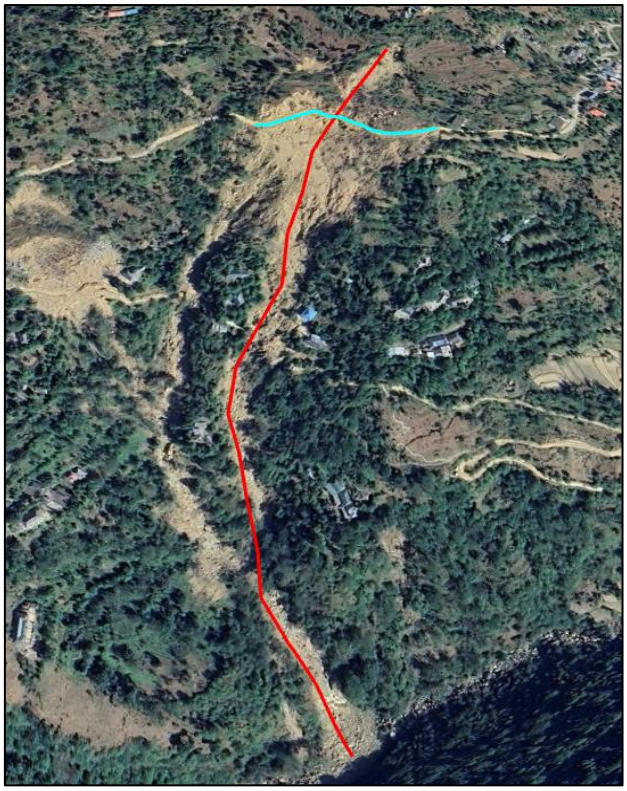
2.3.4 Sub-Division: Sarkaghat

Site 1: Jawali

High risk - Immediate action needed

1. A significant landslide occurred in the Jawali region of Sarkaghat Mandi on August 12, 2023, resulting in substantial damage to the local infrastructure and displacement of several families.

2. The landslide had a width of approximately 200 meters and extended over 680 meters.



Aerial extent of landslide.

3. Jawali is characterized by complex geological formations, including steep slopes and varying rock types. The presence of these geological features contributes to the susceptibility of the area to landslides.

4. The landslide altered the topography of the affected area significantly. Vegetation in the path of the landslide was uprooted and displaced.

5. 13 houses were completely damaged, and many suffered partial damage due to the landslide.

Completely damaged households.

6. The incident led to the displacement of 270 individuals, affecting 55 families. The displaced individuals have been relocated, and ongoing efforts are being made to

provide them with necessary support. In addition to monetary compensation from the government, some temporary structures were provided by a Delhi-based NGO.

Temporary dwelling structure provided by a Delhi based NGO.

7. Massive boulders, with diameters reaching up to 12 feet, were a notable feature of the landslide. Such huge boulders further escalated the damage in the area.

Huge boulders.

8. The temporary road connectivity was restored nearly four months after the incident, on December 18, 2023, facilitating access to the affected area. However, the temporary road will be affected again in the next monsoon season.

The temporary road restored in December 2023.

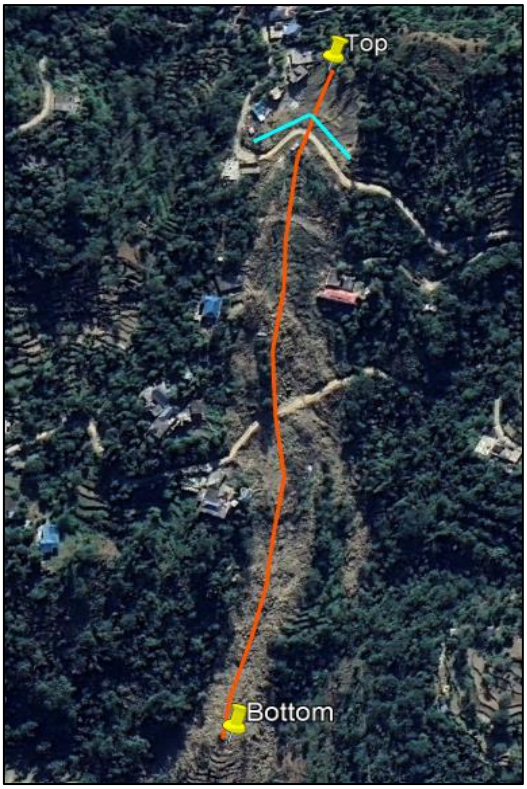
Suggestions

- To address the issues, a comprehensive restoration plan should be implemented.
- The restoration project should adhere strictly to engineering specifications and standards.
- Construction activities, if any, should be avoided on such fragile and vulnerable slopes.
- Proper monitoring of subsidence should be done to avert potential catastrophic events.

Site 2: Jamal Galu

Moderate risk - Evacuation and road restoration

1. A significant landslide occurred in the Jamal Galu region of Sarkaghat Mandi on August 12, 2023, resulting in substantial damage to the local infrastructure and displacement of several families.
2. The landslide exhibited a width of approximately 80 meters. It extended over an area of 500 meters.



Aerial extent of landslide.

3. The landslide caused significant damage, destroying five houses, one temple, one water tank, and 15 cow sheds. This indicates the force and impact of the landslide, raising concerns about the vulnerability of structures in similar topographical and future rainfall conditions.

Complete failure of house.

Fully damaged house.

4. The earlier road infrastructure was displaced by 60 meters downward due to the landslide. In response to the incident, a temporary road has been constructed to restore connectivity to the affected area.

Displaced road.

5. Notably, numerous cracks were identified in the walls of buildings, serving as a clear indication of the structural stress imposed by the landslide. These observations underscore the need for thorough structural assessments to evaluate the extent of damage and prioritize remediation efforts to ensure the safety of the affected community.

Cracks were observed in the walls of partially damaged structures.

6. The landslide incident in Jamal Galu resulted in the displacement of several buildings, profoundly altering the landscape of the affected area. The force and extent of the mass movement led to the complete dislodgment of structures from their original positions.

Displaced part (kitchen) of building 1.

Suggestions

- The site necessitates clearance, entailing the removal of construction debris and building remnants.
- To address the issues, a comprehensive road restoration plan should be implemented.
- The restoration project should adhere strictly to engineering specifications and standards to guarantee the longevity and durability of the repaired road.
- Regular monitoring and maintenance after the restoration should also be implemented to promptly address any emerging concerns and uphold the road's structural integrity over time.

Site 3: Maseeran

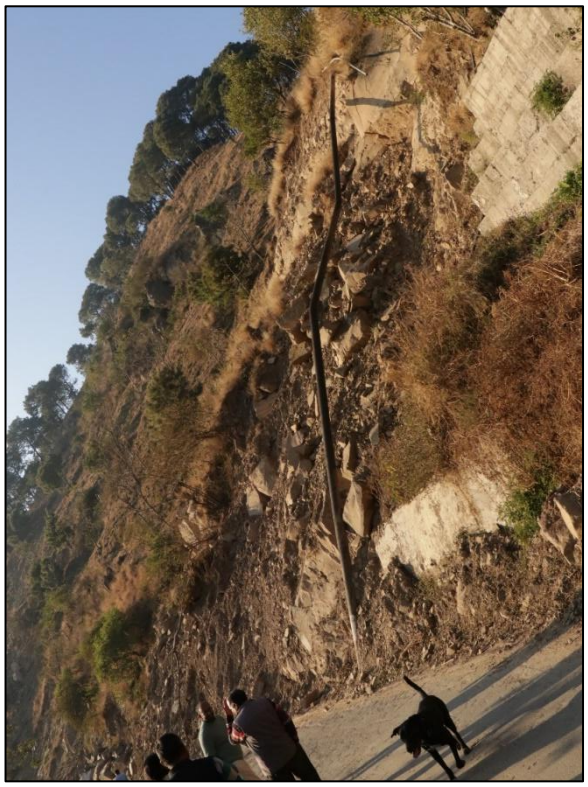
Low risk

1. A significant landslide occurred in the Maseeran region of Sarkaghat Mandi in August 2023; however, a similar small landslide was observed during rains in July 2023.
2. The landslide exhibited a width of approximately 40 meters.

Landslide site above road.

Landslide site below road.

3. Significant structural damages were not evident. However, the incident did damage a water pipe, indicating the potential for infrastructure vulnerabilities even in comparatively gradual landslide events.



Damaged water pipe.

4. During the assessment, partial damage was reported in a few houses situated on the downslope side of the landslide. The structural compromise prompted residents to evacuate their homes, highlighting the immediate impact on the community. While the damages were not extensive, the evacuation underscores the potential dangers of such landslides.

A few partially damaged houses are situated on the downslope side of the landslide.

Suggestions

- The construction of a proper retaining wall along the affected road segment is imperative. The retaining wall will provide lateral support, preventing further erosion and subsidence.

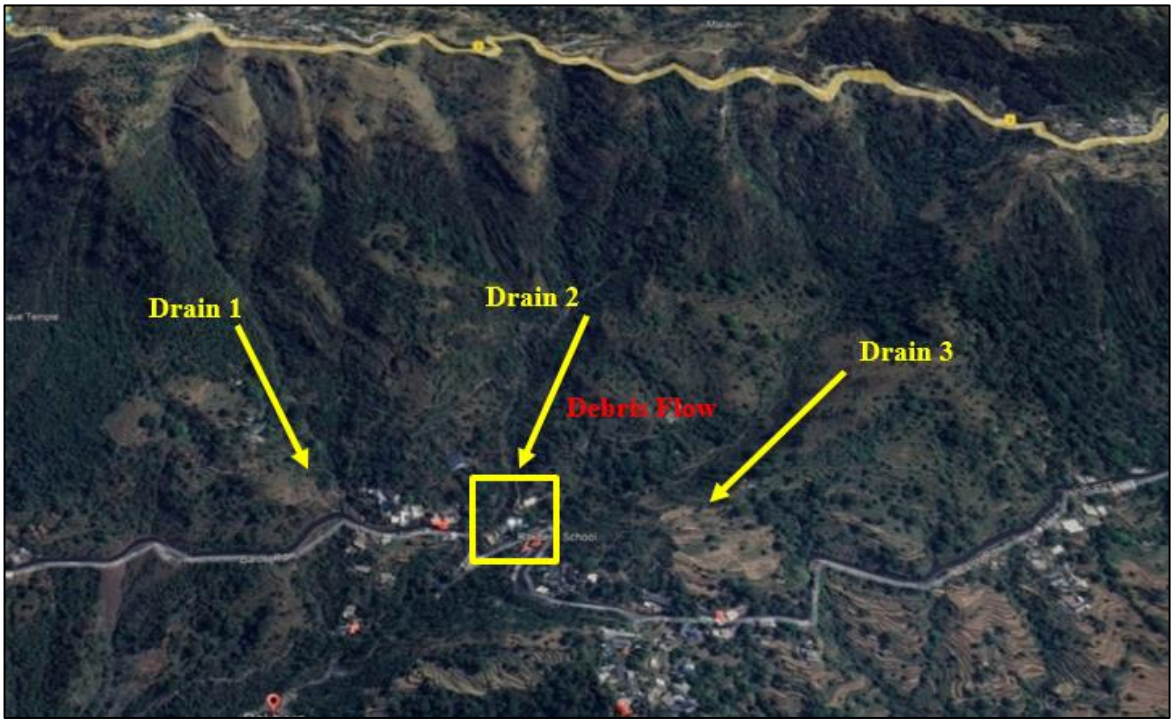
2.3.5 Sub-Division: Dharampur

Site 1: Rakhera

Low risk

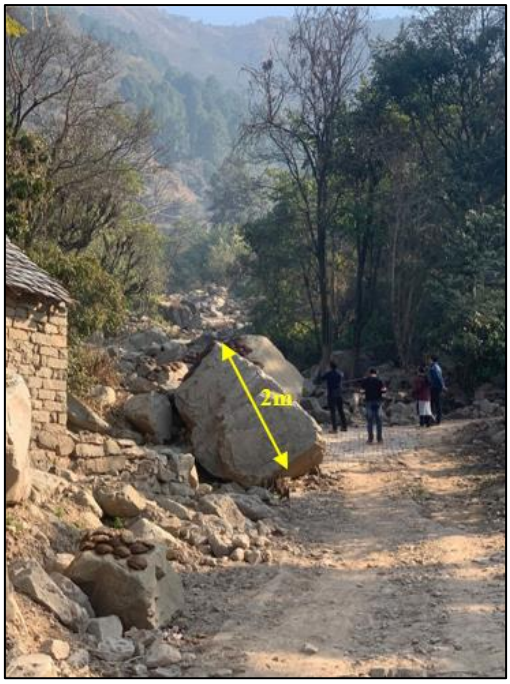
The following observations are made from the rapid visual-based screening.

1. The catchment of the Rakhera consists of 3 drains converging on the downstream side. Due to excessive precipitation on 14 August 2023, subsequent debris mobilized through drain 2, affecting an area spanning approximately 1.5 to 2 km.



Catchment of Rakhera.

2. Debris consisted of large boulders (approx. 2m), rocks, and a significant amount of fines, causing damage to local roads and houses.



Huge boulders at site.

3. Minor debris was observed through drains 1 and 3. Entrainment characteristics observed in debris flow have caused damage to the surrounding area.

Damage due to Debris flow.

4. During the inspection, it was observed that the culvert constructed for water flow through drain 3 was smaller, which can impact its ability to manage debris entrainment effectively.

Suggestions

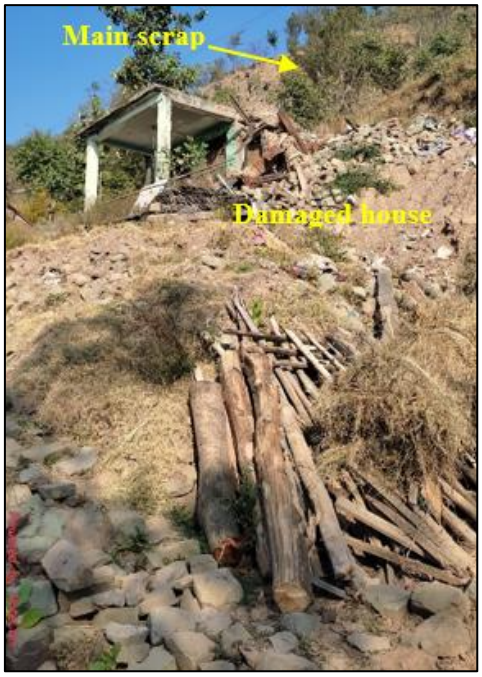
- Landslide hazard mapping is crucial to identify the high-risk areas.
- Proper maintenance and channelization of drains.

- Constructing culverts with appropriate sizing is essential, considering the history of debris flows in the area.

Site 2: Langehar

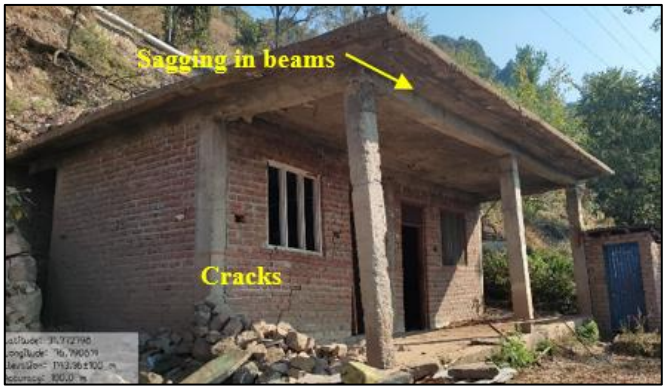
Low risk

1. At this site, landslides and subsidence occurred in August during heavy rainfall. The main scrap of the landslide was observed above the damaged houses.



Damaged houses.

2. Among 5 houses, some are partially damaged, and the residents still live there. One house under construction had developed cracks and sagging in the beams.



Damage in building under construction.

Settlement observed at site.

3. One of the residents mentioned improper soil filling was done before the construction of the house, and heavy rainfall exacerbated the situation by washing away the soil fill, leading to severe damage to the house.

Partially damaged house.

Suggestions

- Restrict construction on unstable slopes.
- Enforce strict adherence to building codes and regulations.
- Raise community awareness, develop emergency preparedness plans and educate residents to recognize warning signs of instability.

2.3.6 Sub-Division: Thunag

Site 1: Thunag

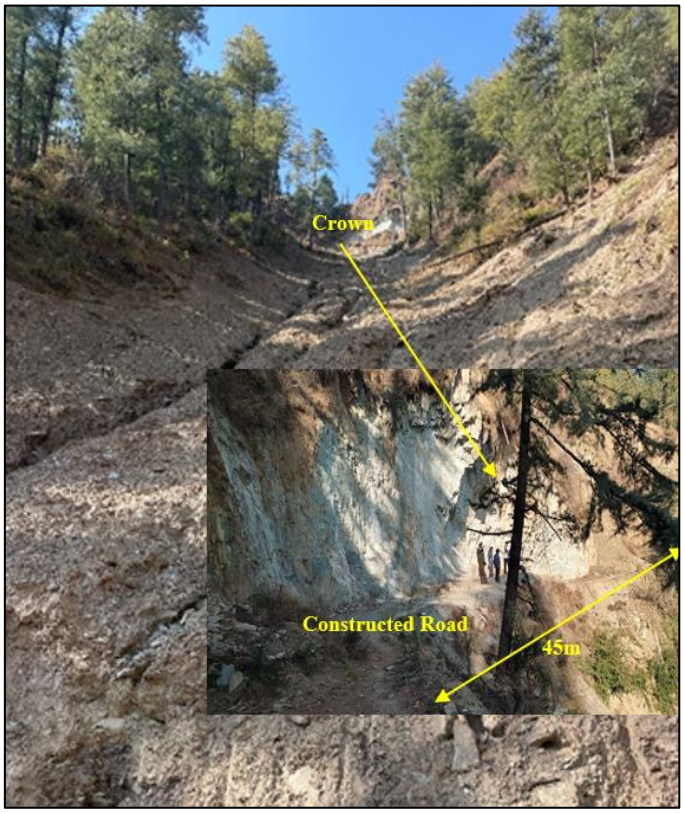
Moderate risk: Early warning measures

1. Thunag was flooded with hundreds of wood logs and mudslides on July 09, 2023, due to which numerous downhill areas experienced substantial damages, including houses, roads, and 60 shops in the main market.

2. The massive mudslide that flooded the entire market was choked with wood logs and debris from local road construction in 2020 at the crown of the landslide employing ballasting.

3. The soil excavated during the road-cutting process was dumped downstream directly. Subsequently, rainfall lasting consistently for 72 hours, along with damage in underground water supply pipes (3 inches) near the crown (45m long), caused this loose soil deposit to displace along with slope failure that caused massive debris flow.

4. Slates, weak strata emphasized by steeper slopes, comprise the region's geology, making it more susceptible to slope failures.



Crown of landslide.

Debris flow through hill.

Weak strata.

5. The debris flow unfolded in four stages:

- Initially, a minor landslide occurs and dislodged material accumulates at an elevated point (crown).
- Subsequently, persistent and intense rain causes debris accumulation, including trees and underlying soil, to initiate downstream flow and become obstructed at intermediate points.
- This sequence repeats in the third and fourth stages, culminating in a substantial volume of accumulated debris flowing into the main market after the fourth stage. 2-3 buildings were completely swept away along with debris, and some buildings, including shops, were partially damaged in the local market.

Damages houses in the main market due to debris flow.

Suggestions

- Implement strict land-use regulations in the affected area to restrict construction on unstable slopes and ensure proper drainage systems for new development.
- It is strongly advised to implement a plan to prevent the illegal chopping of trees.
- Provision of proper dumping sites for muck generated from constructing roads or tunnels.
- A temporary early warning system (EWS) using rainfall gauges and ground movement sensors can be implemented to alert residents of potential landslides before they occur.

Summary

The report presents a well-rounded set of short- and long-term measures to address the risks at hand and ensure continued stability effectively. The short-term actions detailed in the report include evacuation, drainage provisions, dwelling structures, erosion control, and debris removal. Meanwhile, the long-term strategies focus on comprehensive restoration plans, retaining walls, adherence to engineering standards, landslide hazard mapping, community awareness, and land-use regulations. The report underscores the importance of taking a holistic approach, combining engineering solutions, community involvement, and environmental conservation to effectively mitigate the impact of landslides and ensure the long-term resilience of the affected area.

Short-Term Measures

1. Evacuation of the area due to imminent landslide risks in upcoming rainfall events.

2. Provision of drainage systems to minimize water infiltration into tension cracks.

3. Proper dwelling structures for displaced families.

4. Immediate implementation of erosion control measures.

5. Removal of fallen debris to ensure road infrastructure functionality and safety.

6. Assessment and potential modification of existing rock bolting system.

7. Construction of retaining structures for slope stabilisation.

8. Channelization of drains to control water flow and prevent flooding.

9. Clearing and removal of construction debris and building remnants.

10. Proper monitoring of subsidence to avert potential catastrophic events.

Long-Term Measures

1. Comprehensive restoration plan addressing various issues.

2. Design and construction of retaining walls along vulnerable road segments.

3. Strict adherence to engineering specifications and standards in restoration projects.

4. Avoidance of construction on fragile and vulnerable slopes.

5. Landslide hazard mapping to identify high-risk areas.

6. Enforced adherence to building codes and regulations.

7. Community awareness, emergency preparedness plans, and resident education on recognizing instability warning signs.

8. Strict land-use regulations in affected areas, restricting construction on unstable slopes.

9. Prevention of illegal tree chopping through the implementation of a plan.

10. Provision of proper dumping sites for construction-generated muck.

11. Implement an early warning system (EWS) using rainfall gauges and ground movement sensors at medium-risk locations and temporarily at high-risk locations.

Declaration

To effectively mitigate the risks of landslides, it is crucial to take immediate steps such as evacuation, emergency drainage, and providing temporary shelters. To ensure long-term safety, strict adherence to engineering standards, community awareness, and land-use regulations is necessary. Following these measures will help to address immediate risks while promoting sustained stability in the affected area. Prioritising safety by creating evacuation plans before initiating landslide mitigation efforts is important. Technical assessments must be carried out and engineering standards strictly followed to establish a comprehensive long-term strategy. Additionally, community awareness must be considered, land-use regulations enforced, and environmental conservation fostered. This holistic approach will maximise effectiveness and promote sustained stability in the vulnerable area.

Table 1: Summary of site conditions, recommendations for each site

Sub-division	Site	Hazard	Risk	Suggestions
Sundernagar	Rela	Moderate	High	Evacuation
	Nihri	Low	Low	
Balichowki	Jalanal	High	High	Immediate action
	Thalaut	Moderate	Moderate	Early warning measures
Sadar	Deori	Low	Low	
Sarkaghat	Jawali	High	High	Immediate action
	Jaman Galu	Moderate	Moderate	Evacuation, road restoration
	Maseeran	Low	Low	
Dharampur	Rakhera	Low	Low	
	Langehar	Low	Low	
Thunag	Thunag	Moderate	Moderate	Early warning measures